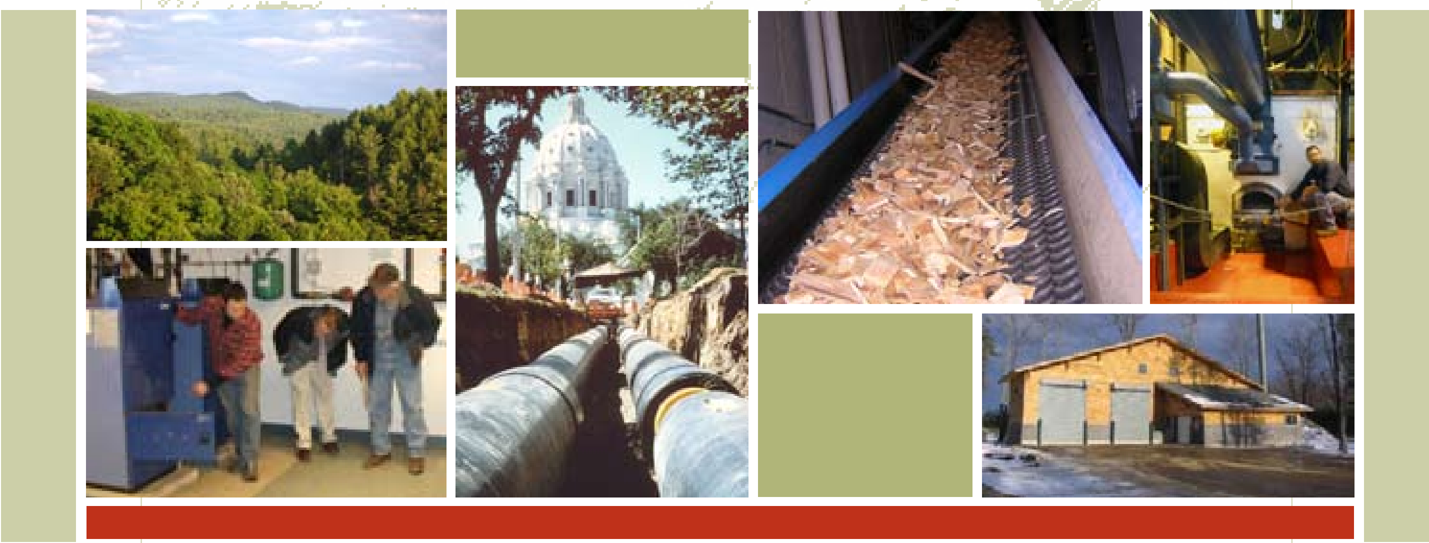
Community Roadmap to Renewable Woody Biomass Energy



A STEP-BY-STEP DECISION-MAKING TOOL FOR NEW HAMPSHIRE COMMUNITIES

The *Community Roadmap to Renewable Woody Biomass Energy: A Step-by-Step Decision-Making Tool for New Hampshire Communities* was commissioned by the North Country Resource Conservation and Development (RC&D) Area Council and its partners, Plymouth State University, the Coos County Economic Development Corporation, the Northern Forest Center, the Bethlehem Energy Committee, and the UNH Cooperative Extension.

This project received principal financial support from the NH Greenhouse Gas Emissions Reduction Fund, administered by the NH Public Utilities Commission. Additional funding was provided by the US Department of Energy through the support of Senator Patrick Leahy and the Biomass Energy Resource Center.

Members of the project committee that volunteered their time and resources to make this happen include: Russ Dowd, North Country Resource Conservation and Development Area Council; Thaddeus Guldbrandsen, Center for Rural Partnerships, Plymouth State University; Peter Riviere, Coos County Economic Development Corporation; Allison Grappone, Northern Forest Center; Sarah Smith, UNH Cooperative Extension; David Auger, Resident of Groveton, NH; David Van Houten, Bethlehem, NH Energy Committee.

The committee was assisted by Tom Evans, Graduate Student, Plymouth State University and Rick DeMark, USDA Coordinator of the North Country RC&D Area. For more information about North Country RC&D and the network of RC&D Councils located around the country, go to www.nhrcd.net; (603) 527-2093. We would also like to thank the following individuals who participated in a focus group to help us refine this workbook: Dorn Cox, Lee, NH; Laurel Cox, Lee, NH; Dick Harris, Colebrook, NH; Michael Kowalski, Barnstead, NH; Kevin McKinnon, Colebrook, NH; Ian Raymond, Sanbornton, NH; Alan Rossetto, Lancaster, NH; and Mark Saltsman, Concord, NH.

Yellow Wood Associates, Inc. and the Biomass Energy Resource Center were contracted by the committee to create the *Roadmap*.

Yellow Wood Associates, Inc., is a woman-owned consulting firm located in St. Albans, Vermont, and has been providing services in natural resource-based rural community economic development since 1985. Yellow Wood has extensive experience in research, planning, and economic development; feasibility studies; market analysis; and economic and fiscal impact analysis. www.yellowwood.org; (802) 524-6141.

The **Biomass Energy Resource Center (BERC)** is an independent, national nonprofit organization that assists communities, colleges and universities, state and local governments, businesses, utilities, schools, and others in making the most of their local energy resources. BERC's mission is to achieve a healthier environment, strengthen local economies, and increase energy security across the United States through the development of sustainable biomass energy systems at the community scale. www.biomasscenter.org; (802) 223-7770.

This Roadmap was produced by Yellow Wood Associates and the Biomass Energy Resource Center for the North Country RC&D.

Welcome to the

Community Roadmap to Renewable Woody Biomass Energy

A Step-by-Step Decision-Making Tool for New Hampshire Communities

Why a "Roadmap"? In 2008, a group of over 40 individuals representing communities, organizations, and public agencies throughout New Hampshire started to meet to explore how and why energy from wood biomass could be expanded in New Hampshire for heat, cooling, and power generation. This was in response to a series of workshops and tours at successful institutional-scale wood biomass heated facilities around New Hampshire, the completion of several wood biomass heat conversion feasibility studies at NH schools, a university campus, two county administrative complexes, a state government building, and a community-scale wood biomass district heating system in Groveton, New Hampshire.

One of the first ideas to surface was the need for a user-friendly decision-making tool that could help lead a community or group through the myriad of important issues and decisions that are involved in pursuing a wood biomass energy project, from a single building to an entire community district. From there, the idea for this workbook took shape.

The *Roadmap* is a civic decision-making tool to help New Hampshire communities through the information-gathering process required to decide whether woody biomass heating and cooling technologies applied to one or more buildings can be expected to help meet one or more community goals. This workbook was created so that communities will have the information they need and a logical process to follow to make informed decisions about the role biomass may play in their energy future.

While this *Roadmap* can be used by interested individuals, it is really designed to be used by groups such as energy or conservation committees, facilities building committees, or economic development groups working together to gather and interpret information about their community.

This project was funded by the New Hampshire Public Utilities Commission's Greenhouse Gas Emissions Reduction Fund (GHGERF), a program initiated to lower greenhouse gas emissions through energy efficiency. The GHGERF consists of proceeds from the auction of carbon allowances through New Hampshire's participation in the Regional Greenhouse Gas Initiative (RGGI), an effort by 10 Northeastern and Mid-Atlantic states to reduce emissions of greenhouse gases from the electric power sector.

We hope you find this document of value to your community.

Russ Dowd, Biomass Projects Liaison
North Country Resource Conservation & Development Area Council

September 2010

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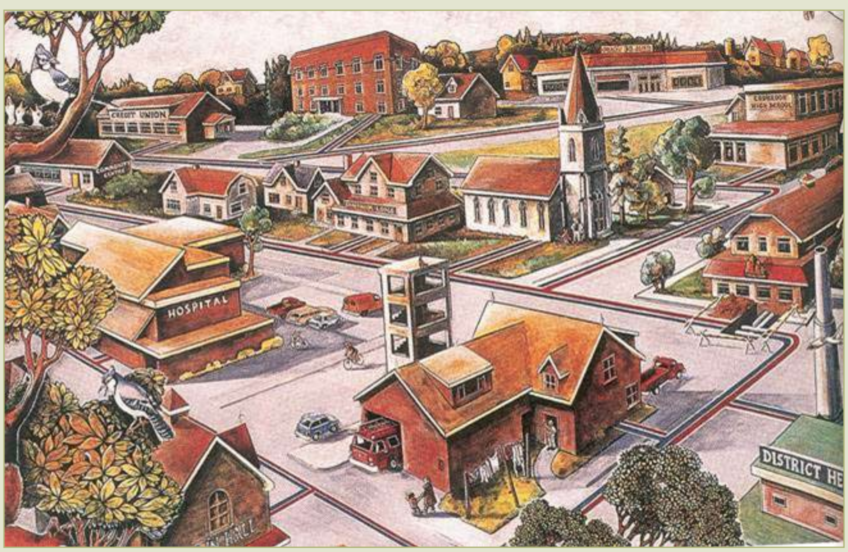

Community District Energy:

The use of a central heating plant to provide heat or combined heat and power (CHP) to multiple buildings using buried pipes to distribute the energy.

This Roadmap was produced by Yellow Wood Associates and the Biomass Energy Resource Center for the North Country RC&D.

Introduction to the *Community Biomass Roadmap*

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When you print this document, replace this and other tab-indicated pages with a tab set (purchased at any office supply store). These tabs will help to make the printed version of the document more useful.

Introduction to the Roadmap

This Roadmap was produced by Yellow Wood Associates and the Biomass Energy Resource Center for the North Country RC&D.

Introduction to the *Roadmap*

The *Community Biomass Roadmap* is a civic decision-making tool to help New Hampshire communities through the information-gathering process required to decide whether it makes sense to consider woody biomass heating.

What is the *Community Biomass Roadmap*?

This tool provides step-by-step instructions for assessing **whether a potential biomass project makes sense** and how using biomass energy might help communities achieve their energy-related goals. For the purpose of considering biomass projects, we define community as a neighborhood, municipality, industrial park, institutional buildings, or other combination of buildings that could be served by a biomass district system. This tool can be used to assess a large variety of project types including a single building, an institution like a hospital, a school campus, an industrial park, or a community district. Biomass fuels can include woodchips, wood pellets, agricultural residues, or dedicated energy crops like willow or grasses. The *Roadmap* focuses on woodchips and wood pellets only.

Along the way, the *Roadmap* will provide information regarding biomass, energy efficiency, technologies, community engagement, and other topics relevant to community decision making.

The *Roadmap* is not a substitute for a full-scale feasibility study or even a complete pre-feasibility study. Rather, it is a tool for determining whether or not it makes sense to invest in such a study.

The *Roadmap* is intentionally not a webpage, but rather a PDF that can be used electronically or printed out. This allows the tool to be used off line and by people who may not have ready access to online services.

The *Roadmap* is not intended to be used page-by-page, or all at once, instead we hope communities will work with the sections that are most useful to them—printing out pages as they go and putting them into a three-ring binder—creating their own personalized roadmap.

DISCLAIMER: The *Roadmap* is not a substitute for a feasibility study. It should not be used as the basis for implementation of a biomass system without further analysis.

Why Use the *Community Biomass Roadmap*?

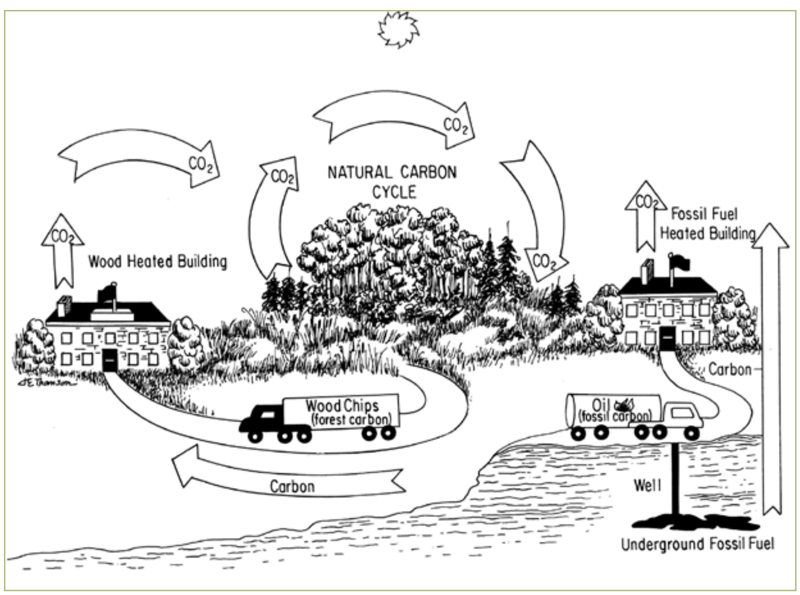
The *Roadmap* is a free tool for your community to determine if biomass heat in one or more buildings makes sense. There are two main reasons most communities consider investing in biomass heat: Money and the Environment.

Money. Low fuel cost is the main attraction of heating with biomass. Unlike fuel oil, propane, and natural gas, biomass—a proven technology used across the United States, Canada, and Europe—has a history of stable prices that are unaffected by global economics and political events.

Biomass is a locally available fuel source that can increase the region's energy independence and security while stimulating the local economy by keeping energy dollars circulating in the region rather than exporting them. Using wood also helps to support the forest products industry, creating markets and forestry and agriculture jobs in the surrounding region.

Environment. Biomass is a substitute for fossil fuels and can provide heat or heating and cooling from a renewable resource. Renewable energy is energy that comes from natural resources that are naturally replenished. It is important to remember that biomass is only considered a renewable energy source if the biomass is sustainably harvested. Other examples of renewable energy are sun, wind, water, and geothermal heat.

Carbon dioxide (CO_2) buildup in the atmosphere is a significant cause of global climate change. Fossil fuel combustion takes carbon that was locked away underground (as crude oil and gas) and transfers it to the atmosphere as CO_2. When wood is burned, however, it recycles carbon that was already in the natural carbon cycle. Consequently, the net effect of burning sustainably harvested wood fuel is that little or no new CO_2 is added to the atmosphere, and if the biomass is replacing fossil fuels, the impact on the climate is reduced.



The carbon cycle is a complex series of processes through which all of the carbon atoms in existence rotate. At right, the carbon cycling of biomass-heated buildings versus fossil fuel-heated buildings.

Fuel Cost Savings

The woodchip plant at Crotched Mountain Rehabilitation Center

Crotched Mountain Rehabilitation Center provides medical and rehabilitative services for individuals with disabilities on its 1,400-acre campus in Greenfield, New Hampshire. The center installed a woodchip heating plant in 2007. The plant heats 315,000 SF of building space, consuming approximately 3,300 tons of woodchips annually. The center saved $222,000 in fuel costs in its first season of operation (2007-2008 heating season) and more than $350,000 in the 2009-10 heating season. The center estimates more than a $2,000,000 savings in fuel costs in the system's first five years of operation.

Vermont schools have been heating with woodchips since the late 1980s. Schools report a wide range of fuel cost savings, based both on their total heating load and the amount of that heating load that they are able to meet with woodchips. The following examples represent savings near the high and low end of the range of fuel cost savings achieved by Vermont schools.

- **Spaulding High School** in Barre, Vermont installed a woodchip heating system in 2002. They provide 98% of the heat for their 220,000 SF facility with woodchips, using about 1,255 tons of woodchip fuel annually. The school saved over $173,000 in fuel cost savings during the 2008-2009 heating season..
- **Blue Mountain Union High School** in Wells River, Vermont is smaller high school, totaling 77,000 SF in area. Their biomass system burns about 400 tons of woodchips per year to provide 77% of their space heat annually. During the 2008-2009 heating season, the school saved just under $20,000 in fuel costs.

The relationship between fuel cost savings and total project savings depends on many factors including the project's financial structure, debt load, and other operating costs. These examples are included for illustrative purposes only and in no way should be used to predict the fuel cost or total project savings for projects of similar size.

For additional case studies on successful biomass projects, visit **www.biomasscenter.org/resources/case-studies.html**

Who Should Use the *Roadmap*?

The *Roadmap* is intended to be used by citizen groups and is designed to be used by a wide range of individuals and communities.

This might include a local energy committee, a school board, a developer, a municipal planning office, or anyone that is interested in assessing the viability of biomass energy in their community. While it is possible for one person to complete the *Roadmap,* it makes more sense to have a group of people working together to gather information and it will be a more effective tool if the affected community is engaged in the process.

How to Use this *Roadmap*

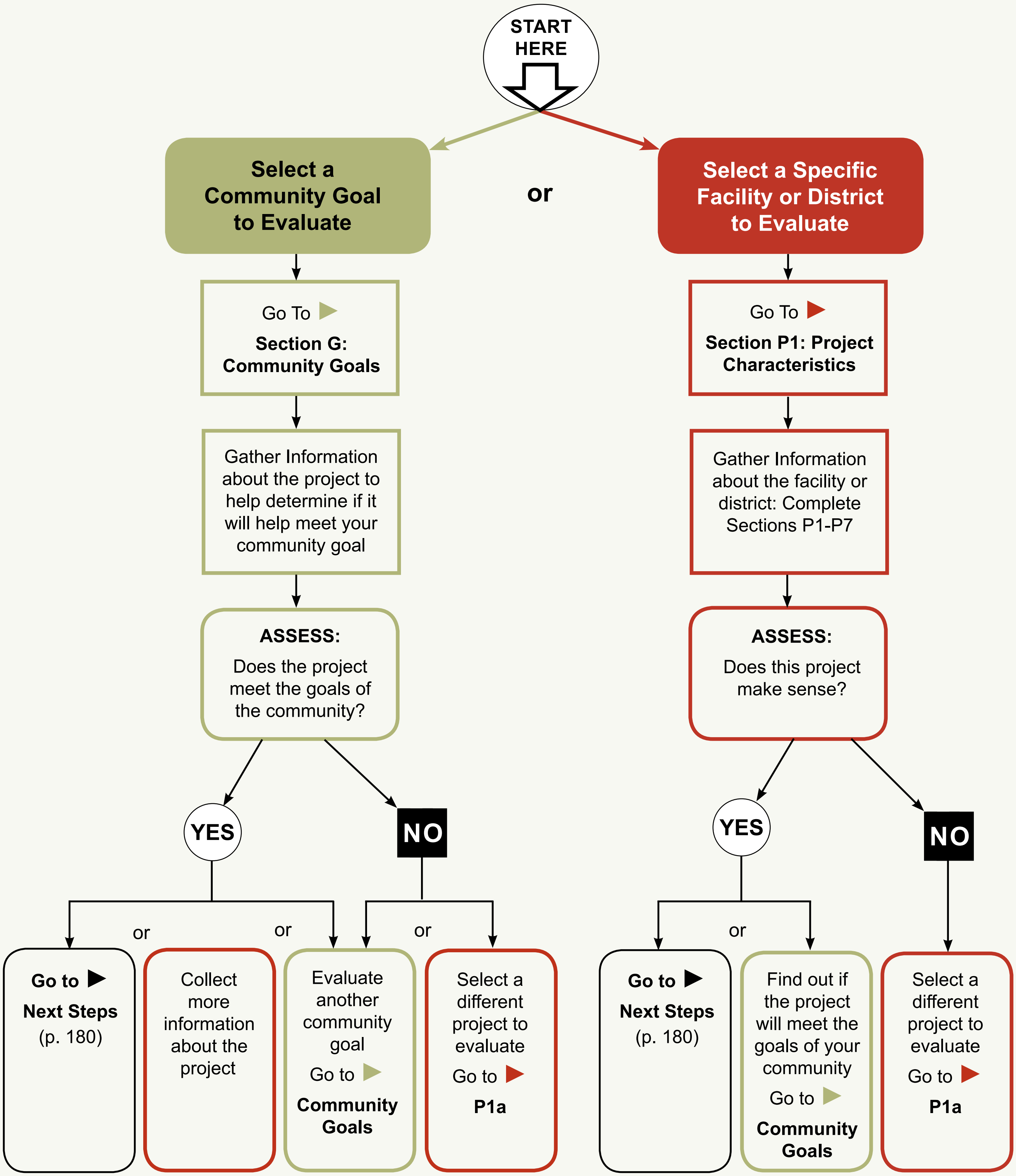
With the *Roadmap,* users can choose to begin their exploration of biomass in one of two places: by selecting the goal or goals of greatest interest to the community; or by zeroing in on a building or group of buildings for which the community wishes to consider a biomass system. The *Roadmap* will guide you, step by step, through the information gathering process required to determine whether or not a specific biomass project will help meet community goals and is likely to be viable. Along the way, the *Roadmap* will provide information regarding biomass, energy efficiency, technologies, community engagement, and other topics relevant to community decision-making. The *Roadmap* was developed in 2010, and contains numerous links that should enable you to access the most recent information available on a variety of topics from technologies to regulations.

At the end of the journey, you will have a pretty good idea of whether it makes sense to pursue one or more biomass projects in your community. You will also have collected much of the information a contractor will need to take your community to the next step in pre-feasibility analysis.

There is no "right way" to use this document. Communities that are in different places along the spectrum of decision making will use the document differently. It is designed to help communities gather the information needed to assess the viability of a biomass project. As information is collected and analyzed in each section of the *Roadmap*, the results of the analyses can be transferred to the worksheet pages in the front of the *Roadmap*. When the worksheet(s) relevant to your situation are completed, you will have all the information you need in one place to make a basic determination about next steps.

A Note on the Numbers: This tool is intended to help you determine whether or not a biomass project makes sense for your community. To do this the document uses estimates, general guidelines, and simple equations to provide you with enough information to determine whether further investment into the feasibility of the biomass project makes sense. The numbers and equations used throughout this document are based on the work and experience of the Biomass Energy Resource Center unless otherwise noted. As more and more communities in the United States gain experience with biomass technology, which is already well tested and proven effective in other countries, the numbers used in this *Roadmap* may be refined. If you find an alternate number or equation that you feel will help you make a better assessment of your project, feel free to substitute it wherever it makes sense. The numbers and equations used in the *Roadmap* are "ballpark" figures and it is important to remember that numbers will be different on each biomass project.

Roadmap Decision Tree



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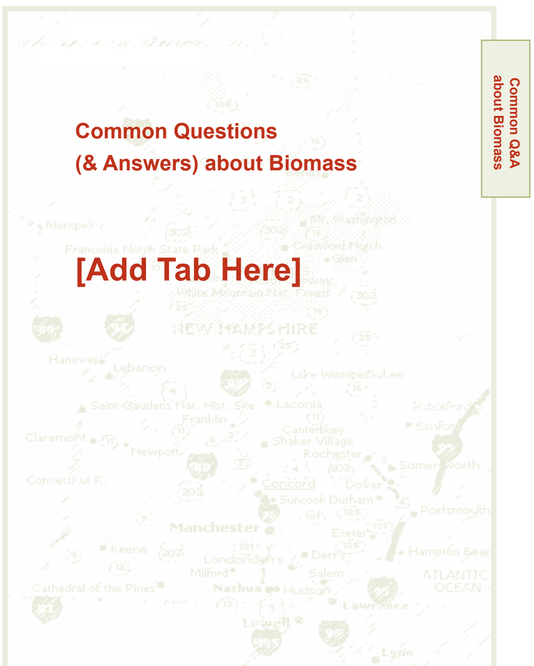
Printing the Document and Collecting Data

The *Roadmap* is designed to be completed electronically or by hand. Either way, we do not recommend trying to go straight through from cover to cover or printing it out all at once. When viewing the electronic document, clicking on different sections in the table of contents and the summary worksheets will take you to the appropriate section in the *Roadmap*.

You will notice "Add Tab Here" pages throughout the document—you can purchase tab sets at an office supply store to insert into a three-ring binder with the printed *Roadmap*—these tabs will help to make the printed version of the document more useful.

All tables and worksheets that appear in the *Roadmap* are duplicated in Appendix C for easy printing and duplication. In the electronic document you will be able to type your data directly into these forms (make sure to save the pages onto your own computer before you begin filling in data electronically).



Print or fill-out and save sections as you need them. For both electronic and manual users of the *Roadmap,* we recommend printing out completed sections and storing them in a three-ring binder. This binder of information will provide a valuable and comprehensive document that can be shared with the community and used in further stages of the document.

Getting Started

The *Roadmap* has two main sections: **Community Goals** and **Evaluate a Biomass Project**, and numerous subsections each with its own table of contents. These sections all contain introductory information, instructions for gathering data, and technical background information where required. In addition, many of these sections include links to further information such as published reports or data about topics relevant to that section. **The *Roadmap* is a guidebook, not a novel.** There are numerous points at which you will be instructed to move back and forth between the two main sections in order to gather the necessary information.

In addition to these two sections, there is introductory material on woody biomass, a Worksheets section, a detailed description of Next Steps (addressing how a community can move forward once completing the *Roadmap*), and a Glossary of terms used in the document. Words that are bolded in the document are defined in the Glossary.

If you already know which building, or buildings, you want to evaluate, you can start anywhere in the document. If you do not know which building, or buildings, you want to evaluate you should start at section P1a: Selecting a Project. Once you have selected a project to evaluate you can return to the Community Goals or continue collecting information about the project.

The documents in the Worksheets section will show you: what information needs to be collected to evaluate a biomass project in your community; where to find the instructions for collecting that information; and how to summarize the information you collect in the tables provided throughout the *Roadmap*. In the electronic version of the document, these summary worksheets will link you to the section of the document where you can find instructions for gathering the data and allow you to type in the information you are gathering about the biomass project. (**Make sure to save the pages onto your own computer** before you begin filling in data electronically.)

If you already have a project in mind and have begun collecting information about that project, use the detailed table of contents in the Evaluate a Biomass Project section to help you identify where you should start using the *Roadmap*, **Go to ▶ Page 144**.

The **Community Goals** section will allow you to identify one or more goals the community is trying to achieve with a biomass project and then evaluate a building, or multiple buildings, to determine if a biomass system serving the building, or buildings, will help you to achieve that goal.

To start with a community goal, **Go to ▶ Page 55**.

The **Evaluate a Biomass Project** section will walk you through gathering information that will help you determine whether a biomass project makes sense. Once you have completed this section you can enter the information gathered in the appropriate summary worksheet(s) to see which community goals it might help achieve.

To select a project to evaluate, **Go to ▶ Page 143**.

Information Collected in the *Roadmap*

The following tables list all of the different types of information you can collect using this *Roadmap* and indicates where you can find it in the document. Sections starting with a "G" are in the Community Goals segment and sections starting with a "P" are in the Evaluate a Biomass Project segment.

BUILDING(S)

INFORMATION TYPE	LOCATION
Selecting Building(s) to be Considered for Biomass	P1a
Building Owner	P1c
Building Bill Payer	P1c
Building Maintenance Staff	P1c
Identifying Anchor Loads (District)	P1h
Distance Between Buildings (District)	P1h
Total Square Footage (District)	P1h
Building Use	P2a
Building Size	P2a
Type of Construction/Renovation	P2c
Construction / Renovation Time Frame	P2c
Building Efficiency (Thermal)	P3d

EXISTING FUEL

INFORMATION TYPE	LOCATION
Existing Fuel Type	P3a
Existing Fuel Average Annual Usage	P3a
Existing Fuel Average Annual Heat Load	P3a
Domestic Hot Water Fuel Type	P3b
Domestic Hot Water Annual Usage	P3b
Domestic Hot Water Annual Heat Load	P3b
Existing Fuel Average Annual Cost	P3c
Existing Fuel Average Cost / Unit	P3c
Existing Fuel Use / Square Foot	P3d
Existing Heat Load / Square Foot	P3d
Reliability of Existing Heating Fuel(s)	G3a
% of Existing Heating Fuel Use from Renewable Sources	G5b
Current Amount of Heating Fuel from Local Sources	G2b
CO_2 Emissions of Existing Heating Fuel(s)	G4b
Existing Annual CO_2 Emissions	G4b
Efficiency of Existing Heating Fuel	G6d

EXISTING HEATING & DISTRIBUTION SYSTEM

INFORMATION TYPE	LOCATION
Existing Central Heating System	P4a
Existing # of Heating Systems	P4a
Existing Heat Generation	P4a
Existing Heating Equipment	P4a
Existing Heating Equipment Size	P4a
Existing Heating Equipment Fuel Type	P4a
Existing Heating Equipment Age	P4a
Existing Heating Equipment Condition	P4a
Existing Heat Distribution	P4b
Existing Heat Generation (District-Central Plant)	P4d
Age of System (District-Central Plant)	P4d
Condition of System (District-Central Plant)	P4d
Existing Heat Distribution (District-Central Plant)	P4d
Individual Back-Up Heating Systems (District-Central Plant)	P4d
Central Heating (District)	P4e
Existing Heat Generation (District)	P4e
Existing Heat Distribution (District)	P4e
Existing Domestic Hot Water (District)	P4e
Reliability of Existing Heating System(s)	G3b
Efficiency of Existing Heating System	G6b

BIOMASS SYSTEM	
INFORMATION TYPE	**LOCATION**
Community Biomass Champion	P5a
Biomass Woodchip or Wood Pellet System	P5b
Biomass System Size	P5c
Biomass Heat Output	P5d
Biomass 5-day Woodchip Supply	P5d
Biomass Woodchip Storage Volume	P5d
Biomass Woodchip Storage Area	P5d
Biomass Woodchip Storage Length	P5d
Biomass 1-day Woodchip Supply	P5e
Biomass Weekly Woodchip Supply	P5e
Biomass - # of Woodchip Truckloads per Week	P5e
Biomass System Location	P5g
Biomass System Capital Cost	P5h
Biomass System Distribution Cost (District)	P5h

BIOMASS FUEL	
INFORMATION TYPE	**LOCATION**
Amount of Existing Fuel to be Replaced with Biomass Fuel	P6c
Biomass Fuel Amount	P6c
Efficiency of Biomass Fuel	G6d
CO_2 Emissions of Biomass Fuel	G4c
Annual CO_2 Emissions of Biomass Fuel	G4c
Total Estimated Annual CO_2 Emissions with Biomass	G4c
Estimated Annual CO_2 Emission Savings	G4d
Definition of Local	G2a
Proposed Amount of Biomass Fuel from Local Sources	G2c
Total Proposed Amount of Heating Fuel from Local Sources with Biomass	G2c
Estimated % of Biomass Fuel from Renewable Sources	G5c
Total Estimated % of Fuel from Renewable Sources with Biomass	G5c
Community-Owned Wood Resource to Supply Biomass Fuel	G3c
Biomass Fuel Procurement Standards	P6a
Biomass Fuel Source Criteria	P6a
Access to Sustainably Harvested Biomass	G5a
Biomass Fuel Providers	P6d
Biomass Provider: Distance From Site	P6d
Biomass Provider: Type of Fuel	P6d
Biomass Provider: Cost per Ton	P6d
Biomass Provider: Long-Term Contract	P6d
Biomass Provider: Provide Amount Required	P6d
Biomass Provider: Self-Unloading Trailer	P6d
Biomass Provider: Bulk/Silo Pellet Delivery	P6d
Biomass Provider: Sources of wood	P6d
Biomass Provider: Type of Harvesting	P6d
Biomass Provider: Meets Sustainability Criteria	P6d
Number of Biomass Fuel Providers	P6d
Number of Biomass Fuel Providers that Provide Locally Sourced and Sustainably Harvested Wood	P6d

AIR QUALITY & PERMITTING

INFORMATION TYPE	LOCATION
Indoor Air Quality Issues	P7d
Applicable New Hampshire Air Emission Requirements	P7g
Required Local Permits	P7g
Required State Permits	P7g
Applicable Zoning Regulations	P7g

COST

INFORMATION TYPE	LOCATION
Existing Fuel Average Annual Cost	P3c
Existing Fuel Average Cost / Unit	P3c
Proposed Biomass Fuel Cost	G1b
Proposed Annual Fuel Cost with Biomass	G1b
Estimated First Year Fuel Savings	G1b/c
Estimated Payback Period	G1d
% of Existing Fuel $ Staying in the Local Economy	G7b
Estimated % of Fuel $ Staying in the Local Economy with Biomass	G7c
Estimated # of Jobs Supported with Biomass	G7d

Common Questions (& Answers) about Biomass

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Common Q&A
about Biomass

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Common Questions (& Answers) about Biomass

This section answers common questions about biomass systems. Knowing the answers to these questions about biomass will be a key component in moving a community biomass project forward.

Q: What is biomass?

A: Biomass is any biological material that can be used as fuel. Biomass fuel is burned or converted in systems that produce heat, electricity, or both heat and electricity (CHP). Woodchips, wood pellets, and other low-grade wood wastes are the major types of biomass fuel. Other common biomass fuel sources are agricultural crop residues and farm animal wastes.

Q: Why use biomass fuels?

A: Low fuel cost is the main attraction of heating with woodchips. Unlike fuel oil, propane, and natural gas, biomass has a history of stable prices that are unaffected by global economics and political events. Biomass is a locally available fuel source that increases the region's energy independence and security while stimulating the local economy by keeping energy dollars circulating in the region rather than exporting them. Using wood also helps to support the forest products industry, creating markets and forestry and agriculture jobs in the surrounding region.

Modern community-scale biomass systems burn cleanly with virtually no visible emissions or odors, and, compared with modern residential-scale wood and pellet stoves, with far less emissions of particulate matter (PM), an exhaust product of wood combustion known for its adverse effects on human respiratory health. For example, over the course of a winter season, the heating plant of a 200,000 SF wood-heated school in a cold northern climate produces about the same amount of PM as five residential-scale wood stoves. Reference: **http://biomasscenter.org/resources/fact-sheets/benefits-for-schools-and-communities.html**.

Carbon dioxide (CO_2) buildup in the atmosphere is a significant cause of global climate change. Fossil fuel combustion takes carbon that was locked away underground (as crude oil and gas) and transfers it to the atmosphere as CO_2. When wood is burned, however, it recycles carbon that was already in the natural carbon cycle. Consequently, the net effect of burning wood fuel is that little or no new CO_2 is added to the atmosphere if the biomass is sustainably harvested and climate mitigation efforts are improved if the biomass is replacing fossil fuels.

Biomass is any biological material that can be used as fuel.

Woodchips, wood pellets, and other low-grade wood wastes are the major types of biomass fuel.

In New Hampshire, woody biomass fuel can come from various sources—sawmills, harvesting operations in the woods, and clean community wood wastes.

Q: Where does woody biomass come from?

A: Woody biomass fuel can come from various sources—sawmills that chip wood as a by-product, directly from harvesting operations in the woods, or from clean community wood wastes such as chipped urban tree trimmings, stumps, and Christmas trees. (While woodchips can also come from clean construction and demolition material, this fuel is not acceptable in New Hampshire due to possible chemical contamination of the material and the associated air quality issues from burning it.) In addition to these traditional sources, chips are increasingly being produced from chipped low-grade logs or "pulpwood" in dedicated chip yards and chip mills.

Q: What kinds of facilities use biomass?

A: Facilities suitable for biomass systems include colleges, universities, hospitals, public buildings, hotels and motels, commercial buildings, greenhouses, large-scale agricultural operations, manufacturing plants, power plants, schools, and community district energy systems (the latter being the use of a central heating plant to provide heat to multiple buildings using buried pipes to distribute the energy).

Q: What's the relationship between biomass energy and combined heat and power (CHP)?

A: Because of the relative efficiencies and economies of thermal and electrical energy generation with biomass, CHP projects work best when the system is sized to the thermal load rather than maximized electrical production. Before a community can determine if they have a viable CHP project, they must determine if they have a viable thermal energy project. CHP calculations are complicated and difficult, and can be evaluated by professionals in the pre-feasibility level of study. For more information on CHP, see Appendix B on page 263.

Q: What does a woodchip system look like? Will it make our building look like a saw mill or factory?

A: With careful attention to design, the woodchip system can blend in with the building. Biomass heating facilities are similar in their functional parts to those that run on conventional fuels. All require fuel storage capability, a means of moving the fuel from the storage bin to the boiler, a boiler to burn the fuel and extract the useable heat from combustion, and a connection to a chimney to disperse the combustion gases. With woody biomass systems, the boilers are larger and the fuel handling equipment takes up extra space, therefore it may require a larger area. Biomass systems also call for a taller stack (chimney) than an oil or gas system.

Q: Does burning wood involve a lot of labor?

A: In an automated woodchip or pellet system, the operator never handles the fuel. The wood fuel is loaded into the bin automatically and handled by completely automated equipment in the building. In a semi-automated system, the operator will spend 15-30 additional minutes each day to feed the day bin. Reference: **http://biomasscenter.org/resources/technology/heating-systems-semiautomated.html.**

Q: Why should we experiment with an unfamiliar technology?

A: Burning woodchips and other forms of biomass for heat has been common in the wood products industry for decades. In the last 25 years, woodchip systems have been successfully installed in hundreds of buildings, including hospitals, government facilities, greenhouses, commercial buildings, schools, hotels, and motels. The technology is well proven and there are a number of manufacturers with successful track records.

Q: Is a woodchip system noisy?

A: As with other heating options, the building occupants usually never hear the woodchip system unless they go into the boiler room.

Q: Isn't wood a dirty fuel that will make a mess at our building?

A: The woodchips are stored in a closed bin and burned in the boiler room, in a sealed combustion chamber. They never get out onto the grounds or into the rest of the building.

Q: Will we continue to use fossil fuels if we build a biomass system?

A: Yes. A redundant fossil fuel system (often the building's current heating system in a single building biomass project) will provide energy during portions of the heating season. Please see Appendix A on 'efficiency' and 'redundancy' for more information.

Q: Will we use our backup system more as the woodchip system gets older?

A: Judging from systems that have been in operation for many years, this has not proven to be the case. A well-maintained system, however, is essential to the longevity of any piece of equipment as well as to its operational efficiency. As examples, two of Vermont's state-owned district heating systems (in Waterbury and Montpelier) have older wood boilers that, over the years, have been operating to the full extent that their air permits allow.

Q: Will big trucks be coming and going every day?

A: Depending on the season and the size of the building, chip deliveries might be as infrequent as one truckload every two months, or as frequent as two-to-three loads per week. Interviews with system owners indicate that truck traffic for institutional biomass systems is not a significant issue. Generally, the number of deliveries depends largely on the size of the facility and its heating requirements. Reference: **http://biomasscenter.org/resources/faqs.html#11**.

Q: Is there a danger that a large store of woodchips will catch fire?

A: It is possible for large woodchip piles to spontaneously combust and has been known to happen on rare occasion. This spontaneous combustion is due to increased temperature within the chip pile as a result of fermentation and decomposition and only happens in very large piles that have been sitting for prolonged periods of time (over 3 months). Wood that needs to be stored for periods longer than 3 months should be stored in round wood form and not as piled woodchips. This stored round wood can then be chipped on demand as needed.

Q: How stable is the supply of woodchips? Will they always be available?

A: The answer depends on the region as well as the sizes and types of biomass heating projects that need to be supplied with wood. In many western US states, biomass is readily available in large sustainable volumes as a forest by-product. Various low-quality, small-diameter species must be culled in very large volumes from Western forests to reduce the 'fuel' that feeds wildfires. By burning this hazardous material— fuel biomass systems can help prevent and reduce the intensity of fires while at the same time promoting the health of commercial timber stands. In the Northeast, biomass as a by-product is well-spoken for and transitioning from a waste-stream product to a commodity. A gauge to the vitality of this market commodity is the strength of the forest products industry, which provides the infrastructure (loggers, mills, trucks, etc.) required to supply the seasonal heating market. The biomass energy needs of the seasonal heating market can be better met if integrated into the existing market by piggybacking onto a regional anchor such as a pulp mill or cluster of wood-fired facilities.

Q: What do you expect the price of woodchips to do?

A: The price of woodchips is dependent upon the regional supply. Where woodchips are available as a plentiful by-product such as in the US western states, the price will continue to stay relatively low and stable. In places where by-product material is well-spoken for and the seasonal heating market is transitioning from a by-product to a commodity, the prices can be higher and may escalate some. Nevertheless, woodchips generally will continue to be much less expensive than oil. Based on the energy content (Btu output) of each, even if woodchips were to reach $100 per ton, approximately twice the current price, it would be the same as paying $1.71 per gallon of oil.

Q: Why should we use the forest for energy?

A: Humans have a long history of utilizing forests for sustenance— including food, fuel, shelter, clothing, fences and barriers, weapons, and numerous other uses. As we continue to use wood products, it makes sense to also use the low-grade material and wood wastes that are generated to displace fossil fuels for heating. In fact, providing markets for these low-grade and waste materials is a key component of both sustainable harvesting and forest conservation, helping forested parcels maintain long-term value as a sustained resource. Sustainably produced biomass from forests is a local renewable energy source that keeps energy dollars circulating in the local economy by creating markets for low-grade wood, adding economic vitality and jobs to the forest-products industry, and improving the health of our forests.

Q: What are the impacts of using the forest for fuel?

A: Procuring biomass fuel is integrated into harvesting operations that are already occurring; therefore there is no additional impact to the forest. Removing low-quality trees for biomass can actually help forests by opening up space necessary for higher-quality trees to grow faster. Further, without markets for low-quality wood, only high-quality trees are harvested, thereby degrading the forest quality over time. While any forest management plan should consider the resiliency of the particular forest being harvested, some level of management and harvest most often is restorative as opposed to damaging, with short-term impacts minimized and long-term impacts negligible. Some positive impacts include sustaining the local forest products industry, maintaining the value of forested land, and sourcing forest-based products locally rather than putting that burden on more distant forests. 'Community-scale' biomass projects that are properly sited and implemented do not put undue strain on forest resources.

Q: Does using biomass from the forests destroy habitats?

A: Biomass fuel harvesting is nearly always conducted as part of an integrated timber harvest where multiple products (veneer, saw logs, pulp, and firewood) are removed at the same time. As long as good forest management practices are followed, the biomass fuel harvesting, results in no additional impact on wildlife habitat. It is important to note that some harvesting is often prescribed by foresters specifically for enhancing or expanding the habitat of various game and non-game wildlife. Many types of wildlife require open areas created by harvesting and the early successional vegetation that takes over after a harvest. Depending on the forest management objectives, biomass harvesting can in fact contribute to the diversity of wildlife habitat in a forest.

Q: Will the wood smoke be an air-quality problem?

A: Automated, commercial-sized woodchip and pellet systems burn much cleaner than even the most modern home wood or pellet stove. They produce no creosote and practically no visual smoke or odor. Because the biomass fuel is green, or close to 50% water, however, in cold weather the chimney may show a plume of condensed water vapor. Interviews with dozens of system operators support the conclusion that odor generated by the fuel or the smoke is almost never a problem, and in most cases, both chip and pellet systems easily meet state air quality standards. Best Available Control Technologies (BACT) for air quality should be identified and evaluated for the biomass project in the feasibility study process. In most cases with installation of emissions control equipment as identified per BACT, both chip and pellet systems easily meet state air quality standards.

Based on the energy content (Btu output), even if woodchips were to reach $100 per ton—approximately twice the current price—it would be the same as paying $1.71 per gallon of heating oil.

Q: Are woodchips as clean as gas or oil?

A: The answer depends on the pollutant to which you are comparing woodchips. Wood has lower sulfur dioxide emissions and net greenhouse gas emissions than both oil and propane; however, particulate matter, carbon monoxide, and total organic compound emissions are higher from wood than oil. Oxides of nitrogen (NOx) emissions from wood are comparable to oil. Volatile organic compounds (VOCs), some of which are produced by combustion, are higher when using wood than when using natural gas or oil, but each fuel emits different VOCs at varying levels and each type has varying reactivity. It is important to note that using the best available control technology and combustion practices, careful siting, appropriate stack (chimney) height, and careful consideration of dispersion patterns will bring emissions well within permissible limits and lessen the impacts of any pollutants emitted when burning biomass.

Q: Will the system produce airborne wood ash that will fall over the neighborhood?

A: No. A well-designed woodchip system burns at a high rate of efficiency, resulting in a small percentage of residual ash (about 1% of the original fuel volume). In addition, these systems require specific stack (chimney) heights that effectively disperse any emissions into the prevailing winds.

Q: Are the wood ashes toxic? Where and how are they disposed?

A: Wood ash from institutional and commercial heating plants is not toxic, in fact, it is an excellent soil additive for agricultural use. It can also be spread on athletic fields and gardens or disposed of at a landfill.

Q: What are carbon credits, and will my project be eligible for them?

A: Carbon credits are the ‘currency’ in an approach to controlling global greenhouse gas pollution by providing economic incentives on an industrial scale to reduce the emission of pollutants. Carbon credits can be exchanged between businesses or bought and sold in international markets. There are also many companies that sell carbon credits to commercial and individual customers who are interested in lowering their carbon footprint on a voluntary basis. These carbon offsetters purchase the credits from an investment fund or a carbon development company that has aggregated the credits from individual projects. As long as the United States continues to be in voluntary mode, it is difficult meet eligibility requirements, particularly for smaller projects. Applying for credits is cost- and time-prohibitive for smaller projects (a lot of paperwork for very little credit). A creative way to make the process viable may be to aggregate smaller projects into a single application as mentioned above.

Community Engagement

Community Engagement

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Community Engagement

This Roadmap was produced by Yellow Wood Associates and the Biomass Energy Resource Center for the North Country RC&D.

Community Engagement

This section of the *Roadmap* provides an introduction to community engagement and some recommendations for how and when to work with the community in regards to a biomass energy project.

Specifically, you will learn about:

- Why it is important to engage the community
- Identifying stakeholders
- When to engage the community
- How to engage the community
- Identifying community goals
- Sharing the findings and educating the public about potential biomass projects
- Questions frequently asked by community members

Four Good Reasons to Seek Broad Community Engagement in Assessing the Potential of Biomass Applications

1. Inviting participation offers opportunities to make good use of local expertise and connections.
2. Community engagement allows leaders to gauge the extent to which community goals are actually shared and to discover shared goals that may lie underneath the appearance of conflict.
3. When people are actively involved in gathering information about biomass, it gives them an opportunity to learn new information and test their assumptions. Engagement has been known to turn naysayers into supporters.
4. The more the people in the community understand about the proposed biomass application, the more willing they will be to make decisions and the better informed their decisions will be.

What Do We Mean by "Community"?

For the purpose of considering biomass projects, we define community as a neighborhood, municipality, industrial park, institutional buildings, or other combination of buildings that could be served by a biomass district system. Similar to centralized water or wastewater systems, biomass district systems rarely serve entire municipalities, particularly in rural areas. However, depending on community goals, system financing, governance, and other considerations, the entire community may have a role in approving the biomass project. The *Roadmap* can be used to evaluate biomass applications for individual buildings as well as district applications. If the individual building is publicly owned (e.g., school, town hall, etc.), the affected public is considered to be the community.

Identifying Stakeholders

There are three types of stakeholders in any biomass project and, depending on the project; there may be overlap among them. The first are the people whose support is required to make it happen. This could include building owners, financers, and, potentially, voters. The second is the people who will be affected directly or indirectly by the project. This could include tenants, neighbors of the facility, and building maintenance people. The third is the people who have the power to prevent the project from happening.

For any given project, it is important to identify the three types of stakeholders in your community as early as possible and make an effort to engage them in helping to assess, plan, and understand the projects you are considering. People who will be affected by the project may have insights that will improve the project overall. People who have the power to prevent the project may become supporters if their concerns are taken into account and they are given the opportunity to contribute to project development. Ideally, you will want to have a mix of different types of stakeholders involved in using the *Roadmap* and sharing the findings.

When to Engage the Community

There are at least five points at which community engagement will enrich the biomass assessment process. The first is the articulation of community goals with respect to energy. The second is the selection of potential projects, particularly if these are with publicly owned buildings. The third is in gathering information to complete the *Roadmap*, the fourth is sharing the findings, and the fifth is providing input on next steps.

How to Engage the Community

There are many processes to bring diverse members of communities together from kitchen table meetings in which neighbors come together to discuss and learn in an informal setting, to study circles, to community-wide gatherings or committees. When successful, these processes generally share the following ingredients:

- **A GOOD FACILITATOR.** This can be someone from the community or an outsider. A good facilitator is a neutral voice whose job is to plan and execute productive interactions between individuals and groups so that everyone has an opportunity to participate and be heard.
- **REFRESHMENTS.** Food is the lubricant of choice for community engagement. Home-made and/or regional food is especially powerful, but any food will do.
- **SENSE OF PURPOSE.** The most effective gatherings have a clear sense of purpose, agendas, and time frames that are adhered to.
- **UNDERSTANDABLE PROCESS.** We hope the *Roadmap* provides an understandable process around which groups that wish to explore the potential for biomass applications at the community level can organize.

- **DIVERSE PARTICIPANTS.** The most exciting and rewarding exchanges often occur between individuals who do not normally interact or do not normally interact about the subject at hand. The best way to get a diverse mix of participants is to issue them a personal invitation that highlights why you would value their participation in particular.
- **ADEQUATE UNSTRUCTURED TIME** so people can mix and get to know one another.
- **EXPERIENTIAL COMPONENT.** Learning something new is a powerful enticement for engagement. Field trips to see biomass installations in other communities, sustainably managed forests, or workdays in which participants go around and talk with building owners and collect information for the *Roadmap* will engage people who are not necessarily going to sit through multiple meetings.

One or more successful public engagement events often result in a core group of "champions" interested in learning more and contributing to the assessment process over time.

Identifying Community Goals

If your community has not worked together to identify its goals, you may wish to consider doing so. Processes that bring groups together to imagine the future and identify shared goals range from kitchen table meetings to more formal public processes.

Informal processes can be quite effective in laying the groundwork for successful formal processes, especially if they are open to diverse participants and are not perceived as occurring behind closed doors.

Several more formal processes for imagining the future (rather than discussing the past or present) and getting clarity about the different scenarios that are possible are described below. They involve developing stories or narratives that describe alternative paths toward the future. Possibilities are studied so that communities can make informed decisions about their future. They require professional facilitation. Costs will vary.

A. SCENARIO PLANNING. Scenario planning is used in a wide variety of contexts. In communities, it can be part of a structured dialogue among stakeholders whose futures are intertwined but who often oppose or take no notice of one another. It is a civic dialogue tool that focuses on the future instead of the past or present.

Scenarios are plausible what-if stories or narratives that describe alternative paths toward the future based on particular lenses that explore how people's choices today and dynamics beyond their control will shape the future. In scenario planning, a broad range of possibilities are considered to assure people are making informed decisions.

www.meadowlarkproject.com

B. PLAYING THE FUTURES GAME. This is a scenario game used by David Beurle of Innovative Leadership Australia for the rural "wheatbelt" of Western Australia. This highly interactive and participatory game allows participants to tackle the challenges of community and economic development in a fun and engaging manner.

The Game is played in a small team format, and the teams make a series of critical decisions that shape the future of a region over a 25-year period. The game integrates decision making across community, economic, and environmental dimensions, and challenges the teams to assimilate global, national, and local issues in their decision making. The game includes a debrief session, where teams compare their outcome and explore their critical decision-making pathways for this hypothetical region.

www.ila.net.au

http://www.webs1.uidaho.edu/mkyte/ui_strategic_plan implementation/resources/Goal%203%20Moscow%20 Workshop%20Report%203%205%2008.pdf

C. SEARCH INSTITUTE. Search Institute is an independent nonprofit organization whose mission is to provide leadership, knowledge, and resources to promote healthy children, youth, and communities. To accomplish this mission, the institute generates and communicates new knowledge, and brings together community, state, and national leaders. The Search Institute has a listing of case studies that help them identify key factors for launching and growing community-wide asset-building initiatives focused on community change, evaluation, families, education, and social change/social norms.

www.searchinstitute.org

D. YOU GET WHAT YOU MEASURE®. You Get What You Measure® is a trademarked, alternative approach to strategic planning and evaluation offered through Yellow Wood Associates. You Get What You Measure® is a process developed by Yellow Wood for helping people with diverse perspectives who share common goals learn how to measure progress toward their shared goals. It is a powerful tool that uses systems thinking to identify the key leverage points in a system that, if moved in the desired direction, will cause the entire system to move toward attaining the goal at hand.

You Get What You Measure® has been used successfully by the U.S. Department of Agriculture, the U.S. Forest Service, the Missouri Departments of Mental Health, Health, and Economic Development, the Northwest Area Foundation, and by Arizona Cooperative Extension, among others, to develop and implement meaningful measures of progress.

www.yellowwood.org

Sharing the Findings and Educating the Public about Potential Biomass Projects

Once you have completed a biomass project assessment using the *Roadmap*, it will be important to share these findings with the broader community. There are many ways to go about educating the public about biomass projects. Here are a few suggested steps:

1. Develop a consistent, comprehensive and easy to understand description of the proposed project. Explain what it is, why it is being considered (what community goals does it address, what problems does it solve), where it is, who will be affected by it, and when it is expected to happen. Include pictures and maps.

2. Use multiple communication channels to get the information out to the public. These might include newsletters, community website, libraries, pulpits, utility bill inserts, and, leafleting.

3. Create opportunities for public discourse about the project where concerns can be raised and addressed. These might include radio shows, public access television, public meetings, workshops or presentations at community events, or an 800 number. Opportunities that allow for face-to-face or voice-to-voice interactions are less likely to lead to misunderstandings. If questions come up that cannot be answered at the present time, explain how the process will arrive at answers and when those answers can be expected.

4. Develop a regular schedule of communications that addresses concerns as they emerge in a consistent manner and keep the community updated on progress.

5. Engage the community in considering next steps.

Tours of facilities with biomass energy systems can be informative when considering such a project in your community.

This Roadmap was produced by Yellow Wood Associates and the Biomass Energy Resource Center for the North Country RC&D.

Summary Worksheets

Summary Worksheets

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Summary Worksheets

This Roadmap was produced by Yellow Wood Associates and the Biomass Energy Resource Center for the North Country RC&D.

▶ Community Goals

Summary Worksheets

The following worksheets summarize the key information you will need to collect about the biomass project you are evaluating in relationship to the goals your community is trying to achieve. You can complete the summary for only one goal or all of the goals. (These worksheets have space to enter information about two buildings; if you are evaluating more than two buildings save or print additional copies of these pages).

G1. We Have Lower Energy Costs

BUILDING		
Current Annual Fuel Costs (p.60)		
Estimated Annual Fuel Costs with Biomass Project (p.62)		
Estimated First-Year Fuel Savings (p.63)		
Estimated Payback Period (p.64)		

G2. We Are Energy Independent

BUILDING		
Definition of Local (p.74)		
Total % of Existing Fuel from Local Sources (p.75)		
Estimated % of Existing Fuel from Local Sources with Biomass System (p.77)		

G3. Our Energy Is Reliable

BUILDING		
Lack of Availability of Current Heating Fuel Source (p.86)		
Reliability of Current Heating System (p.87)		
Reliability of Biomass Supply (p.88)		
Multiple Suppliers (p.88)		
Long-Term Contracts (p.88)		
Community-Owned Wood Source (p.88)		

G4. We Emit Less Carbon

BUILDING		
Total Existing Annual CO_2 Emissions (p.98)		
Total Estimated Annual CO_2 Emissions with Biomass Project (p.99)		
Estimated Annual CO_2 Emission Savings with Biomass System (p.101)		

G5. We Rely on Renewable Energy Resources

BUILDING		
Access to Sustainably Harvested Biomass Fuel? (p.108)		
Current % of Fuel from Renewable Energy Sources (p.109)		
Estimated % of Fuel from Renewable Energy Sources with a Biomass System (p.111)		

G6. We Are Energy Efficient

BUILDING		
Efficiency of Thermal Envelope (p.118)		
Efficiency of Existing Heating System (p.120)		
Efficiency of Existing Heating Fuel (p.123)		
Efficiency of Biomass Heating Fuel (p.123)		

G7. We Have a Strong Local Economy

BUILDING		
Total % of Fuel Dollars Staying in the Local Economy with Current Fuel Use (p.132)		
Total % of Fuel Dollars Staying in the Local Economy with Proposed Biomass System (p.133)		

► Assess

Community Goals Summary Worksheets

Now that you have completed collecting information about your community goal(s), you should know whether this biomass project will help your community achieve its energy-related goals.

Will the project help the community achieve one or more energy-related goals?

Yes ☐ **No** ☐

Yes → GO

No → ROADBLOCK

If the project will help the community achieve its goals, you can now:

1. Collect **more information** about the potential project **to further clarify its feasibility (Go to ► P1. Project Characteristics).** Remember, you have already collected some of this information to complete your assessment of the community goal(s). You can enter the information you have collected into the Evaluate a Biomass Project Summary Worksheets to determine which information you still need to collect. **Go to ► Evaluate a Biomass Project Summary Worksheets.**
2. Learn more about **how to move this project forward.** If you feel you have collected all of the possible information about this project, **Go to ► Next Steps** to learn what your community will do next to continue to evaluate this biomass project.

If the project will not help achieve the energy-related goals of your community, you can:

1. Try to **move around the roadblock(s).** Many sections of the *Roadmap* identify potential areas that might create a roadblock to a biomass project and suggestions for how you might move around these roadblocks. Remember, as energy costs, regulations, and technologies continue to change, a project that does not currently meet the goals of your community may do so in the future.
2. **Evaluate** whether a **different facility or district** will be more effective at achieving the goals of your community if you are still interested in pursuing a biomass project. **Go to ► P1a. Selecting a Project** and then come back to the community goals section.

► Evaluate a Biomass Project

Summary Worksheets

The following worksheets summarize the key information you will need to collect about the biomass project you are evaluating. Each time you complete a section you can transfer the information from the summary table of each Evaluate a Biomass Project section (P1-P7) into these summary worksheets.

The summary worksheets allow you to see all of the information you have collected about the project in one place. (These worksheets have space to enter information about two buildings; if you are evaluating more than two buildings save or print additional copies of these pages).

P1. PROJECT CHARACTERISTICS

	BUILDING ONE	BUILDING TWO
BUILDING NAME		
Contact Information (p.152)		
Owner Name		
Owner Address		
Owner Phone		
Owner Email		
Bill Payer Name		
Bill Payer Phone		
Bill Payer Email		
Maintenance Name		
Maintenance Phone		
Maintenance Email		
Other important contact Name		
Other important contact Phone		
Other important contact Email		

District/Community Project Anchor Buildings

Anchor Building Total Square Footage (p.161)	
Total Distribution Cost (p.161)	
SF to Distribution Cost Ratio (p.162)	

P2. BUILDING INFORMATION

	BUILDING ONE	BUILDING TWO
BUILDING NAME		
Building Use (p.172)		
Building Size (p.172)		
Building Status (p.174)		
Time Frame (p.174)		

P3. EXISTING FUEL USE

	BUILDING ONE	BUILDING TWO
BUILDING NAME		
Square Footage of Conditioned Space (p.180)		
Type of Heating Fuel (p.180)		
Average Annual Heating Fuel Usage (p.180)		
Average Annual Heat Load (p.183)		
DHW Fuel Type (p.185)		
DHW Average Annual Usage (p.185)		
DHW Average Annual Heat Load (p.185)		
Total Average Cost of Fuel (p.186)		
Total Average Annual Fuel Bill (p.186)		
Thermal Efficiency (p.189)		

P4. EXISTING HEATING & DISTRIBUTION SYSTEM

	BUILDING ONE	BUILDING TWO
BUILDING NAME		
Single Building/Individual System		
Number of Heating Plants / Locations (p.196)		
Type of Heating System (p.196)		
Type of Fuel (p.196)		
Age of System (p.196)		
Condition of System (p.196)		
How Heat Is Distributed to Rooms (p.197)		
District Heat with Existing Central Heating Plant		
How Heat Is Generated (p.198)		
Type of fuel (p.198)		
Age of System (p.198)		
Condition of System (p.198)		
How Heat Is Distributed to Buildings (p.198)		
Individual Building back-up Heating System (p.198)		
District Heat without Existing Central Heating Plant		
Heat Generation (p.198)		
Heat Distribution (p.198)		
Domestic Hot Water (p.198)		

P5. BIOMASS SYSTEM

	BUILDING ONE	BUILDING TWO
BUILDING NAME		
Champion (Yes / No) (p.204)		
Champion Contact Info (p.204)		
Type of System (Woodchip / Pellet) (p.206)		
Size of System (p.207)		
Space Required for Woodchip Storage (p.209)		
Max.# of Woodchip Deliveries per Week (p.210)		
System Location (p.211)		
Capital Cost (p.212)		

P6. BIOMASS FUEL SUPPLY

	BUILDING ONE	BUILDING TWO
BUILDING NAME		
Procurement Standards (list) (p.220)		
Harvesting Practices (list) (p.221)		
Type of Biomass (Woodchips, Pellets) (p.226)		
Estimated Amount of Biomass Required (p.230)		
# of Fuel Providers that Meet your Requirements (p.234)		

P7. EMISSIONS, PERMITTING, AND AIR QUALITY

	BUILDING ONE	BUILDING TWO
BUILDING NAME		
Indoor Air-Quality Issues (p.248)		
NH Air Emission Requirements (p.248)		
Local Permit Requirements (p.248)		
State Permit Requirements (p.248)		
Applicable Zoning Regulations (p.248)		

▶ Assess

Evaluate a Biomass Project Summary Worksheets

Now that you have completed collecting information about this biomass project, you should be able to determine whether this is likely to be a viable biomass project.

Does this biomass project make sense in your community?

Yes ☐ **No** ☐

Yes ➔ GO

No ➔ ROADBLOCK

If this appears to be a viable project for your community, you can:

1. Assess whether the project will help your community **achieve one or more energy-related goals.** You can **Go to ▶ Community Goals** to select a goal to evaluate.

OR

Enter information you have already collected into the Community Goals Summary Worksheets to identify which goals the project is likely to achieve - **Go to ▶ Community Goals Summary Worksheets.**

2. Learn more about **how to move this project forward.** If you feel you have collected all of the possible information about this project, **Go to ▶ Next Steps** to learn what your community will do next to continue to evaluate this biomass project.

If the project does not make sense in your community and you are still interested in pursuing a biomass project, you can:

1. Try to **move around the roadblock(s).** Many sections of the *Roadmap* identify potential areas that might create a roadblock to a biomass project and suggestions for how you might move around these roadblocks. Remember, as energy costs, regulations, and technologies continue to change, a project that does not currently meet the goals of your community may do so in the future.

2. **Evaluate** whether a **different facility or district** will be more viable in your community. If you have another project in mind you can begin to collect information about this facility or district. Remember some of the information you have already collected (like Biomass Fuel Source) may be relevant for more than one project. You do not need to collect this information again. If you are unsure about which facility or district in your community to evaluate **Go to ▶ P1a. Selecting a Project.**

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Community Goals

Community Goals

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Community Goals

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What Is a Community GOAL?

A goal is a condition that a community wishes to achieve. A goal is not an action. It is not about doing or making; it is about being. Achieving a goal requires a change in the way the community looks, acts, and feels.

Goals are stated in the present tense because this produces the maximum psychological tension between current reality and desired reality. If you hold fast to your goals, this tension will propel you to change current reality to meet them. If you frame goals in the future tense, all the tension dissipates.

It's not just semantics. Avoid using active verbs when crafting your goal because action verbs are powerful. They divert attention away from the condition you wish to achieve and hurl you prematurely into action. For instance "being a community that is fueled by renewable energy" leaves room for engaging others in a wide-ranging discussion about how the community will look and feel if and when this condition is achieved. "Putting in a biomass system" is an activity. It may be one way to make progress toward the goal, but it is not the only way, nor is it necessarily the best way.

The Biomass Community Roadmap does not assume that biomass is the answer to achieving community goals. Rather, it allows you to investigate the relationship between your goals and biomass and to determine for yourselves the extent to which implementing biomass heating may or may not help achieve the goals your community cares the most about. For information on how to engage communities in developing goals, **Go to ▶ Community Engagement**.

This *Roadmap* helps communities to evaluate whether a specific biomass project in the community will help meet seven common community goals. Work with the community to identify which community goal is the highest priority and begin using the *Roadmap* there. Complete as many community goal sections as make sense for your community.

Get Started

If you do not know which facility or district you want to evaluate for biomass heat, Go to ▶ P1a. Select a Project, and then come back to this page. If you already know which facility or district you want to evaluate for biomass heat, select a community goal to get started.

If your community goal is:	Go to
We Have Lower Energy Costs	▶ G1. Page 59
We Are Energy Independent	▶ G2. Page 73
Our Energy is Reliable	▶ G3. Page 85
We Emit Less Carbon	▶ G4. Page 95
We Rely on Renewable Energy Resources	▶ G5. Page 107
We Are Energy Efficient	▶ G6. Page 117
We Have a Strong Local Economy	▶ G7. Page 129

G1. We Have Lower Energy Costs

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G1. We Have Lower Energy Costs

► We Have Lower Energy Costs

► We Are Energy Independent

► Our Energy Is Reliable

► We Emit Less Carbon

► We Rely on Renewable Energy Resources

► We Are Energy Efficient

► We Have a Strong Local Economy

► COMMUNITY GOAL 1

G1. We Have Lower Energy Costs

DEFINITION: **We spend less on energy and our energy spending is relatively stable.**

Introduction

Once capital investments are made, biomass fuels used for heating are significantly less expensive than fossil fuels on a cost/Btu basis. Fuel savings cover the cost of capital investments over some period of time. Long-term contracts for biomass can provide stable pricing with little impact from global economic and political events. The price of biomass fuels in the New England area has remained very stable in the last 20 years and is likely to fluctuate much less than the fossil fuel prices.

While biomass fuel pricing tends to be more stable than fossil fuels, the market does still fluctuate. The best way to predict the cost of your biomass fuel is to contact local providers (**go to ► Section P6. Biomass Fuel**). In New Hampshire, the average price for biomass in 2009-2010 was approximately $55 per ton of delivered wood-chips and $250 per ton of delivered pellets (this is bulk delivery of pellets by truck to silo, bagged pellets are more). You should confirm prices in your area before completing this section. **Go to ► Section P6. Biomass Fuel**.

If you do not know which building(s) to assess for biomass heat, **go to ► Section P1a. Selecting a Project.**

IN THIS SECTION

G1a. Existing Fuel Costs

Complete the following table to determine the existing fuel costs for each building being evaluated for a biomass heating system:

Instructions: Existing Fuel Costs

COLUMN 1: List each building that will be affected by the biomass project.

COLUMN 2: List the type of fuel(s) currently being used to heat each building. (For more detailed information on collecting fuel use/cost data, **go to ▶ P3. Existing Fuel Use**).

COLUMN 3: Identify how much of each type of fuel you are using per year. Check if the fuel used for heating includes fuel for domestic hot water (DHW). If the fuel used for heating does not include DHW, get the estimated consumption of fuel for DHW from the building owner/maintenance staff and add it to your Current Annual Usage. If no estimates are available add 11% of the fuel consumption for space heating for DHW. Annual Usage for Heat _____ x 11% = DHW. (Add this to Current Annual Usage for heat) in column 3.

COLUMN 4: Identify how much you are paying (per gallon, kWh, etc.) for each type of fuel.

COLUMN 5: Multiply column 3 by column 4 to determine the average annual cost of each type of fuel.

COLUMN 6: Multiply current annual usage (column 3) by 15% (see Appendix A for an explanation of this number) to identify how much of your existing fuel sources you will be using after the biomass energy system has been installed.

COLUMN 7: Multiply column 6 by column 4 to determine the average annual cost of non-biomass fuel you will need with the proposed biomass system.

G1a. EXISTING FUEL COSTS

COLUMN 1 Building	COLUMN 2 Type of Fuel	COLUMN 3 Current Annual Usage	COLUMN 4 Current Average Price	COLUMN 5 Average Annual Cost	COLUMN 6 Average Usage with Biomass System	COLUMN 7 Average Annual Cost with Biomass System

G1a EXAMPLE. **EXISTING FUEL COSTS**

COLUMN 1 Building	COLUMN 2 Type of Fuel	COLUMN 3 Current Annual Usage	COLUMN 4 Current Average Price	COLUMN 5 Average Annual Cost	COLUMN 6 Average Usage with Biomass System	COLUMN 7 Average Annual Cost with Biomass System
School	*Fuel Oil*	*100,000 gallons*	*$2.50*	*$250,000*	*15,000 gallons*	*$37,500*
Town Hall	*Propane*	*8,000 gallons*	*$2.00*	*$16,000*	*1,200 gallons*	*$2,400*

G1b. Estimated Fuel Cost Savings

Biomass projects are capital intensive projects and require substantial upfront cost. The biomass system also has marginally higher Operation and Maintenance (O & M) costs than fossil fuel systems. The net savings in annual cost is likely to be much lower than savings in fuel cost.

The worksheet below estimates the first-year dollar savings, but the major benefits of a biomass system often come in future years when fossil fuel prices have escalated significantly while the biomass fuel rates stay quite flat due to stable fuel pricing and operating costs.

NOTE: **If you are evaluating a district biomass heating plant that will be owned and operated by an independent entity (not the facility owner or town), go to ▶ Section G1c.**

You can estimate the proposed fuel costs, and estimated savings, with a biomass system for a facility- or town-owned biomass system with the table on page 62.

Modern biomass systems use state-of-the-art control technologies to ensure efficient and clean combustion.

Instructions: Estimated Savings with Biomass Heating System

COLUMN 1: Repeat buildings from Section G1a.

COLUMN 2: Repeat existing fuel types from Section G1a.

COLUMN 3: Multiply column 3 of Table G1a by 85% for amount of existing fuel to be replaced (see **Appendix A for Assumptions**).

COLUMN 4: Identify what type of biomass fuel you will be using – see ▶ **Section P5b. Biomass Systems** to identify the type of fuel you will be using. You can use the very rough average of 10 tons of woodchips per 1000 SF per year or see ▶ **Section P6c. Amount of Biomass Fuel**, to determine your projected annual usage.

COLUMN 5: Determine how much you will pay per ton of biomass fuel. You can use an average of $55 per ton of woodchips or $250 per ton of wood pellets or see ▶ **Section P6d. Biomass Fuel Providers** to get current accurate pricing.

COLUMN 6: Multiply column 4 from Table G1a by column 5 to find the average annual cost of biomass fuel.

COLUMN 7: Add column 7 from Table G1a to column 6 to estimate total annual fuel costs with biomass system.

COLUMN 8: Subtract column 7 from column 5 from Table G1a to estimate your annual fuel savings with a biomass system. **(If this number is negative you will not save money with a biomass system.).**

G1b. ESTIMATED SAVINGS WITH BIOMASS HEATING SYSTEM

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8
Building	**Existing Fuel Type**	**Amount of Existing Fuel to Be Replaced**	**Tons Required to Replace Existing Fuel**	**Cost per Ton**	**Average Annual Cost for Biomass**	**Total Average Annual Cost**	**Estimated Savings**

G1b EXAMPLE. **ESTIMATED SAVINGS WITH BIOMASS HEATING SYSTEM**

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8
Building	**Existing Fuel Type**	**Amount of Existing Fuel to Be Replaced**	**Tons Required to Replace Existing Fuel**	**Cost per Ton**	**Average Annual Cost for Biomass**	**Total Average Annual Cost**	**Estimated Savings**
School	*Fuel Oil*	*85,000 gallons*	*1,450*	*$55*	*$5,500*	*$117,250*	*$132,750*
Town Hall	*Propane*	*6,800*	*73*		*$4,015*	*$6,470*	*$9,530*

In this example, switching to biomass fuel (woodchips) will save $132,750 per year on the school heating bills and $9,530 on the town hall heating bill for a total annual savings of $142,280.

G1c. Estimated Fuel Cost Savings with a District Biomass System Owned and Operated by an Independent Entity

It is important to note that fuel cost savings calculated in section G1b are for single or multiple buildings that have a biomass system that is owned by the facility or community. The district heating systems are more like an electric or gas utility, where the price the customer pays depends on fuel cost but also on many other costs that the system owner/operator must bear. The rate for heat paid by the customer has to reflect all the system owner's costs, not just the fuel cost. Hence if the district heating system is owned by a developer or independent party that owns and operates the district heating plant, the actual savings to the facility owners will be about 5-10% of their annual fuel cost without any investment in the project. In such a case, no payback period analysis is required. There may be options for facility owners to contribute part of the cost of the energy transfer station and inter-connection. Such options should be considered in the feasibility study. To evaluate fuel cost savings with a district system owned and operated by an independent entity complete the table below:

Instructions: Estimated Savings with Biomass Fuel for a District System with an Independent Owner/Operator

COLUMN 1: List buildings that are being evaluated for tie-in to the district heating system.

COLUMN 2: List the total current annual fuel costs for each building (see **G1a**).

COLUMN 3: Multiply the current annual fuel costs (column 2) by 10% to estimate savings for each building that will tie into the district biomass system.

G1c. ESTIMATED SAVINGS WITH BIOMASS FUEL FOR A DISTRICT SYSTEM WITH AN INDEPENDENT OWNER/OPERATOR

COLUMN 1	COLUMN 2	COLUMN 3
Building	**Current Annual Fuel Cost**	**Estimated Year-One Savings**

EXAMPLE: In this example, a town is contracting with an independent operator to build and run a district biomass heating system.

G1c EXAMPLE. **ESTIMATED SAVINGS WITH BIOMASS FUEL FOR A DISTRICT SYSTEM WITH AN INDEPENDENT OWNER/OPERATOR**

COLUMN 1	COLUMN 2	COLUMN 3
Building	**Current Annual Fuel Cost**	**Estimated Year-One Savings**
Wastewater Trt. Plant	*$110,000*	*$11,000*
Supermarket	*$55,000*	*$5,500*
Safety Complex	*$80,000*	*$8,000*

G1d. Payback / Life-Cycle Costs

To fully evaluate the economic benefits of a biomass system you need to look at the life cycle costs, which take into account the capital investment required for the biomass systems, cost of energy over the life of system considering escalation in fuel cost, and time-value of the money. The life-cycle costs analysis is a complex analysis that needs to be done by the consultants during the pre-feasibility or feasibility study and is outside the scope of the *Roadmap*. At this stage a simple payback analysis based on savings in fuel cost for the first year can be used as a general guideline. It must be noted that the simple payback analysis does not consider the increase in fuel cost savings over the period of operation of the biomass system. This simple estimate will over-estimate the length of the payback period because the cost of fossil fuel is expected to increase more rapidly than the cost of biomass fuel. The benefits to users comes in future years when fossil fuel prices have escalated significantly while the biomass fuel rate stays quite flat due to stable fuel pricing and operating costs.

Complete the table below for a rough estimate of your payback period.

Instructions: Payback Period Simple *Estimate*

COLUMN 1: Determine the average capital cost of your system. **Go to ▶ P5h. Capital Cost** to estimate the capital cost for your system.

COLUMN 2: For **Single Buildings**, sum the estimated fuel savings for each building (section G1b). For **Multiple buildings**, sum the estimated fuel savings for all buildings (section G1b or G1c).

COLUMN 3: Divide Column 1 by Column 2 for the estimated payback period.

G1d. PAYBACK PERIOD *SIMPLE* ESTIMATE

COLUMN 1		COLUMN 2		COLUMN 3
Capital Cost ($)	÷	First Year Fuel Savings ($)	=	Payback Period (Years)

ROADBLOCK

If the payback period is longer than 15 years, it may be difficult to acquire financing. Community members should consider other factors such as the total project savings over time and other sources of capital that could improve the payback period. They should also discuss what an acceptable payback period is for their community and if this project is an effective way to meet the goal, "We Have Lower Energy Costs." Finally, it is important to remember that fossil fuel prices are constantly changing and doing this analysis in another year or two may result in a much different pay-back period.

G1d EXAMPLE. **PAYBACK PERIOD *SIMPLE* ESTIMATE**

COLUMN 1		COLUMN 2		COLUMN 3
Capital Cost ($)	÷	First Year Fuel Savings ($)	=	Payback Period (Years)
$1,800,000		*$142,250*		*12.7*

If the biomass system required to heat the school and town hall costs $ 1.8 million (including buildings, storage and distribution) and the annual fuel savings will be $ 142,250, it will take twelve and three quarter years to pay off the cost of putting in the system (covered by annual fuel savings). The actual payback period will be much shorter depending on how fast the cost of fossil fuels escalates over the cost of biomass fuel in the coming years.

The back-up oil boiler for the woodchip-fired district energy system that provides heat to the state office building complex in Montpelier, Vermont.

G1e. Stability of Fuel Pricing

While the stability of fuel pricing varies by type of fuel, the majority of New Hampshire's heating fuel comes from fossil energy that is not produced within the region, making the state vulnerable to supply disruptions and price shocks. The graph on the opposite page shows the historic pricing for heating fuels in New Hampshire over the past 20 years.

Woodchip Fuel Pricing

The cost of woodchips used for heating fuel tends to increase more slowly and has historically been much more stable in price over the past two decades than fossil fuels. In Vermont for example, the statewide average woodchip fuel price for institutional biomass heating systems rose from $25 per ton to $55 per ton in the period between 1990 and 2009. The average annual increase during this period was about 3.6% annually[1] with the greatest increases happening recently.

Because woodchip fuel is locally produced from what is generally considered a waste product from some other forest product business, it does not have the same geopolitical pressures that fossil fuels have. Over the past 20 years, woodchip fuel costs have been far less volatile than fossil fuels; however, if biomass becomes a preferred fuel source, pricing dynamics may change in the future.

Wood Pellet Pricing

Wood pellet pricing tends to more closely mirror the fossil fuel market than woodchips do for two reasons:

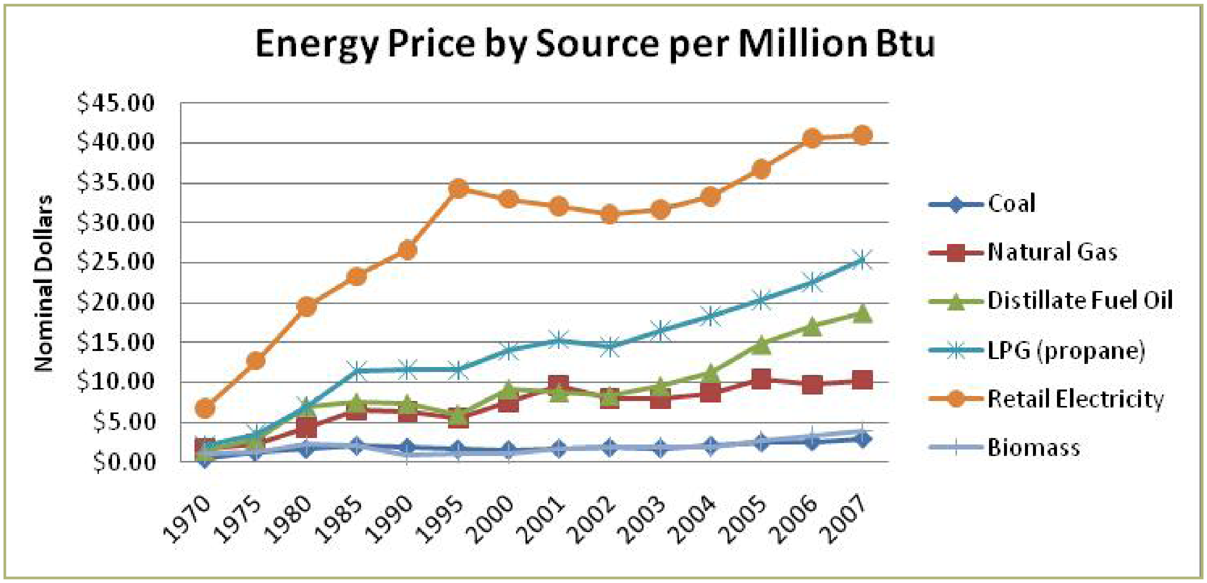
1. Economics of supply and demand
2. There is more fossil fuel input into pellet manufacture and transport than there is into woodchips.

While there is not historical price data for wood pellets, there has been a great fluctuation in pellet prices over the last several years as with fossil fuels. In 2010, wood pellet prices are lower than they were two years ago.

Wood pellet pricing tends to more closely mirror the fossil fuel market than wood-chips.

[1] Extrapolated from Vermont Superintendent Association School Energy Management Program data. Vermont woodchip price history is used because it is one of the only states that has this historical data.

HISTORIC NEW HAMPSHIRE FUEL PRICES



Source: Energy Information Administration: Energy Data 2007: Prices and Expenditures

Biomass and Price Stability

Data shows that woodchip pricing has been relatively stable over the past 20 years while wood pellet prices have fluctuated significantly in parallel with the fossil fuel markets (see chart above). If fuel cost stability is the primary goal of your community, only projects incorporating a woodchip system should be considered at this time. (**see ▶ Section P5. Biomass Energy System**).

Will the biomass project you are evaluating improve the pricing stability of your heating fuel costs?

Yes ☐ **No** ☐

G1f. Summary

Complete the summary table below with information from preceding tables in section G1. (Columns with the shaded background in preceding tables show which informtion should be transferred to the summary table.)

G1f. LOWER ENERGY COSTS SUMMARY

Building	Current Annual Fuel Costs	Estimated Annual Fuel Costs with Biomass	Estimated Annual Fuel Savings with Biomass	Pay-Back Period	Price Stability (G1e)

The cost of woodchips used for heating fuel tends to increase more slowly and has historically been much more stable in price over the past two decades than fossil fuels.

Links

USDA Fuel Value Calculator
http://www.fpl.fs.fed.us/documnts/techline/fuel-value-calculator.pdf

Fuel Costs

Fuel Cost Comparison Calculator
http://www.warmair.net/html/fuel_cost_comparisons.htm

Heating Systems Cost Calculator
http://www.energyexperts.org/CalculatorsTools/HeatingCostCalculator.aspx

Pricing Trends

Energy Price and Expenditure Estimates by Source: New Hampshire
http://www.eia.doe.gov/emeu/states/sep_prices/total/pdf/pr_nh.pdf

Heating Oil Prices and Outlook
http://tonto.eia.doe.gov/energyexplained/index.cfm?page=heating_oil_prices

Factors Affecting Heating Oil Prices
http://tonto.eia.doe.gov/energyexplained/index.cfm?page=heating_oil_factors_affecting_prices

Fuel Oil pricing history for New Hampshire can be found at:
http://tonto.eia.doe.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=WHOWS074&f=W

Factors Affecting Propane Prices
http://tonto.eia.doe.gov/energyexplained/index.cfm?page=propane_factors_affecting_prices

Propane pricing history for New Hampshire can be found at:
http://tonto.eia.doe.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=WPRRE074&f=W

Electric power pricing history can be found at (you will need to open the 1990-2008 Excel Spreadsheet and sort by state to determine NH's electric power pricing history):
http://www.eia.doe.gov/cneaf/electricity/epa/epa_sprdshts.html

Fuel Cost for Electricity Generation: 1997-2008
http://www.eia.doe.gov/cneaf/electricity/epa/figes4.html

Pricing Forecast

All Fuels Demand and Price Forecast
http://www.nyserda.org/sep/sepappendix.pdf

US Energy Information Administration: Annual Energy Outlook
http://www.eia.doe.gov/oiaf/aeo/index.html

► Assess

Section G1. We Have Lower Energy Costs

You have now completed Section G1. We Have Lower Energy Costs. Based on the information you have collected:

Does the Estimated Fuel Cost Savings meet the needs of the community?

Yes ☐ **No** ☐

Does the Pay-Back Period meet the needs of the community?

Yes ☐ **No** ☐

Yes → GO

If you answered yes to both of these questions, transfer the information you have collected into the Community Goals summary worksheets. You can now:

1. Assess whether the project will help you meet **another community goal** (**Go to** ► **Section G. Community Goals** to select another goal to evaluate)
2. Collect **more information** about the project **to further clarify its feasibility** (**Go to** ► **P1. Project Characteristics**). Remember, you have already collected some of the information in this section to complete your assessment of Goal G1. You can enter the information you have collected into the Evaluate a Biomass Project Summary Worksheets to determine which information you still need to collect. **Go to** ► **Evaluate a Biomass Project Summary Worksheets**.

No → ROADBLOCK

If you answered no to at least one of these questions it is less likely that this biomass project will help the community lower its energy costs. You can:

1. Decide to continue evaluation of this project. See choices above.
2. Try to **move around the roadblock(s)**. Remember that as the price of fossil fuels goes up and the biomass technology continues to evolve, this project may help the community lower its energy costs in the future. Reassess this community goal in one to two years.
3. Select a different facility or district to evaluate if you are still interested in pursuing a biomass project in your community. **Go to** ► **P1a. Selecting a Project**.

G2. We Are Energy Independent

[Add Tab Here]

G2. We Are Energy Independent

G2. We Are Energy Independent

This Roadmap was produced by Yellow Wood Associates and the Biomass Energy Resource Center for the North Country RC&D.

► We Have Lower Energy Costs
► We Are Energy Independent
► Our Energy Is Reliable
► We Emit Less Carbon
► We Rely on Renewable Energy Resources
► We Are Energy Efficient
► We Have a Strong Local Economy

► COMMUNITY GOAL 2

G2. We Are Energy Independent

DEFINITION: **Energy is derived from local sources as much as possible to assure a degree of price stability and protection from international supply disruptions.**

Introduction

There is a significant volume of woody biomass available in the northeast. Woody biomass is a highly efficient source of heat energy and may be used to meet most local energy needs for space heating.

To find out if a biomass heating system will help you meet your goal you first have to define the parameters of energy use you want to focus on. You will need to decide which buildings to consider. For example, you may decide to focus on one or more municipally owned buildings like a town hall or garage, or you may want to focus on commercial, industrial, or residential buildings or clusters of buildings. You will also have to decide what you mean by "local."

IN THIS SECTION

G2a. Define "Local Sources"

Everyone has a different definition of local and sometimes this definition will change depending on the issue it is addressing. It is up to you and your community to define what local means to you in relation to sources of fuel. Some options include:

- Within _________ miles from the site (fill in distance you define as local)
- Within the State of New Hampshire
- Within the Northeast
- Within the United States
- Other definition of local: ____

You also may want to rank your options where, "Local 1" is within 30 miles of your site, "Local 2" is within the State of New Hampshire and "Local 3" is within the Northeast. Any fuel that does not come from one of these three local rankings will be considered external.

What definition of "Local" will you be using?

LOCAL = ____

OR

LOCAL 1 = ____

LOCAL 2 = ____

LOCAL 3 = ____

G2b. Current Amount of Heating Fuel from Local Sources

To determine what percentage of your current heating fuel comes from local sources, complete the following table:

Instructions: Percent of Existing Heating Fuel from Local Sources

COLUMN 1: List each building that will be affected by the biomass project.

COLUMN 2: List the type of fuel(s) currently being used to heat each building.

COLUMN 3: Using your definition of local and the information in section **G2d. Where Does My Fuel Come From?**, identify if the fuel is generated locally or externally (not locally).

COLUMN 4: Identify what proportion each fuel is of the overall fuel use. See **G2b-2. Buildings with Multiple Heating Fuels Worksheet**.

If the building is heated by only one type of fuel, this will be 100%.

If the building is heated by more than one type of fuel you will determine what percentage that fuel is of the overall fuel used based on the square footage of each zone of fuel use.

COLUMN 5: List the total percentage of fuel used from local sources. Note: If you are using multiple "local" definitions, list the percentage from each level of local (see example on page 74).

G2b-1. PERCENT OF EXISTING HEATING FUEL FROM LOCAL SOURCES

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Building	Type of Fuel	Local/External	% of Total Fuel Use	Total % of Fuel from Local Sources for each Building

EXAMPLE: *This example looks at a biomass system that will serve two town buildings. The community has defined two levels of local, Local 1 = within 30 miles and Local 2 = within New Hampshire. The school is currently heated by fuel oil and the town hall is heated by propane.*

G2b-1 EXAMPLE. PERCENT OF EXISTING HEATING FUEL FROM LOCAL SOURCES

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Building	**Type of Fuel**	**Local/External**	**% of Total Fuel Use**	**Total % of Fuel from Local Sources for each Building**
School	*Fuel Oil*	*External*	*100%*	*0%*
Town Hall	*Propane*	*External*	*100%*	*0%*

Instructions: Buildings with Multiple Heating Fuels Worksheet

COLUMN 1: For each building heated by multiple sources, list each building zone heated by a separate fuel source.

COLUMN 2: List the type of fuel used in each zone.

COLUMN 3: List the size of each zone in square footage (for more information see section P3a – Heating Fuel Type and Usage).

COLUMN 4: Divide the square footage of the zone (column 3) by the total building square footage (for more information on total building square footage **go to ▶ Section P2b. Building Size**).

G2b-2. BUILDINGS WITH MULTIPLE HEATING FUELS WORKSHEET

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4
Building Zone	**Type of Fuel Used**	**Square Footage**	**% of Total**

G2c. Estimated Amount of Heating Fuel from Local Sources with Proposed Biomass System

To estimate what percentage of your heating energy will come from local sources with a biomass heating system, complete the following table.

Instructions: Estimated % of Heating Fuel from Local Sources with Biomass Systems

COLUMN 1: Repeat buildings from previous table.

COLUMN 2: If none of your existing fuel comes from local sources enter "0" in this column. If some of your existing fuels comes from local sources multiply the number in column 5 from Table G2b-1 by 15%. If you are using more than one definition of local indicate which level of local (for example, 5% Local 1).

COLUMN 3: Using your definition of local, determine if your biomass fuel will come from local or external sources (**go to ▶ P6. Biomass Fuel**). If some of your fuel will come from local sources and some from external sources or if you are using multiply definitions of local list the biomass fuel as many times as necessary per building.

COLUMN 4: Enter 85% (see Appendix A) if you are using only one definition of local. If you are using more than one definition of local, identify what percentage of your biomass fuel will come from each category and then multiply by 85%.

Local 1: ________% multiplied by 85% = _______ %

Local 2: ________% multiplied by 85% = _______ %

COLUMN 5: Add column 2 and column 4 to estimate what % of your fuel will come from local sources. Note: If you are using multiple "local" definitions total % for each level of "local."

G2c. ESTIMATED % OF HEATING FUEL FROM LOCAL SOURCES WITH BIOMASS SYSTEM

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Building	**% of Existing Fuel from Local Sources**	**Local / External**	**Biomass = % of Total Fuel Use**	**Total % of Fuel from Local Sources for each Building**

EXAMPLE. *This example looks at a biomass system that will serve two town buildings. The community has defined two levels of local, Local 1 = within 30 miles and Local 2 = within New Hampshire. For this community it is possible to get 75% of the biomass needed for the school from a local chipper (15 miles from the site); the rest will come from within New Hampshire. All of the biomass fuel needed for the town hall will come from the local chipper (15 miles from the site).*

G2c EXAMPLE. **ESTIMATED % OF HEATING FUEL FROM LOCAL SOURCES WITH BIOMASS SYSTEM**

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Building	**% of Existing Fuel from Local Sources**	**Local/External**	**Biomass = % of Total Fuel Use**	**Total % of Fuel from Local Sources for each Building**
School	*0%*	*Local 1*	*(75% x 85%) 63.75%*	*63.75% - Local 1*
School		*Local 2*	*(25% x 85%) 21.25%*	*21.25% - Local 2*
Town Hall	*0%*	*Local 1*	*85%*	*85% - Local 1*

This example shows that with a biomass heating system, 85% (sum of Local 1 and Local 2) of the school's heating energy will come from within New Hampshire, with 63.75% of that coming from within 15 miles of the site, and 85% of the Town Hall's heating energy will come from within 15 miles of the site.

G2d. Where Does My Fuel Come From?

Fuel Oil

The United States has two sources of heating oil: domestic refineries and imports from foreign countries. Refineries produce heating oil as a part of the "distillate fuel oil" product family, which includes heating oils and diesel fuel. All distillate fuel oil is a product of crude oil. The world's top five crude oil-producing countries are: Russia, Saudia Arabia, the United States, Iran, and China. About 53% of the crude oil and petroleum products used in the US in 2009 came from outside the country. Crude oil that is produced in the US comes primarily from the Gulf of Mexico, Texas, Alaska, California, Louisiana, and North Dakota.

http://tonto.eia.doe.gov/kids/energy.cfm?page=oil_home-basics

Propane

Propane is a one of many petroleum hydrocarbons that come from crude oil or natural gas processing plants. The majority of our propane, about 90%, is produced in the US from petroleum and natural gas but, since the US imports two-thirds of the petroleum we use, more than 30% of the "US" propane is made from imported fuel. The major points of production for propane in the US are Conway, Kansas and Mont Belvieu, Texas.

http://www.eia.doe.gov/bookshelf/brochures/propane/propane06/propane.pdf

Natural Gas

Natural gas reserves are located in areas called supply basins. The largest producing regions currently are, in order, Texas, Offshore Gulf Coast, Wyoming, Oklahoma, and New Mexico. The majority of imported natural gas comes from Canada. Recently New England has added three new natural gas pipeline systems, delivering gas from the Gulf Coast, Western Canada, and Eastern Canada. New England is also linked to the import terminal for liquefied natural gas (LNG), located in Massachusetts. Imports come primarily from Trinidad and Tobago in the Caribbean.

http://tonto.eia.doe.gov/energyexplained/index.cfm?page=natural_gas_where

http://www.puc.nh.gov/Gas-Steam/natural-gasinnh.htm

Electric

In 2007, electric power generated in New Hampshire primarily came from coal (13.%), oil (8.9%), gas (13.9%), hydro (6.1%), and nuclear (44.1%).

http://www.nwf.org/Global-Warming/~/media/PDFs/Global%20Warming/Clean%20Energy%20State%20Fact%20Sheets/NEW_HAMPSHIRE_10-22-10.ashx

New Hampshire also produces electricity from renewable energy sources, including hydroelectric power, wood, landfill gas, and municipal solid waste. 10% of the state's electricity generation is derived from these renewable sources. In May 2007, New Hampshire adopted a renewable portfolio standard that requires 25% of the state's electricity to be generated from renewable sources by 2025.

http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=NH

You can use the EPA "Power Profiler" to determine what percentage of your electricity comes from fossil fuel: **http://www.epa.gov/cleanenergy/energy-and-you/how-clean.html**

NH Electricity Sources: Coal - West Virginia, Kentucky, and Pennsylvania are the largest producers of bituminous coal (the type used for generating electricity); **Oil –** See above; **Gas –** See above; **Hydro –** There are Hydroelectric plants in Manchester, Winchester, Bath & Penacook, NH; **Nuclear –** The Seabrook Station Nuclear Power Plant is located just south of Portsmouth, NH.

G2e. Summary

Complete the summary table below with information from preceding tables in section G2. (Columns with the shaded background in preceding tables show which informtion should be transferred to the summary table.)

G2e. SUMMARY

Definition of Local	Building	% Current Heating Fuel from Local Sources	Estimated % of Heating Fuel from Local Sources with Proposed Biomass System

Links

Defining Local

World Bank Local Economic Development Definition
http://go.worldbank.org/EA784ZB3F0

Cornell University: "Community Food Systems" primer
http://www.hort.cornell.edu/department/faculty/eames/foodsys/primer.html

Economic Development and Biomass
http://www.biomasscenter.org/resources/fact-sheets/economic-development.html

Energy Independence

Cooperative Extension System: Biomass Feedstocks and Energy Independence
http://www.extension.org/pages/Biomass_Feedstocks_and_Energy_Independence

Woody Biomass Availability

See ▶ Section P6. Biomass Fuel

► Assess

Section G2. We Are Energy Independent

You have now completed section G2. We Are Energy Independent. Based on the information you have collected:

Will you obtain more heating fuel from local sources with the proposed biomass system?

Yes ☐ **No** ☐

Yes → GO

No → ROADBLOCK

If you answered yes to this question, transfer the information you have collected into the Community Goals summary worksheets. You can now:

1. Assess whether the project will help you meet **another community goal** (**Go to ► Section G. Community Goals** to select another goal to evaluate).
2. Collect **more information** about the project **to further clarify its feasibility** (**Go to ► P1. Project Characteristics**). Remember, you have already collected some of the information in this section to complete your assessment of Goal G2. You can enter the information you have collected into the Evaluate a Biomass Project Summary Worksheets to determine which information you still need to collect. **Go to ► Evaluate a Biomass Project Summary Worksheets**.

If you answered no to this question, it is less likely that this biomass project will help the community be more energy independent. You can:

1. Decide to continue evaluation of this project. See choices under GO.
2. Try to **move around the roadblock**, by continuing to investigate potential local sources of biomass; re-evaluate your community's definition of local; identify the potential for a community-owned wood resource.
3. **Select a different facility or district to evaluate** if you are still interested in pursuing a biomass project in your community. **Go to ► P1a. Selecting a Project**.

G3. Our Energy Is Reliable

[Add Tab Here]

G3. Our Energy Is Reliable

This Roadmap was produced by Yellow Wood Associates and the Biomass Energy Resource Center for the North Country RC&D.

G3. Our Energy Is Reliable

▶ We Have Lower Energy Costs

▶ We Are Energy Independent

▶ Our Energy Is Reliable

▶ We Emit Less Carbon

▶ We Rely on Renewable Energy Resources

▶ We Are Energy Efficient

▶ We Have a Strong Local Economy

▶ **COMMUNITY GOAL 3**

G3. Our Energy Is Reliable

DEFINITION: **Our community has consistent access to energy for heating whenever we need it.**

Introduction

There is a significant volume of woody biomass available in the northeast. Woody biomass may improve energy reliability depending on current conditions, supply continuity, and performance of biomass technologies.

To find out if a biomass heating system will help you meet your goal you first have to clarify your concerns with respect to reliability. What is causing a lack of reliability currently (or what do you anticipate will cause lack of reliability in the future)? If you are concerned about future availability of fossil fuels, has there been a problem in the past? Do you anticipate future problems? Or is your goal really about energy independence rather than reliability? If so, **go to ▶ G2: We Are Energy Independent.**

IN THIS SECTION

G3a. Existing Fuel Supply Reliability

The reliability of heat needs to be addressed on two levels, the first is fuel supply. The majority of heating systems in New Hampshire are currently run on fossil fuels, such as fuel oil or propane. While electric heat provides the most obvious example of reliability issues (due to power outages), disruptions and volatile pricing have the ability to affect the reliability of all heating fuels.

How reliable are your current heating fuel sources?

Consider each source of heating fuel the building(s) being assessed for a biomass heating system currently uses and whether or not there has ever been an issue with lack of availability:

G3a. EXISTING HEATING FUEL AVAILABILITY

Heating Fuel	Lack of Availability (Yes / No)

Do you expect there to be a lack of availability in the future?

Yes ☐ **No** ☐

The reliability of heat needs to be addressed on two levels:

- **the fuel supply**
- **the system creating and delivering the heat**

G3b. Existing Heating System Reliability

The second issue related to the reliability of heat is the system creating and delivering the heat. All heating systems need to be serviced regularly and all systems have the ability to fail, creating a reliability issue. It is important to consider the performance, warranty, and availability of service providers for biomass systems, as it is for all types of heating systems.

How frequently do your current systems fail?

Fails several times per year .... Very Unreliable

Fails one time per year on average .... Somewhat Reliable

Has failed a few times in its lifetime .... Reliable

Has never failed .... Very Reliable

Instructions: Existing Heating System Reliability

COLUMN 1: List each heating system in building(s) being evaluated.

COLUMN 2: List level of reliability of each system based on how frequently the system fails (see above).

G3b. EXISTING HEATING SYSTEM RELIABILITY

COLUMN 1	COLUMN 2
Heating System	**Level of Reliability**

G3c. Biomass Fuel Supply Reliability

While communities tend to have more control over locally sourced energy, biomass fuel supply also can have reliability issues which must be addressed. The reliability of local supply sometimes glosses over issues like mud season, deer hunting season and Christmas-time mill shutdowns. There is also the potential reliability issue of having relatively few woodchip fuel suppliers available in your area, unlike oil and propane where there are lots of competitors throughout the state.

There are three main keys to reliable biomass fuel supply:

1. Having access to multiple suppliers that can get you the type of biomass fuel your system requires. Back-up supply is helpful if the first choice falls through.
2. Securing long-term supply contracts for biomass fuel helps with the reliability of biomass fuel and fuel costs. One year contracts are common but 3-5 year contracts provide greater security.
3. Ownership of the wood resource –a large majority of wood fuel comes from privately owned forestland. Unlike farmers, loggers do not typically own the harvested land. While the lack of resource ownership presents a conceptual weak link in the supply chain, there is a long history of reliable supply of timber from privately owned forestland. One possible solution is that many towns own town forests that could potentially supply at least a part of their biomass needs within a sustainable management regime. While self-supply from town owned forestland may prove helpful in concept, feeding chips to a facility on a continual basis will likely require supply from privately owned forestland.

Fuel supply from town-owned land will provide the community with guaranteed access to reasonably priced fuel.

Go to ▶ P6. Biomass Fuel for more information on answering these questions.

G3c. BIOMASS FUEL SUPPLY RELIABILITY		
	YES	**NO**
We have access to multiple suppliers of the type of biomass fuel we will need.		
We have access to suppliers that are willing to enter into long-term, renewable contracts for biomass fuel.		
Our community owns a wood resource that can supply the biomass fuel we will need AND our community's private landowners are interested in supplying wood fuel.		

G3d. Biomass System Reliability

The reliability of well designed modern biomass systems is the same as, or comparable to, fossil fuel-based systems. As an added precaution, a standby fossil fuel system is always available to ensure 100% reliability. It is normal practice to install a standby fossil fuel-based system to improve overall reliability of biomass systems and provide heat during shoulder seasons. If a biomass system is not able to provide required heat the fossil fuel system can automatically kick in and provide the heat.

Later in the process, if/when the biomass system is being designed, you should consider the technical support available for each system as this will have a great impact on the reliability of your biomass system.

G3e. Summary

Complete the summary table below with information collected in the preceding sections of G3.

G3e. SUMMARY

Building	Reliability of Current Heating Fuel Source	Reliability of Current Heating System(s)	Reliability of Biomass Supply		
			Multiple Suppliers	Long-Term Contracts	Community-Owned Wood Source

Links

Reliability of Fossil Fuel Supply in the Future

National Academy of Sciences Oil Overview

http://needtoknow.nas.edu/energy/energy-sources/fossil-fuels/oil.php

US Energy Information Administration Oil Overview

http://tonto.eia.doe.gov/energyexplained/index.cfm?page=oil_prices

NH and Fuel Supply

NH Office of Energy and Planning overview of NH energy facts and sources

http://www.nh.gov/oep/programs/energy/nhenergyfacts/2007/introduction.htm

New Hampshire Electric Cooperative – Outage Map

http://www.nhec.com/oms.php

Public Service of New Hampshire – Outage Map

http://www.psnh.com/outage/outagemap.aspx

Ready NH Article on the effect of Ice Storms in New Hampshire

http://www.nh.gov/readynh/resources/icestorms.htm

Biomass Fuel Supply

See ► Section P6. Biomass Fuel

Reliability & District Energy

NH Office of Energy and Planning: Energy Planning Advisory Board, Report on June 23, 2006 Stakeholder Forum

http://www.nh.gov/oep/programs/energy/documents/EPAB_Stakeholder_Forum_Report.pdf

New Hampshire Energy Plan

http://www.nh.gov/oep/programs/energy/StateEnergyPlan.htm

U.S. Department of Energy – Office of Electricity Delivery and Reliability

http://www.oe.energy.gov/organization.htm

Energy Efficiency and Reliability

Energy Efficiency and Reliability Center at Purdue

http://www.calumet.purdue.edu/energycenter/

Energy Efficiency and Electric System Reliability

http://www.funtener.org/pdfs/u021full.pdf

The Contribution of Energy Efficiency to the Reliability of the U.S. Electric System

http://ase.org/uploaded_files/consumers/ElecReliabilityWP.pdf

▶ Assess

Section G3. Our Energy Is Reliable

You have now completed Section G3. Our Energy is Reliable. Based on the information you have collected:

Will the proposed biomass system provide a more reliable heating system?	**Yes** ☐	**No** ☐
Will the community have access to multiple suppliers of the type of biomass fuel required?	**Yes** ☐	**No** ☐
Will the community have access long-term, renewable contracts for biomass fuel?	**Yes** ☐	**No** ☐
Does the community own a wood resource that can supply the biomass fuel required?	**Yes** ☐	**No** ☐

Yes ➔ GO

If you answered yes to most of these questions, transfer the information you have collected into the Community Goals summary worksheets. You can now:

1. Assess whether the project **will help you meet another community goal** (**Go to ▶ Section G: Community Goals** to select another goal to evaluate)
2. Collect **more information** about the project **to further clarify its feasibility** (**Go to ▶ P1. Project Characteristics**). Remember, you have already collected some of the information in this section to complete your assessment of Goal G3. You can enter the information you have collected into the Evaluate a Biomass Project Summary Worksheets to determine which information you still need to collect. **Go to ▶ Evaluate a Biomass Project Summary Worksheets**.

No ➔ ROADBLOCK

If you answered no to at least one of these questions it is less likely that this biomass project will help the community have reliable energy. You can:

1. Decide to continue evaluation of this project. See choices under GO.
2. Try to **move around the roadblock(s)**. Continue to investigate potential suppliers of biomass fuel, contract options and the potential for a community-owned wood resource. Remember that access to biomass suppliers that meet the needs of your community may evolve over the coming years.
3. **Select a different facility or district to evaluate** if you are still interested in pursuing a biomass project in your community. **Go to ▶ P1a. Selecting a Project**.

G4. We Emit Less Carbon

[Add Tab Here]

G4. We Emit Less Carbon

G4. We Emit
Less Carbon

▶ We Have Lower Energy Costs

▶ We Are Energy Independent

▶ Our Energy Is Reliable

▶ We Emit Less Carbon

▶ We Rely on Renewable Energy Resources

▶ We Are Energy Efficient

▶ We Have a Strong Local Economy

▶ COMMUNITY GOAL 4

G4. We Emit Less Carbon

DEFINITION: **Our community is able to reduce its net carbon emissions.**

Introduction

Burning biomass (wood) recycles carbon that was already in the natural carbon cycle and adds little or no additional carbon to the atmosphere as long as the biomass is sustainably harvested. There are carbon emissions associated with the equipment used to harvest and process biomass as well as for transport of the biomass to your community.

IN THIS SECTION

G4a. Carbon Emissions and Heating Fuels

Carbon emissions refer to the release of greenhouse gases into the atmosphere. In this context we are referring to greenhouse gases that are released through the combustion of heating fuels. Reducing carbon emissions reduces impact on climate change. We have listed the EPA CO_2 guidelines here, but there are many tools available for determining the carbon emissions of your current fuel use (**see G4 Links section**).

G4a. CO_2 EMISSIONS BY HEATING FUEL TYPE

Fuel Type	Pounds of CO_2 per Unit	Unit	Pounds of CO_2 per Million Btu (input on dry basis)
Fuel Oil*	22.26	gallon	161.29
Propane*	12.54	gallon	137.34
Natural Gas*	0.12	cubic foot	117
Electricity**	0.79	kWh	231.46
Biomass – Not Sustainably Harvested***	3667	ton	222.2
Biomass – Sustainably Harvested***	0	ton	0

* http://www.eia.doe.gov/oiaf/1605/coefficients.html

**This number includes a mix (listed in order of percentage) of: Natural Gas, Nuclear, Coal, Oil, Hydro, Biomass and other Fossil Fuels. http://www.epa.gov/cleanenergy/documents/egridzips/eGRID2007V1_1_year05_SummaryTables.pdf

You can use the EPA Power Profiler: http://www.epa.gov/cleanenergy/energy-and-you/how-clean.html to determine the exact CO_2 emissions for your region or, by entering a year's worth of kWh information from you building, you can determine the exact CO_2 emissions for each building.

***Biomass Energy Resource Center. See page 97 for a definition of sustainably harvested biomass.

Biomass Fuel and Carbon Emissions

Most biomass fuel is produced within an average human lifetime, and is therefore considered an active component of the global carbon cycle, a process that transports carbon in various forms throughout the earth's natural systems. Significant quantities of CO_2 are absorbed by plants through photosynthesis, and then released through plant decay. Removing biomass fuel from forests using sustainable forestry practices stimulates the growth of replacement wood. This replacement growth absorbs approximately the same amount of CO_2 as was released during combustion. The key factor is the sustainable harvesting of biomass.

Fossil fuels, such as coal, oil, or natural gas deposits, are produced within a geologic timeframe. The carbon in these long-term deposits is considered 'sequestered' from the global carbon cycle and, when used for energy, add to the cycle additional new carbon that would have remained underground.

If the biomass is not sustainably harvested, meaning that the wood used to make the fuel is not replaced with a similar amount of wood to absorb the CO_2 you can assume that there are 3,667 pounds of CO_2 per ton of biomass burned or 222.2 pounds per million Btu (input on a dry basis).

G4b. Current Carbon Emissions

Complete the table below to estimate the CO_2 emissions of your existing heating fuel use.

Instructions: Existing Carbon Emissions

COLUMN 1: List each building that will be affected by the biomass project.

COLUMN 2: List the type of fuel(s) currently being used to heat each building. If there is more than one fuel type, leave a blank row to total emissions by building.

COLUMN 3: Determine how much of each type of fuel you use annually. **See ▶ P3. Existing Fuel Use** for more information.

COLUMN 4: Determine the CO_2 emissions for each type of fuel used (see CO_2 Emissions by Heating Fuel Type on page 96 or calculate using a different carbon tool).

COLUMN 5: Multiply annual fuel use (column 3) by CO_2 emissions (column 4) to determine your current CO_2 emissions. If a building uses more than one type of fuel, total CO_2 emissions by building.

G4b. EXISTING CO_2 EMISSIONS

COLUMN 1 Building	COLUMN 2 Fuel Type	COLUMN 3 Average Annual Fuel Usage	COLUMN 4 CO_2 Emissions for Fuel Type	COLUMN 5 Total Annual CO_2 Emissions

EXAMPLE: This example looks at a biomass system that will serve two town buildings. The school is currently heated by fuel oil and the town hall is heated by propane.

G4b EXAMPLE. **EXISTING CO_2 EMISSIONS**

COLUMN 1 Building	COLUMN 2 Fuel Type	COLUMN 3 Average Annual Fuel Usage	COLUMN 4 CO_2 Emissions for Fuel Type	COLUMN 5 Total Annual CO_2 Emissions
School	*Fuel Oil*	*10,000 gallons*	*22.26 pounds / gallon*	*222,600 pounds*
Town Hall	*Propane*	*8,000 gallons*	*12.54 pounds / gallon*	*100,320 pounds*
Total				*322,920 pounds*

G4c. Estimated Carbon Emissions with Proposed Biomass System

Step 1 To determine the estimated carbon emissions with the proposed biomass system, you first need to determine if you have access to sustainably harvested biomass. (For more information **go to ▶ P6. Biomass Fuel Sustainability**).

Step 2 Decide what rate of CO_2 emissions you are going to assume for your biomass heat source: _____ lbs/ton. (See CO_2 Emissions by Heating Fuel Type on page 96)

Step 3 Complete the table below to estimate the CO_2 emissions with the proposed biomass system.

Instructions: CO_2 Emissions with Biomass System

COLUMN 1: Repeat buildings from previous table.

COLUMN 2: List all existing fuel types plus biomass fuel for each building. Leave a blank row between buildings to total emissions.

COLUMN 3: For existing fuels multiply average annual fuel usage (**see ▶ G4b. Amount of Biomass Fuel Required**) by 15% (See ▶ Appendix A for Assumptions).

For amount of biomass fuel see ▶ P6c. Amount of Biomass Fuel.

COLUMN 4: List the CO_2 emissions for each fuel type. See CO_2 Emissions by Fuel Type on page 96 or calculate using a different tool.

COLUMN 5: Multiply annual fuel use (column 3) by carbon emissions (column 4) for the estimated CO_2 emissions. Total the CO_2 emissions for each building.

G4c. CO_2 EMISSIONS WITH BIOMASS SYSTEM

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Building	**Fuel Type**	**Average Annual Fuel Usage**	**CO_2 Emissions for Fuel Type**	**Total Annual CO_2 Emissions**

EXAMPLE: *This example assumes access to sustainably harvested biomass, and that the biomass fuel is carbon neutral (has no CO_2 emissions).*

G4c EXAMPLE. CO_2 EMISSIONS WITH BIOMASS SYSTEM

COLUMN 1 Building	COLUMN 2 Fuel Type	COLUMN 3 Average Annual Fuel Usage	COLUMN 4 CO_2 Emissions for Fuel Type	COLUMN 5 Total Annual CO_2 Emissions
School	*Fuel Oil*	*1,500 gallons*	*22.26 pounds / gallon*	*33,390 pounds*
	Biomass	*145 tons*	*0 pounds / ton*	*0 pounds*
School Total				*33,390 pounds*
Town Hall	*Propane*	*1,200 gallons*	*12.54 pounds / gallon*	*15,048 pounds*
	Biomass	*72 tons*	*0 pounds / ton*	*0 pounds*
Town Hall Total				*15,048 pounds*

The carbon implications and/or benefits of biomass energy depend entirely on several factors, including: where the wood comes from, applied forest management practices, how harvesting and management are distributed over the landscape and over time, and the types of technology used.

G4d. Estimated Annual CO_2 Emission Savings

Complete the following table to determine the estimated annual rate of CO_2 emissions savings.

Instructions: Estimated Annual Rate of CO_2 Emissions Savings

COLUMN 1: Add up the totals from column 5 of Existing CO_2 Emissions table (G4b).

COLUMN 2: Add up the totals from column 5 of CO_2 Emissions from Biomass table (G4c).

COLUMN 3: Subtract column 2 from column 1 to estimate your annual CO_2 savings. For district systems, you can total the numbers in column 3 to estimate the entire impact of the system.

NOTE: **If you get a negative number in column 3, you will be increasing your CO_2 emissions with the proposed system.**

G4d. ESTIMATED ANNUAL RATE OF CO_2 EMISSIONS SAVINGS

COLUMN 1		COLUMN 2		COLUMN 3
Total Existing CO_2 Emissions (pounds)	minus	Total Estimated CO_2 Emissions with Biomass System	=	Annual CO_2 Savings (pounds)

This example shows the proposed biomass project will save approximately 274,482 pounds of CO_2 emissions each year.

G4d EXAMPLE. **ESTIMATED ANNUAL RATE OF CO_2 EMISSIONS SAVINGS**

COLUMN 1		COLUMN 2		COLUMN 3
Total Existing CO_2 Emissions (pounds)	minus	Total Estimated CO_2 Emissions with Biomass System	=	Annual CO_2 Savings (pounds)
322,920		*48,438*		*274,482*

G4e. Summary

Complete the summary table below with information from preceding tables in section G4. (Columns with the shaded background in preceding tables show which information should be transferred to the summary table.)

G4e. SUMMARY

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
	EXISTING	PROPOSED	PROPOSED	PROPOSED
Building	Total Annual CO_2 Emissions	Total Estimated Annual CO_2 Emissions	Estimated Annual CO_2 Emission Savings	Estimated % Reduction on Annual CO_2 Emissions (Divide column 4 by column 2)

Links

Carbon Emissions of Different Fuels

Biomass Energy Centre Carbon Emissions of Different Fuels

http://www.biomassenergycentre.org.uk/portal/page?_pageid=75,163182&_dad=portal&_schema=PORTAL

EPA Emissions Calculator Assumptions and References

http://www.epa.gov/climatechange/emissions/ind_assumptions.html

Electricity

Electricity emissions factors are categorized by geographic subregion. Source: EPA. eGRID Version 2.1 Plant File, 2006. "Typical" annual CO_2 emissions are 14,796 pounds per household, assuming approximately 900 kWh per month. Source: U.S. Energy Information Administration 2004. A Look at Residential Energy Consumption in 2001.

Natural Gas

Carbon coefficient for natural gas: 117 pounds of CO_2 per million BTU, or 0.12 pounds per cubic foot of gas. Source: U.S. EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005 (EPA 2007). "Typical" annual CO_2 emissions of 9,500 pounds per household based on national average monthly consumption of 7,915 cubic feet of gas. Source: U.S. Energy Information Administration 2004. Natural Gas Navigator 2001.

Fuel Oil

Carbon coefficient for distillate fuel (fuel oil): 161.29 pounds of CO_2 per million BTU, or 22.37 pounds per gallon. Source: U.S. EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005 (EPA 2007).

"Typical" annual CO_2 emissions of 11,400 pounds per household based on national average monthly consumption of 42 gallons of oil. Source: U.S. Energy Information Administration 2004. A Look at Residential Energy Consumption in 2001.

Propane

Carbon coefficient for LPG (propane): 137.34 pounds of CO_2 per million Btu, or 12.17 pounds per gallon. Source: U.S. EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005 (EPA 2007). "Typical" annual CO_2 emissions of 6,800 pounds per household based on national average monthly consumption of 45 gallons of propane. Source: U.S. Energy Information Administration 2004. A Look at Residential Energy Consumption in 2001

Biomass

Carbon Dioxide and Biomass Energy

http://www.biomasscenter.org/resources/fact-sheets/biomass-co2.html

Other Carbon Footprint Tools

New England Carbon Challenge Carbon Calculator

http://necarbonchallenge.org/calculator.jsp

Small Town Carbon Calculator

http://www.cleanair-coolplanet.org/for_communities/stocc.php

ACORE Calculate your Carbon Footprint

http://www.acore.org/carbon_footprint

Biomass and Carbon Emissions

Biomass Fuels, Energy, Carbon, and Global Climate Change

http://www.ornl.gov/info/ornlreview/rev28_2/text/bio.htm

Biomass, Bioenergy, and Carbon Management

http://www.nrel.gov/docs/gen/fy99/25695.pdf

▶ Assess

Section G4. We Emit Less Carbon

You have now completed section G4. We Emit Less Carbon. Based on the information you have collected:

Will the proposed biomass system provide sufficient carbon savings to meet the goals of the community?

Yes ☐ **No** ☐

Yes → GO

No → ROADBLOCK

If you answered yes to this question, transfer the information you have collected into the Community Goals summary worksheets. You can now:

1. Assess whether the project will help you meet **another community goal** (**Go to ▶ Section G: Community Goals** to select another goal to evaluate)
2. Collect **more information** about the project to further clarify its feasibility (**Go to ▶ P1. Project Characteristics**). Remember, you have already collected some of the information in this section to complete your assessment of Goal G4. You can enter the information you have collected into the Evaluate a Biomass Project Summary Worksheets to determine which information you still need to collect. **Go to ▶ Evaluate a Biomass Project Summary Worksheets**.

If you answered no to this question, it is less likely that this biomass project will help the community reach its carbon emissions goals. You can:

1. Decide to continue evaluation of this project. See choices under GO.
2. **Select a different facility or district to evaluate** if you are still interested in pursuing a biomass project in your community. **Go to ▶ P1a. Selecting a Project**.

G5. We Rely on Renewable Energy Resources

[Add Tab Here]

This Roadmap was produced by Yellow Wood Associates and the Biomass Energy Resource Center for the North Country RC&D.

G5. We Rely on Renewable Energy Resources

► We Have Lower Energy Costs

► We Are Energy Independent

► Our Energy Is Reliable

► We Emit Less Carbon

► We Rely on Renewable Energy Resources

► We Are Energy Efficient

► We Have a Strong Local Economy

► COMMUNITY GOAL 5

G5. We Rely on Renewable Energy Resources

DEFINITION: **More of the energy our community uses comes from non-fossil fuel sources.**

Introduction

Biomass is a substitute for fossil fuels and can provide heat or heating and cooling from a renewable resource. Renewable energy is energy that comes from natural resources that are naturally replenished. The energy source is considered "renewable" when the rate of generation is higher than the rate of use. In the case of biomass, this means the removal (and hence the use) of biomass must be less than the growth of biomass in the forest. It is important to remember that biomass is only considered a renewable energy source if the biomass is sustainably harvested.

Other examples of renewable energy are sunlight, wind, water and geothermal heat. Some of New Hampshire's energy already comes from renewable energy resources such as hydropower and biomass, but most of the fuel used in New Hampshire comes from fossil fuels that are non-renewable. Fossil fuels include fuel oil, propane, natural gas, and electricity (depending on the source of your electricity). You can determine where your electric energy comes from with the EPA "Power Profiler": **http://www.epa.gov/cleanenergy/energy-and-you/how-clean.html.**

While this *Roadmap* focuses exclusively on biomass, other renewable energy sources such as geothermal and solar may also be able to move you toward your goal, possibly in combination with biomass.

IN THIS SECTION

G5a. Sustainably Harvested Biomass Fuel

To determine if a biomass system will help you meet your goal of increasing reliance on renewable energy resources, you will need to define what sustainably harvested biomass fuel means to your community and then determine if you have access to sustainably harvested biomass fuel that meets your definition.

One Common Definition of Sustainable Forestry: *Sustainable forestry keeps the forest healthy and ensures that harvest management supports the overall ecological function and integrity of the forest ecosystem. The simplest definition of sustainable harvesting is harvesting wood from the forest no faster than it is being re-grown. Biomass can be harvested as part of sustainable forest management.*

There are many resources available in New Hampshire to assist you in learning and thinking about sustainable forest management and the role of biomass fuel production, including:

- UNH Cooperative Extension
  (800) 444-8978 and http://ceinfo.unh.edu/Forestry/Forestry.htm
- NH Timberland Owners Association
  (603) 224-9699 and http://www.nhtoa.org/
- Good Forestry in the Granite State: Recommended Voluntary Forest Management Practices for New Hampshire
  www.goodforestry.pbworks.com
- Energy From Woody Biomass: A Review of Harvesting Guidelines and a Discussion of Related Challenges
  www.pinchot.org/uploads/download?fileId=488

Local foresters and forest professionals can be helpful as well. Be sure to inform yourselves about sustainable forestry overall before developing a definitions of sustainable biomass harvesting. **Go to ▶ P6a. Biomass Fuel Sustainability** for more information.

What is your definition of sustainably harvested biomass fuel?

____

____

Do you have access to sustainably harvested biomass fuel as per your definition?
(**See ▶ Section P6d. Biomass Fuel Providers** for more information.)

☐ **Yes** ☐ **No**

ROADBLOCK **If you do not have access to sustainably harvested biomass fuel, a biomass heat system will not help you achieve your goal of increasing reliance on renewable energy sources. To move around this roadblock, you can continue to investigate access to sustainably harvested biomass fuel. Remember that access to biomass suppliers and fuel that meet the needs of your community may evolve over the coming years.**

G5b. Current Heating Fuel from Renewable Energy Sources

If you do have access to sustainably harvested biomass you will now need to determine how reliant you currently are on renewable energy resources for heating and then compare that to how reliant you will be on renewable energy resources when the biomass heating system is implemented.

Complete the following table to identify your current use of renewable energy sources.

Instructions: Existing % of Heating Fuel from Renewable Energy Sources

COLUMN 1: List each building that will be affected by the biomass project.

COLUMN 2: List the type of fuel(s) currently being used to heat each building.

COLUMN 3: Using the information above, identify whether the fuel is a renewable energy resource.

COLUMN 4: What proportion is that fuel of the overall fuel use? (If the building is heated by more than one type of fuel, you will need to determine what percentage each fuel is of the overall.)

If the building is heated by only one type of fuel, this will be 100%.

If the building is heated by more than one type of fuel you will determine what percentage that fuel is of the overall based on the square footage of each zone of fuel use. If the building you are evaluating uses more than one type of heating fuel, go to ▶ **G2b-2. Buildings with Multiple Heating Sources Worksheet.**

COLUMN 5: Add up the percentages of all fuels for each building that are from renewable sources.

G5b. EXISTING % OF HEATING FUEL FROM RENEWABLE ENERGY SOURCES

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Building	**Type of Fuel**	**Renewable / Non-Renewable Fuel**	**% of Total Fuel Use**	**Total % of Fuel from Renewable Energy for each Building**

EXAMPLE: *This example looks at a biomass system that will serve two town buildings. The school is currently heated by fuel oil and the town hall is heated by propane.*

G5b EXAMPLE. EXISTING % OF HEATING FUEL FROM RENEWABLE ENERGY SOURCES

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Building	Type of Fuel	Renewable / Non-Renewable Fuel	% of Total Fuel Use	Total % of Fuel from Renewable Energy for each Building
School	*Fuel Oil*	*Non-renewable*	*100%*	*0%*
Town Hall	*Propane*	*Non-renewable*	*100%*	*0%*

Without markets for low-quality wood, only high-quality trees are harvested, thereby degrading the forest quality over time.

G5c. Estimated Heating Fuel from Renewable Energy Sources with Proposed Biomass System

Now complete the table below to estimate the percentage of heating fuel that will come from renewable sources with the proposed biomass system.

Instructions: Estimated % of Heating Fuel from Renewable Energy Sources with Biomass Heating System

COLUMN 1: List each building that will be affected by the biomass project.

COLUMN 2: List the type of fuel(s) that will be used to heat each building including biomass. Leave an empty row between buildings for total.

COLUMN 3: Identify whether the fuel is a renewable energy resource or not.

COLUMN 4: Multiply the percentage of existing fuel (see G5b) by 15%. List biomass fuel as 85%. (See Appendix A for assumptions.)

COLUMN 5: Add up the percentages of all fuels for each building that are from renewable sources.

G5c. ESTIMATED % OF HEATING FUEL FROM RENEWABLE ENERGY SOURCES WITH BIOMASS HEATING SYSTEM

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Building	**Type of Fuel**	**Renewable / Non-Renewable Fuel**	**% of Total Fuel Use**	**Total % of Fuel from Renewable Energy for each Building**

EXAMPLE: *Assuming access to sustainably harvested biomass, all heat that is replaced by biomass will come from a renewable energy source.*

G5c EXAMPLE. **ESTIMATED % OF HEATING FUEL FROM RENEWABLE ENERGY SOURCES WITH BIOMASS HEATING SYSTEM**

COLUMN 1 Building	COLUMN 2 Type of Fuel	COLUMN 3 Renewable / Non-Renewable Fuel	COLUMN 4 % of Total Fuel Use	COLUMN 5 Total % of Fuel from Renewable Energy for each Building
School	*Fuel Oil*	*Non-renewable*	*15%*	
	Biomass	*Renewable*	*85%*	
				85%
	Propane	*Non-renewable*	*15%*	
	Biomass	*Renewable*	*85%*	*85%*

Using a biomass system with sustainably harvested biomass will increase the use of renewable energy to 85% at the school and 85% at the town hall.

G5d. Summary

Complete the summary table below with information from preceding tables in section G5. (Columns with the shaded background in preceding tables show which informtion should be transferred to the summary table.)

G5d. SUMMARY

Do you have access to sustainably harvested biomass fuel?	Building	Current % of Fuel from Renewable Energy Sources	Estimated % of Fuel from Renewable Energy Sources with a Biomass System

Links

EPA "Power Profiler" tells you what percentage of your electricity comes from fossil fuels:

http://www.epa.gov/cleanenergy/energy-and-you/how-clean.html

Sustainable Forestry & Sustainably Harvested Biomass

A Market Based Approach to Community Wood Energy

http://www.forestguild.org/publications/research/2008/Market_Based_CWEP_Approach.pdf

Biomass from Forests

http://www.forestguild.org/biomass.html

Developing a Sustainable Forest Biomass Industry: Case of the US Northeast

http://bct.nrc.umass.edu/wp-content/uploads/2009/04/developing_sustainable.pdf

Is Biomass Harvesting Sustainable?

http://www.biomassmagazine.com/article.jsp?article_id=1951

New Hampshire and Renewable Energy

New Hampshire Renewable Energy Incentives

http://www.nh.gov/oep/programs/energy/RenewableEnergyIncentives.htm

Environment "New Hampshire: The High Cost of Fossil Fuels: Why America Can't Afford to Depend on Dirty Energy"

http://cdn.publicinterestnetwork.org/assets/F66V87WjB7enmvzCeB6HrQ/The_High_Cost_of_Fossil_Fuels_NHE1.pdf

Biomass and Renewable Energy

U.S. Energy Information Administration – Renewable Biomass

http://tonto.eia.doe.gov/kids/energy.cfm?page=biomass_home-basics-k.cfm

Woody Biomass – A Renewable Energy Source

http://www.mt.nrcs.usda.gov/technical/ecs/forestry/technotes/forestrytechnoteMT31.html

Woody Biomass as Energy Resource

http://www.altenergymag.com/emagazine.php?issue_number=08.12.01&article=zafar

An Environmental Overview of Woody Biomass Utilization

http://www.extension.org/pages/An_Environmental_Overview_of_Woody_Biomass_Utilization

▶ Assess

Section G5. We Rely on Renewable Energy Resources

You have now completed section G5. We Rely on Renewable Energy Resources. Based on the information you have collected:

Do you have access to sustainably harvested biomass fuel?

Yes ☐ **No** ☐

Will you use more fuel from renewable energy sources with the proposed biomass system?

Yes ☐ **No** ☐

Yes ➔ GO

No ➔ ROADBLOCK

If you answered yes to these questions, transfer the information you have collected into the Community Goals summary worksheets. You can now:

1. Assess whether the project will help you meet **another community goal** (**Go to** ▶ **Section G. Community Goals** to select another goal to evaluate)
2. Collect **more information** about the project to further clarify its feasibility (**Go to** ▶ **P1. Project Characteristics**). Remember, you have already collected some of the information in this section to complete your assessment of Goal G5. You can enter the information you have collected into the Evaluate a Biomass Project Summary Worksheets to determine which information you still need to collect. **Go to** ▶ **Evaluate a Biomass Project Summary Worksheets**.

If you answered no to at least one of these questions it is less likely that this biomass project will help the community have reliable energy. You can:

1. Decide to continue evaluation of this project. See choices under GO.
2. Try to **move around the roadblock(s)** by continuing to investigate access to sustainably harvested biomass fuel. Remember that access to biomass suppliers and fuel that meet the needs of your community may evolve over the coming years.
3. **Select a different facility or district to evaluate** if you are still interested in pursuing a biomass project in your community. **Go to** ▶ **P1a. Selecting a Project**.

G6. We Are Energy Efficient

[Add Tab Here]

G6. We Are Energy Efficient

This Roadmap was produced by Yellow Wood Associates and the Biomass Energy Resource Center for the North Country RC&D.

G6. We Are Energy Efficient

► We Have Lower Energy Costs

► We Are Energy Independent

► Our Energy Is Reliable

► We Emit Less Carbon

► We Rely on Renewable Energy Resources

► We Are Energy Efficient

► We Have a Strong Local Economy

► COMMUNITY GOAL 6

G6. We Are Energy Efficient

DEFINITION: **Using less energy to provide the same level of service.**

Introduction

Biomass in itself does not impact energy efficiency. Energy efficiency in buildings comes from: 1) conserving energy through a tight building envelope; 2) using fuel that converts to heat and/or power efficiently; and 3) using a well-maintained and efficient system for conversion. Biomass also does not impact energy conservation, which means using less energy overall. Energy conservation can be achieved through energy efficiency.

Regardless of the type of heating system used energy efficiency is important. A district biomass energy system can offer greater efficiency due to scale of operations over the smaller biomass systems at individual buildings. This is also true for other fossil fuels.

IN THIS SECTION

G6a. Building Efficiency (Thermal)

The envelope of a building is composed of floors, walls, ceilings, and roof as well as any breaks in those surfaces such as windows, doors, and skylights. Heat loss occurs through all of these surfaces impacting how much heat is required to make the space comfortable. Heat loss is mitigated through insulation and other thermal envelope barriers.

On average 63,500 Btus, or 0.46 gallons of fuel oil, are required annually to heat one SF of space in New Hampshire. This number may vary greatly depending on such factors as the age of the heating system, the degree of insulation, and the age and quality of windows and doors.

It is very difficult to assess the efficiency of a building without the input of a highly trained audit resource. The table below can be used as a general guideline for finding out the efficiency level of the buildings – to give you an idea of where the building is on the spectrum of efficiency. If the efficiency level of the buildings is average or inefficient, the building owner(s) should consider the consulting a professional energy auditor to find out about options for improving the efficiency of the building.

EFFICIENCY LEVEL	BTU PER SF ANNUALLY
Very Efficient	40,000 Btu or less
Average Efficiency	40,000 Btus – 90,000 Btu
Inefficient	More than 90,000 Btu

How efficient is your building envelope?

List each building being considered for a biomass heating system and the efficiency level of the building envelope. To determine if your building(s) is thermally efficient, **go to ▶ P3e. Thermal Efficiency.**

G6a. EFFICIENCY OF BUILDING THERMAL ENVELOPE	
Building Name	**Efficiency Level**

ROADBLOCK

If the building is rated "inefficient," then it is important to address the efficiency issues of the building before pursuing a biomass project. To move around this roadblock, use the energy efficiency links at the end of this section to learn more about improving building efficiency. You can also work with a professional energy auditor to identify the most cost-efficient way to address thermal efficiency issues.

Energy Efficiency

Energy efficiency is the practice of using less energy to provide the same level of energy service. For example, insulating a home, and improving heating, ventilation, and air conditioning systems (HVAC), allows a building to use less heating and cooling energy to achieve and maintain a comfortable temperature. Hence, an equal amount of energy can provide more heating and power to more community members if energy efficiency measures are in place. Increased energy efficiency is the single most important measure of success for any community energy project. Increased energy efficiency is the fastest route to lower costs.

As part of the Restructuring Act, the State of New Hampshire has a set of energy efficiency programs designed for statewide implementation. A variety of programs exist, serving residential, commercial, and industrial customers. They include programs for new construction, retrofitting existing structures, and rebate programs for selected lighting and appliances. In addition to the statewide programs, individual utilities run specific programs. Additional details on the core energy efficiency programs may be found by visiting **http://www.NHSaves.com**

New Hampshire communities can take advantage of both the federal and state incentives for energy efficiency projects. A comprehensive list of current programs can be found in the Database of State Incentives for Renewables and Efficiency at the DSIRE.org website.

Among the resources at your disposal is the NH Municipal Energy Assistance Program (NHMEAP), a collaborative effort involving existing New Hampshire entities, funded through the NH Public Utilities Commission. The MEAP process guides selected communities through a roadmap process to reduce municipal energy and greenhouse gas emissions. This process involves conducting a municipal inventory of energy use and greenhouse gas emissions; this helps prioritize selection of buildings for energy audits. The purpose is to provide a guided (and staffed) step-by-step process to help up to 48 New Hampshire communities become project-ready. This effort will set the ground work for future technical assistance through Regional planning commissions and other agencies, and for gaining access to funding through state and federal programs for implementation projects.

The current application deadline has passed but there are many reports and resources available on the website. **http://www.nhenergy.org/index.php?title=New_Hampshire_Municipal_Energy_Assistance_Program**

For more information about the program, contact:
Clean Air Cool Planet at (603) 422-6464; **www.cleanair-coolplanet.org**.

Another valuable resource in the state of New Hampshire dedicated to promoting community energy efficiency, on both the policy and implementation levels, is the Jordan Institute.The Jordan Institute is committed to reducing energy use and carbon emissions in buildings through high performance building consultation, comprehensive project management for major energy efficiency projects, training of professionals in the building design and construction field, and energy related state policy design and implementation. More information can be found at **http://www.JordanInstitute.org.**

G6b. Efficiency of Existing Heating System

The efficiency of a heating system or boiler is equal to 100% of the heat minus the percentage of heat lost up the vent or flue. Sometimes called the Annual Fuel Utilization Efficiency (AFUE), the AFUE measures the amount of heat delivered compared to the amount of fuel supplied to the furnace. So a boiler that has an 80% AFUE rating converts 80% of the fuel supplied to heat (the other 20% is lost).

G6b-1. EFFICIENCY OF FOSSIL FUEL SYSTEMS

Efficiency of System	System Characteristics	AFUE
Low Efficiency	Natural draft that creates a flow of combustion fuels	68% - 72%
	Continuous light	
Mid Efficiency	Exhaust fan controls the flow of combustion gases more precisely	80% - 83%
	Electronic ignition (no pilot light)	
	Small diameter flue pipe	
High Efficiency	Condensing flue gases in a 2nd heat exchanger for extra efficiency	90% - 97%
	Sealed combustion	

Source: http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12530

NOTE: **The majority of existing boilers will be in the low-efficiency range. A few recently installed boilers may be in mid-efficiency range. High-efficiency boilers are not commercially available in the United States.**

How efficient is your current heating system?

If the heating system you are evaluating is regularly serviced, you should be able to identify the system efficiency from the annual tune-up report. If the system has not had a recent system efficiency test, use average values from the table above or Efficiency of Fuel Source (G6d) to estimate the efficiency of the existing system.

G6b-2. EFFICIENCY OF EXISTING HEATING SYSTEM

Building Name	System Efficiency Level

G6c. Efficiency of Biomass Heating System

The energy performance of a biomass heating system is influenced by a number of factors such as the type of biomass fuel, the boiler capacity and seasonal heat load, and the boiler type. For steam boilers, these factors may include the boiler operating pressure, the steam temperature, and the feed water temperature. Other factors include the size and the type of the heating load (i.e., space and/or process heating, single or multiple zones, single or multiple buildings). The energy performance of a district heating (multiple buildings) system will also be influenced by the design supply and return temperatures, and the distribution line pipe sizing. Biomass heating systems tend to be 65-75% efficient.

The energy performance of a biomass heating system is influenced by a number of factors such as the type of biomass fuel, the boiler capacity and seasonal heat load, and the boiler type. Biomass heating or heat-led combined heat and power systems tend to be 65-75% efficient.

G6d. Efficiency of Energy Source

Exergy

When evaluating the use of energy within the community, it is important to gain an understanding of what the energy is capable of doing. Communities should consider the use of energy from an exergetic perspective. Exergy considers both the quantity of the energy used (kWh, GJ, etc.) and its quality (warm water, steam, electricity, etc.).

To maximize potential for benefit, every community should strive to match energy demands with the most appropriate source of energy supply. For example, it requires a lot of wood or fossil fuels to generate electricity; this means it is more efficient to create heat directly from wood than by using it first to generate electricity and then heating with electricity.

G6d-1. EFFICIENCY BY FUEL SOURCE

Fuel Type	Heating Value	Efficiency	Net Heating Value	Amount of Fuel Required for 1 Million Btus of Usable Heat	Amount of Fuel Required to Heat 1,000 SF of Space
#2 Fuel Oil	138,000 Btu/gal	83%	115,000 Btu/gallon	8.70 gallons	552.45 gallons
Propane	91,300 Btu/gal	79%	72,000 Btu/gallon	13.90 gallons	882.65 gallons
Natural Gas	1,025,000 Btu/1000 ft³	80%	820,000 Btu/1000 ft³	1,220 ft³	77,470 ft³
Electricity	3,412 Btu/kWh	98%	3,340 Btu/kWh	299 kWh	18,986.50 kWh
Woodchips (45% MC)	9,075,000 Btu/ton	74%	6,715,500 Btu/ton	0.15 tons	9.46 tons
Wood Pellets (6% MC)	15,510,000 Btu/ton	83%	12,873,300 Btu/ton	0.08 tons	5.08 tons

Source: http://www.fpl.fs.fed.us/documnts/techline/fuel-value-calculator.pdf

How efficient are your current sources of fuel?

Instructions: Efficiency of Current Fuel

List your current source(s) of heating fuel and their efficiency (from G6. Efficiency by Fuel Source).

G6d-2. EFFICIENCY OF CURRENT FUEL	
Existing Fuel	**Efficiency**

How efficient is the proposed biomass fuel source?

Instructions: Efficiency of Proposed Fuel

Identify if the proposed system will use woodchips or wood pellets (**see ▶ Section P5. Biomass Energy System**).

List the efficiency for the proposed fuel type (**see G6b. Efficiency by Fuel Source**).

G6d-3. EFFICIENCY OF PROPOSED FUEL	
Proposed Fuel	**Efficiency**

G6e. District Heat

There are potential efficiency benefits of district energy at three levels: Generation, Distribution, and Efficiency. Through economies of scale, district systems will be able to afford more efficient systems, and relative costs will generally require them to use the most efficient technologies to be affordable. The district systems fueled with biomass are **not** more efficient than single-building systems fueled with fossil fuels. The biomass district heating systems will be more efficient than the smaller biomass systems at individual facilities. Biomass district heating does not necessarily increase efficiency but makes it possible to carry out wide scale fuel switching from fossil fuels to a renewable fuel. There are also potential efficiency gains in transmission of biomass heat. Modern, well-insulated hot water distribution systems as used by district systems are more efficient than steam or hot air distribution systems. Finally, with a district heating system, there are potential gains in energy conservation in the space being heated through advanced thermostat controls and zoning systems. The use of thermostat controls and zoning systems is not limited to biomass installations.

When steam, hot water or chilled water arrives at a customer's building in a district energy system, they are ready to use. They are 100% efficient "at the door" assuming distribution pipes are properly maintained, compared with 80% efficient or less when burning fossil fuels with an individual system in the building.

G6f. Summary

Use the table below to summarize information gathered in this section.

G6f. SUMMARY

Building	Efficiency of Thermal Envelope	Efficiency of Existing Heating System	Efficiency of Existing Heating Fuel	Efficiency of Proposed Biomass Fuel

Links

Energy Calculator

http://www.fpl.fs.fed.us/documnts/techline/fuel-value-calculator.pdf

RETScreen International Energy Efficiency Analysis Software

http://www.retscreen.net/ang/energy_efficiency_projects.php

Energy Efficiency Resources

List of NH State Energy Efficiency Programs

http://www.nh.gov/oep/programs/energy/resources.htm

Reports about NH State Energy Efficiency Programs

http://www.puc.nh.gov/Electric/coreenergyefficiencyprograms.htm

NH Municipal Energy Assistance Program (NHMEAP)

http://www.nhenergy.org/index.php?title=New_Hampshire_Municipal_Energy_Assistance_Program

My Energy Plan

http://myenergyplan.net/

Regional Greenhouse Gas Initiative (RGGI)

http://www.rggi.org/states/program_investments/New_Hampshire

NH Energy Efficiency and Sustainable Energy Board (EESB)

http://www.puc.nh.gov/EESE.htm

NH Local Government Center: Office of Energy Efficiency

http://www.nhlgc.org/resources/energyefficiency.asp

Exergy

Exergy Flow Charts – Global Climate and Energy Project at Stanford University

http://gcep.stanford.edu/research/exergycharts.html

Network of International Society for Low Exergy Systems

http://www.lowex.net/

Low Exergy Systems for High-Performing Buildings and Communities

http://www.annex49.com/background.html

System Efficiency

U.S. Department of Energy and AFUE

http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12530

Biomass Energy Performance (RETScreen International)

http://www.retscreen.net/ang/g_biomas.php

Optimal Boiler Size and its Relationship to Seasonal Efficiency

http://www.energy.rochester.edu/efficiency/optimal_boiler_size.pdf

District Energy

International District Energy Association

http://www.districtenergy.org/

► Assess

Section G6. We Are Energy Efficient

You have now completed section G6. We Are Energy Efficient. Based on the information you have collected:

Is the thermal envelope efficient?

Yes ☐ **No** ☐

Will the proposed biomass system and fuel be more efficient than the existing heating system and fuel?

Yes ☐ **No** ☐

Yes ➔ GO

If you answered yes to these questions, transfer the information you have collected into the Community Goals summary worksheets. You can now:

1. Assess whether the project will help you meet **another community goal** (**Go to ► Section G. Community Goals** to select another goal to evaluate).
2. Collect **more information** about the project **to further clarify its feasibility** (**Go to ► P1. Project Characteristics**). Remember, you have already collected some of the information in this section to complete your assessment of Goal G6. You can enter the information you have collected into the Evaluate a Biomass Project Summary Worksheets to determine which information you still need to collect. **Go to ► Evaluate a Biomass Project Summary Worksheets**.

No ➔ ROADBLOCK

If you answered no to at least one of these questions it is less likely that this biomass project will help the community be more energy efficient. You can:

1. Decide to continue evaluation of this project. See choices under GO.
2. Try to **move around the roadblock** of thermal efficiency, by using the links on the following page to access efficiency resources in New Hampshire. Once you have taken measures to improve the thermal efficiency of the building, you can move forward with evaluating the potential of a biomass system for this facility.
3. **Select a different facility or district to evaluate** if you are still interested in pursuing a biomass project in your community. **Go to ► P1a. Selecting a Project**.

G7. We Have a Strong Local Economy

[Add Tab Here]

G7. We Have a Strong Local Economy

G7. We Have a Strong Local Economy

► We Have Lower Energy Costs
► We Are Energy Independent
► Our Energy Is Reliable
► We Emit Less Carbon
► We Rely on Renewable Energy Resources
► We Are Energy Efficient
► We Have a Strong Local Economy

► COMMUNITY GOAL 7

G7. We Have a Strong Local Economy

DEFINITION: **The economic, social, and environmental wealth of a community is developed for the well-being of community members.**

Introduction

Biomass sourced locally can create markets for low-value wood, keep energy dollars in the local economy, create and sustain jobs in the region, strengthen the regional forest-products industry and support sustainable forestry.

A recently released white paper, Heating the Northeast with Renewable Biomass: A Vision for 2025, reports that for every 100,000 tons of biomass produced or utilized each year in New Hampshire: 171 direct jobs will be created, with $6,327,000 of income (assuming $37,000 annual income) and an additional 165 indirect jobs for a total of $8,505,360 of total annual income per 100,000 tons of biomass for the state (see full report at **http://www.biomassthermal.org/resource/pdfs/heatne_vision_full.pdf**).

IN THIS SECTION

G7a. Source of Biomass

Step 1

Define "Local Sources." For the purpose of strengthening the local economy through biomass procurement, how do you define "local"? **See ▶ Section G2a. Define Local Sources** for more information on defining local sources.

Step 2

Determine if you have access to biomass fuel that is sourced locally (based on your definition of local) and the percentage of biomass you will be able to procure locally. **See ▶ Section P6d. Biomass Fuel Providers** to determine if you have access to locally sourced biomass and how much of the biomass you will be able to get locally.

What percentage of biomass fuel will you be able to procure locally? _____________%

ROADBLOCK

If you do not have access to locally sourced biomass fuel it is not likely that a biomass system will help you strengthen your local economy. To move around this roadblock, continue to investigate potential local suppliers of biomass fuel and the potential for forested community land to meet the needs of your biomass system (see P6. Biomass Fuel for more information on wood supply). Remember that access to biomass suppliers that meet the needs of your community may evolve over the coming years.

Traditionally, woodchips are produced from unmerchantable tops and limbs left over from commercial harvesting. In addition, chips can be produced from low-grade roundwood.

G7b. Percentage of Current Fuel Dollars Staying in the Community

There are many different studies and sources that identify what percentage of money spent locally stays in the community compared to money spent non-locally. These range from 40 cents on the dollar to 120 cents on the dollar (using the multiplier effect) versus anywhere from 3 cents to 22 cents on the dollar for money not spent locally. **For the purpose of this exercise we are assuming 60% or 60 cents of every dollar spent on local energy stays in the community versus 13% or 13 cents of every dollar spent on non-local energy.**

Local energy is energy that is produced locally. Non-local energy may be locally distributed, but is not locally produced. You are welcome to substitute your own numbers in this section if your community has done its own study or if you choose to use percentages from a different source.

Complete the table below to estimate the percentage of current fuel dollars spent that stay in the community.

Instructions: What % of the Money Spent on Heating Fuel Currently Stays in the Community?

COLUMN 1: List each building that will be affected by the biomass project.

COLUMN 2: List the type of fuel(s) currently being used to heat each building.

COLUMN 3: Identify what proportion that fuel is of the overall fuel use.

If the building is heated by only one type of fuel, this will be 100%.

If the building is heated by more than one type of fuel you will determine what percentage that fuel is of the overall based on the square footage of each zone of fuel use. If the building you are evaluating uses more than one type of heating fuel, **go to ▶ G2b-2. Buildings with Multiple Heating Sources Worksheet**.

COLUMN 4: Using your definition of local, identify the percentage of the fuel that is locally produced.

COLUMN 5: Using your definition of local and the information in **G2d. Where Does My Fuel Come From**, identify what percentage of the fuel is not locally produced.

COLUMN 6: Multiply the total percentage of locally produced fuel for the building by 60% (.60)_____

Multiply the total percentage of non-locally produced fuel for the building by 13% (.13) _____. Add these two numbers together in column 6.

NOTE: **If you want to determine the actual dollar amount that will stays in the community you can multiply column 6 by the current average amount spent on heating fuel** (**see ▶ Section P3d. Fuel Cost**) **to determine how many of your fuel dollars currently stay in the community.**

G7b. WHAT % OF THE MONEY SPENT ON HEATING FUEL CURRENTLY STAYS IN THE COMMUNITY?

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6
Building	Type of Fuel	% of Total	% of Total Local	% of Total External	Total % of Fuel $ Staying in the Local Economy

EXAMPLE: *This example looks at a biomass system that will serve two town buildings. The school is currently heated by fuel oil. The town hall is heated by propane.*

G7b EXAMPLE. **WHAT % OF THE MONEY SPENT ON HEATING FUEL CURRENTLY STAYS IN THE COMMUNITY?**

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6
Building	Type of Fuel	% of Total	% of Total Local	% of Total External	Total % of Fuel $ Staying in the Local Economy
School	*Fuel Oil*	*100*	*0*	*100*	*0 + [100x13%] 13 = 13*
Town Hall	*Propane*	*100*	*0*	*100*	*0 + [100x13%] 13 = 13*

This example shows that 13% of the community's heating fuel dollars currently stay in the community heating the school and town hall.

G7c. Estimated Percentage of Fuel Dollars Staying in the Community with a Biomass System

Assuming that you have access to locally harvested biomass fuel, complete the table below to estimate the fuel dollars that will stay in the community with a biomass system.

Instructions: Estimated % of Money Spent on Heating Fuel will Stay in the Community with a Biomass System

COLUMN 1: Repeat list of buildings.

COLUMN 2: List Fuel Types (all existing fuels plus biomass for each building). Leave a row between each building for totaling the percentage of fuel from local and external sources by building.

COLUMN 3: For existing fuels, multiply the current percentage (column 3 from **G7b. What Percentage of the Money Spent on Heating Fuel Currently Stays in the Community?**) by 15%.

List biomass fuel at 85% (see Appendix A for assumptions).

COLUMN 4: Identify what percentage of each fuel type is from local sources.

COLUMN 5: Subtract column 4 from column 3 to determine the amount of fuel from non-local sources.

COLUMN 6: Multiply column 4 by 60% __________

Multiply column 5 by 13% __________

Add these two numbers together in column 6 to estimate what percentage of your fuel dollars will stay in the community with a biomass system.

NOTE: **If you want to determine the actual dollar amount that will stay in the community each year with a biomass heating system, you can multiply column 6 by the average amount you will spend on heating fuel** (**see** ▶ **G1b. Estimated Fuel Cost Savings** **to determine the estimated cost of biomass fuel).**

G7c. ESTIMATED % OF MONEY SPENT ON HEATING FUEL WILL STAY IN THE COMMUNITY WITH A BIOMASS SYSTEM

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6
Building	Fuel Type	% of Total	Total % of Fuel from Local Sources	Total % of Fuel from External Sources	Total % of Fuel $ Staying in the Local Economy

EXAMPLE: *This example assumes 80% of the biomass needs can be met from local sources and shows that with a biomass system the percentage of fuel dollars staying in the community will increase to approximately 45%.*

G7c EXAMPLE. ESTIMATED % OF MONEY SPENT ON HEATING FUEL WILL STAY IN THE COMMUNITY WITH A BIOMASS SYSTEM

COLUMN 1 Building	COLUMN 2 Fuel Type	COLUMN 3 % of Total	COLUMN 4 Total % of Fuel from Local Sources	COLUMN 5 Total % of Fuel from External Sources	COLUMN 6 Total % of Fuel $ Staying in the Local Economy
School	*Fuel Oil*	*15*	*0*	*15*	*[68x60%] 40.8 + [32x13%] 4.2 = 45*
	Biomass	*85*	*68*	*17*	
School Total			*68*	*32*	
Town Hall	*Propane*	*15*	*0*	*15*	*[68x60%] 40.8 + [32x13%] 4.2 = 45*
	Biomass	*85*	*68*	*17*	
Town Hall Total			*68*	*32*	

If you are evaluating a district heating system, you can assume additional jobs in the community in several categories, including: design and construction of the facility, operation of the facility, biomass fuel supply, and indirect, or multiplier jobs.

G7d. Jobs

A recent study of the Northern Forest Region states that wood-based biomass energy is an important component of the region's future wood-products economy. **(http://www.biomasscenter.org/pdfs/NFBEI.pdf)**

Another recent study in Austria showed that a region supported 9 local jobs when heating with oil and that this number grew to 135 jobs when replaced with biomass (40 megawatts, equal to 136 MMBtus of thermal energy). Another study by William Strauss, found that, "diversification of the Northeast forest products sector into wood-based fuels will directly create new jobs, and will sustain existing jobs that are being lost in the declining pulp and paper sector.[1]" In addition, if 10% of households in this area converted from fuel oil heat to biomass heat, 21,800 jobs in the forest products industry will be created. See the full report at: **http://www.biomassthermal.org/resource/PDFs/Northeast%20Policy%20Paper%20April%202009.pdf**

Woody biomass fuel markets create an additional revenue stream for harvested wood. Building vertical integration of markets for wood, including the low-grade wood that would be suitable for use as biomass fuel, increases the economic value of forestland. Maintaining and adding revenue streams from managed forestland can help to ensure that this forestland is valuable as a sustained forest (from an economic perspective). This will help to reduce the loss of forestland to other uses like development. Supporting and creating revenue streams from managed forestland strengthens the local forest products industry by supporting existing and adding new work for foresters, loggers, chipping contractors, truckers, and others in the industry.

District Heating Jobs

In addition to jobs created through biomass fuel procurement, there are short-term boosts in construction jobs when a district heating system is installed and generally at least two permanent full time jobs created in plant management and operation.

If you are evaluating a district heating system, you can assume additional jobs in the community in several industries:

- **DESIGN AND CONSTRUCTION OF THE FACILITY:** 36 jobs in the design and construction trades
- **OPERATION OF THE FACILITY:** 2 - 3 jobs
- **BIOMASS FUEL SUPPLY:** 3.5 - 6.5 fuel supply jobs in the categories of forestry, logging, chipping, and trucking depending on the annual fuel supply demand. (These numbers are based on a system using between 10,000 and 20,000 green tons of woodchips annually.)
- **MULTIPLIER JOBS:** For every 50 direct jobs created and supported by the biomass district heat plant as many as 75 to 150 jobs are indirectly supported through supply; re-spending and government support. Reference: "Updated Employment Multipliers for the US Economy" by the Economic Policy Institute. **http://www.epi.org/page/-/old/workingpapers/epi_wp_268.pdf**

[1] Strauss, William. "A Revenue Positive Economic Stimulus Strategy for Northeast." http://www.biomassthermal.org/resource/PDFs/Northeast%20Policy%20Paper%20April%202009.pdf Accessed, May 13, 2010

G7e. Supporting Sustainable Forestry

The majority of wood sourced for heat and/or energy use in New Hampshire will come from harvesting the low-grade portion of new wood that is grown annually on regional forestland. Continual harvesting beyond the rate of growth will reduce the forest inventory at an unsustainable rate. Of particular interest is the portion of net annual growth that is low-grade and appropriate for use as biomass fuel, since it would be inappropriate to chip and burn high-quality trees that could go to higher-value products.

An important first step in addressing the impact on the forests is to conduct a forest resource assessment, often also called a wood resource assessment. These assessments include regional quantification of the forest resource and give perspective on the breadth of the impact of the proposed biomass project on the region's forestland.

Following up on the resource assessment, an important next step is setting standards for procuring wood fuel from local and well-managed forests and for requiring a certain level of verification to make sure that these standards are met. These can include the use of forest management plans, involvement and oversight of professional foresters, and professional and well-trained loggers.

Both the forestland itself and the movement of wood through the supply chain can be certified, showing that the management of forestland meets certain standards, helping to ensure that biomass is harvested in a sustainable way. There are numerous certification systems worldwide, but three common programs are Forest Stewardship Council (FSC), Sustainable Forestry Initiative (SFI), and Tree Farm. The NH Timberland Owners Association administers SFI in New Hampshire, and can be reached at **www.nhtoa.org**.

G7f. Summary

Use the table below to summarize information gathered in this section to help you determine if a biomass heating system will help your community meet its goal of strengthening the local economy.

G7f. SUMMARY

Building	Total % of Fuel $ Staying in the Local Economy with Current Fuel Use	Total % of Fuel $ Staying in the Local Economy with Proposed Biomass System

Links

The Forest Products Industry is a Major Employer in the Rural Northeast
http://evergreenmagazine.com/magazine/article/The_Forest_Products_Industry_is_a_Major_Employer_in_the_Rural_Northeast.html

Northern Forest Biomass Energy: Action Plan
http://www.biomasscenter.org/pdfs/NFBEI.pdf

The Forest Products Economy of the Northern Forest Region: A Summary
http://www.northernforest.org/test001/downloads/nfsei-forest-products-industry.pdf

Energy from Forest Biomass: Potential Economic Impacts in Massachusetts
http://www.mass.gov/Eoeea/docs/doer/renewables/biomass/bio-eco-impact-biomass.pdf

New Hampshire Climate Action Plan A Plan for New Hampshire's Energy, Environmental and Economic Development Future Appendix 7.4: Agriculture, Forestry, and Waste Carbon Emissions and Economic Modeling: Approach and Assumptions
http://des.nh.gov/organization/divisions/air/tsb/tps/climate/action_plan/documents/032509_nhccptf_appendix_7.4.pdf

► Assess

Section G7. We Have a Strong Local Economy

You have now completed section G7. We Have a Strong Local Economy. Based on the information you have collected:

Will more of your fuel dollars stay in the community with the proposed biomass system?

Yes ☐ **No** ☐

Will any jobs be created or supported in the community as a result of the proposed biomass system?

Yes ☐ **No** ☐

Yes → GO

If you answered yes to these questions, transfer the information you have collected into the Community Goals summary worksheets. You can now:

1. Assess whether the project will help you meet **another community goal** (**Go to** ► **Section G: Community Goals** to select another goal to evaluate)
2. Collect **more information** about the project **to further clarify its feasibility** (**Go to** ► **P1. Project Characteristics**). Remember, you have already collected some of the information in this section to complete your assessment of Goal G7. You can enter the information you have collected into the Evaluate a Biomass Project Summary Worksheets to determine which information you still need to collect. **Go to** ► **Evaluate a Biomass Project Summary Worksheets**.

No → ROADBLOCK

If you answered no to at least one of these questions it is less likely that this biomass project will help the community have a strong local economy. You can:

1. Decide to continue evaluation of this project. See choices under GO.
2. Try to **move around the roadblock(s)**. Continue to investigate potential local suppliers of biomass fuel. Remember that access to biomass suppliers that meet the needs of your community may evolve over the coming years.
3. **Select a different facility or district to evaluate** if you are still interested in pursuing a biomass project in your community. **Go to** ► **P1a. Selecting a Project**.

► Transition

from Community Goals to Evaluate a Biomass Project

You have now reached the end of the community goals section of the *Roadmap*.

Now that you have completed collecting information about your community goal(s), you should know whether this biomass project will help your community achieve its energy-related goals.

Will the project help the community achieve one or more energy-related goals?

Yes ☐ **No** ☐

Yes → GO

No → ROADBLOCK

If you answered yes:

1. Enter information you have collected into the Community Goals Summary Worksheets to **share with your community**. **Go to ► Community Goals Summary Worksheets**.
2. Collect more information about the potential project to **further clarify its feasibility** (**Go to ► P1. Project Characteristics**). Remember, you have already collected some of this information to complete your assessment of the community goal(s). You can enter the information you have collected into the Evaluate a Biomass Project Summary Worksheets to determine which information you still need to collect. **Go to ► Evaluate a Biomass Project Summary Worksheets**.
3. Learn more about **how to move this project forward**. If you feel you have collected all of the possible information about this project, **Go to ► Next Steps** to learn what your community will do next to continue to evaluate this biomass project.

If the project will not help achieve the energy-related goals of your community, you can:

1. Try to **move around the roadblock(s)**. Many sections of the *Roadmap* identify potential areas that might create a roadblock to a biomass project and suggestions for how you might move around these roadblocks. Remember as energy costs, regulations, and technologies continue to change, a project that does not currently meet the goals of your community may do so in the future.
2. **Evaluate** whether **a different facility or district** will be more effective at achieving the goals of your community if you are still interested in pursuing a biomass project. If you have a specific project in mind you can repeat the community goal(s) evaluation for this new project. If you are unsure about which facility or district in your community to evaluate, **Go to ► P1a. Selecting a Project** and then come back to the community goals section.

Evaluate a Biomass Project

[Add Tab Here]

Evaluat a
Biomass Project

This Roadmap was produced by Yellow Wood Associates and the Biomass Energy Resource Center for the North Country RC&D.

Evaluate a Biomass Project

The Evaluate a Biomass Project section provides step-by-step instructions for gathering information that will help you determine whether a biomass project for a specific building or group of buildings makes sense.

Beginning with selecting a project and moving all the way through permitting, completing this section of the *Roadmap* will provide you with valuable information that will help your community decide if it makes sense to invest in a biomass pre-feasibility study. **Once you have completed this section you can use the information you have gathered to help determine which community goals will be impacted by the project.**

If you have already begun collecting information about the potential biomass project, you can enter the information you have into the Evaluate a Biomass Project Summary Worksheets (**Go to ▶ page 45).** You can use these worksheets to help identify what information still needs to be collected – go to the relevant section of the *Roadmap* to get instructions on collecting this information.

Get Started

If you do not know which facility or district you want to evaluate for biomass heat, begin at section P1a. Select a Project. If you already know which facility or district you want to evaluate and/or you have begun collecting information about the project, Go to ► P1b to evaluate a single building or Go to ► P1d to evaluate a district or campus.

New Hampshire has many successfully operating biomass energy projects in place already, from woodchip heated schools and community buildings, to resorts and large campuses, to biomass-fueled electrical plants. To learn more about biomass projects in New Hampshire and around the country, visit the following:

- Wood to Energy Project: **http://www.wood2energy.org/.**
- National Database of Community-Scale Facilities Using Biomass Energy: **http://www.biomasscenter.org/database.html**
- Northern Forest Center Visual Index of New Hampshire's Renewable Energy Environment: **http://northernforest.org/mm-nfc/nh.html**

P1. Project Characteristics

[Add Tab Here]

P1. Project Characteristics

P1. Project Characteristics

► Project Characteristics
► Building Information
► Existing Fuel Use
► Existing Heating and Distribution System
► Biomass Energy System
► Biomass Fuel
► Emissions, Permitting, and Air Quality

► EVALUATE A BIOMASS PROJECT 1

P1. Project Characteristics

Biomass energy systems can be used at multiple scales and in multiple types of projects. The *Roadmap* will help communities understand the characteristics of biomass energy systems for a single building, multiple buildings with individual biomass boilers, and district heat systems (one heating plant for multiple buildings).

> *NOTE:* **Combined heat and power (CHP) projects are found to be not as cost effective as the heating only projects with the present policy and incentives framework. It is recommended that the community should consider heating projects initially. The Roadmap does not analyze CHP projects. If the community continues to be interested in a CHP system, this can be evaluated in the pre-feasibility study (see ► Next Steps). For more information on CHP, see ► Appendix B Combined Heat and Power.**

IN THIS SECTION

P1a. Selecting a Project

When selecting a project for biomass heat there are several important issues to consider. Buildings that use propane or fuel oil heating and/or domestic hot water AND have steam or hot water distribution systems tend to be the most cost effective to convert to biomass systems. If the fuel load is high enough, it can be economical to convert other types of distribution systems to a hot water system as part of the biomass project—this will require additional capital investment and is not feasible for smaller buildings. It is important to note that most steam distribution systems are very expensive to convert to hot water distribution in buildings that will be connected to district heating.

Having a year-round biomass heat load adds to the cost effectiveness of a project. Thus buildings that have an **industrial cooling or chilling** demand or include industrial processes that could use biomass for **process heat** should be strongly considered.

When selecting a project to evaluate, remember that district energy projects are practical only if sufficiently sized anchor loads exist in close enough proximity to one another. Residences and small commercial buildings are most often too diffuse an energy load to make the installation of buried piping practical or economical. Two or more large energy users will be required to anchor and define a heating district. Section P1d will help communities identify anchor loads and define a district for study.

You can select a single building or multiple buildings on a "campus" with a single owner, (**go to ▶ P1b**) or you may want to evaluate a district system, where one biomass plant heats multiple buildings (**go to ▶ P1d**).

P1b. Biomass Heat for a SINGLE BUILDING or Multiple Buildings with a Single Owner

If you have chosen one building to investigate (or multiple buildings with a single owner) for biomass heat, keep in mind that each building evaluated should:

- **Be a minimum of 5,000 SF**
- **Have high annual fuel bills (more than $2,500 per year)**

NOTE: **Small residential and commercial buildings (fewer than 5,000 SF) may want to consider installing a wood pellet boiler. The *Roadmap* is not designed to address buildings under 5,000 SF.**

Instructions: Considering Buildings to Be Included

COLUMN 1: List buildings being considered in your community for a biomass project.

COLUMN 2: Answer "yes" if the building is 5,000sf or larger. (For more information on answering this question **go to** ▶ **P2a.**)

COLUMN 3: Answer "yes" if the average annual fuel bill(s) for the building are $2,500 or greater. (For more information on answering this question **go to** ▶ **P3d.**)

COLUMN 4: Answer "yes" if the building uses propane, fuel oil, or electricity for heat. (For more information on answering this question **go to** ▶ **P3a.**)

COLUMN 5: Answer "yes" if the heat is distributed throughout the building by hot water or steam. (For more information on answering this question **go to** ▶ **P4b.**)

COLUMN 6: Answer "yes" if there is an industrial cooling or chilling demand. (For more information on answering this question **go to** ▶ **P3c.**)

COLUMN 7: Answer "yes" if the building requires industrial process heat. (For more information on answering this question **go to** ▶ **P3c.**)

Choose the building(s) that have "yes" in the most columns to evaluate using this *Roadmap* (highlight or circle the building name(s) you have chosen to evaluate).

P1b. CONSIDERING BUILDINGS TO BE INCLUDED

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7
Building Name	**5,000 SF or More Conditioned Space?**	**$2,500 or More Annual Fuel Bill?**	**Propane or Fuel Oil Heat?**	**Steam or Hot Water Distribution?**	**Industrial Cooling or Chilling Demand?**	**Use of Industrial Process Heat?**

P1c. Building Ownership

Identify who owns each building being considered for biomass. The owner will be able to help you answer important questions about the building and its current fuel use and heating systems. The owner will need to be involved in any decisions about making changes to the building's heating system.

If the building is owned by a landlord, corporate entity, the town, or another type of governing body, it will be important to find out: Who pays the fuel bills? Who maintains the current heating system? Who makes decisions about capital projects?

Instructions: Important Contact Information

For each building you are evaluating for a biomass heating system, identify the owner, the person who pays the fuel bills, the person who maintains the current heating system, and each person's contact information.

P1c. IMPORTANT CONTACT INFORMATION
BUILDING NAME
OWNER NAME Address Phone Email
BILL PAYER NAME Phone Email
MAINTENANCE NAME Phone Email
OTHER CONTACT Name Phone Email

P1d. Biomass Heat for MULTIPLE BUILDINGS (with multiple owners) DISTRICT HEAT SYSTEM

District heating systems can be an efficient form of municipal infrastructure, similar to public water or sewage systems. These systems provide heat to more than one building through buried distribution piping connecting a boiler with various buildings and extend and expand the benefits of biomass heating by economies of scale.

A district heating system can provide the heat that would otherwise be produced in tens or hundreds of smaller, individual heating systems. A centralized system reduces redundancy and provides many advantages for both the system customers and the surrounding community. District energy systems can provide space heating for large office buildings, schools, college campuses, hotels, hospitals, apartment complexes, and other municipal, institutional, and commercial buildings. Some district energy systems supply thermal energy to industrial customers for **process heat**, while others capture low-grade waste heat from industry to sell to customers.

In a district heating system, insulated underground pipelines distribute thermal energy from the central plant to each of the buildings connected to the network. Thermal energy is then supplied to the buildings and the return water is piped back to the plant to be re-heated and re-distributed. The heat distribution piping, typically thin-wall welded steel with integral foam insulation and plastic jacketing, is designed to be direct-buried at a depth of about 3 feet. Pipes are placed in pairs with supply pipes delivering hot water from the plant and return pipes carrying lower-temperature water back to the plant to be reheated. Each customer building is served by a pair of lateral pipes from the supply and return mains. Generally, these pipes enter the basement to connect to the energy transfer station, a heat exchanger with energy meter, installed in the basement of a building. The energy transfer station is compact, can be wall mounted, and does not require too much space in the building. The central plant uses variable speed pump controls to minimize the amount of electricity used in the pumping process.

District heating systems can employ a wide variety of fuels, including biomass. A typical district energy system consists of the following subsystems:

- **THERMAL ENERGY GENERATION.** The boilers where the thermal medium, steam or hot water, is produced.
- **THERMAL ENERGY TRANSMISSION AND DISTRIBUTION (T&D).** The pipelines that deliver the thermal energy medium (water) from the production sources to the network of users.
- **CUSTOMER INTERFACE.** The integration of thermal energy at the user's (customer's) location, also known as Energy Transfer Station (ETS).

The modern district heating systems deploy hot water to distribute heat to buildings through an efficient, insulated distribution network. Buildings which currently have steam distribution systems for internal distribution of heat will need to be converted to hot water distribution systems to get connected to district system.

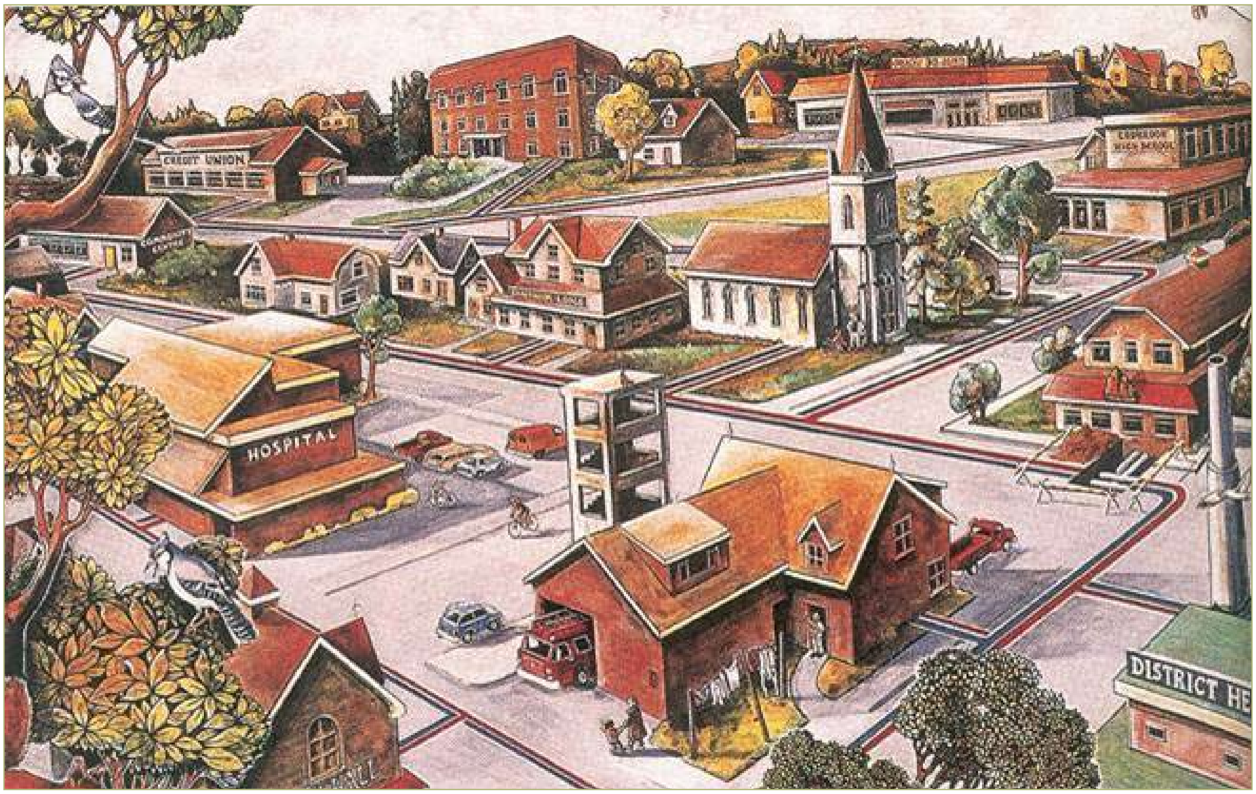


Illustration courtesy of Prince Edward Island Department of Economy, Development & Tourism.

Above: District heating systems provide heat to more than one building through buried distribution piping that connects a boiler with various buildings and expands the benefits of biomass heating through economies of scale.

Advantages of District Energy

The following description of the advantages of district energy is organized in relation to the relevant community goals.

GOAL 1. WE HAVE LOWER ENERGY COSTS

Higher fuel usage provides access to the lower costs associated with bulk purchasing. Additionally, when a district energy system has access to a locally available fuel source to serve all or a portion of the fuel mix, the cost-stabilizing and economic benefits of district energy are further enhanced. The price of wood fuel is not linked to world energy markets or unstable regions, but is instead determined by local economic forces. For this reason, biomass systems do not experience the price instability of conventional fuel systems, especially in areas close to sources of wood fuels

In district heating systems the customer purchases the actual amount of thermal energy used—as measured by a Btu meter—rather than buying the fuel required by a boiler. Since all boilers waste heat through their chimneys and seasonal inefficiencies, the actual amount of heat energy (measured as millions of British thermal units, MMBtu) required for any given building will be less than is used as purchased fuel in a conventional system. New district heat customers converting from older, inefficient boilers will realize greater returns than those that currently have highly efficient systems.

Direct savings can be achieved by avoiding the capital equipment expenses for replacement of individual fuel tanks and boilers, and the time and expense of yearly maintenance. Heating equipment is in one centralized location requiring maintenance staff at one location only, reducing the complexity and cost of maintaining multiple systems in multiple locations.

GOAL 3. OUR ENERGY IS RELIABLE

District energy systems have an unparalleled record of reliable service. They achieve this by well-managed central plant operation, using multiple fuels, having backup boilers in one or more locations, and having standby power at the central plant.

There is a reduced risk of power outage or other “down-time.” District systems have back-up systems and back-up power sources as well as fuel stockpiles. As a result, the risk of interruption in heat supply to customers is minimal. Even when the district heating system needs to shut down for short periods of time, the retained heat in the system is sufficient to provide continuous heat to the customers. As a result, the individual customer does not need to worry about a supply of heat or hot water during a power outage.

GOAL 7. WE HAVE A STRONG LOCAL ECONOMY

District energy infrastructure and stable energy rates improve a community's business climate. Local businesses can become more competitive with stable, lower energy costs, which can help to revitalize downtowns and urban core areas so they can better compete with suburban sprawl. Using biomass as the fuel source, district energy can help build and support sustainable infrastructure.

AIR QUALITY IMPROVEMENTS. Air quality improves—as does community livability—when emissions from a single, well-managed plant replace multiple non-regulated stack emissions from many individual buildings. In addition, district heating systems are of a size that makes it possible and economically feasible to install the best available technology and emissions-control equipment that is typically not feasible in individual building heating systems.

REDUCED ENVIRONMENTAL RISKS. District energy systems can help to mitigate environmental risks by removing fossil fuel tanks and consolidating the fuel storage to a single or small number of locations compared to numerous onsite storage tanks that serve individual buildings. Environmental risks related to conventional fuel storage, including underground and aboveground storage tanks, consist of failing underground tanks that can threaten ground and surface waters as well as above-ground tanks becoming fire hazards or potentially dislodging in the event of a flood.

INCREASED AVAILABILITY OF SPACE. The space that had been used for the boiler in individual buildings can now be used for other purposes.

REDUCTIONS IN HUMAN HEALTH RISK. Risk of fire, carbon monoxide poisoning, and other combustion-related hazards are reduced in a district energy system where combustion happens centrally, not in individual buildings. In addition to making buildings safer, this reduced risk of combustion-related hazards may reduce fire insurance and liability premiums to homes and businesses in the district.

P1e. Defining a Multi-Building Area for District Heating System

The size of buildings and the distances between them are key factors in determining whether district heating is appropriate for a group of buildings. If the buildings are small and widely spaced, the cost of buried distribution piping between them may turn out to be higher than the cost of individual heating systems.

If your community is interested in a district—or multi-building—biomass project, you will need to determine both which buildings will be included for consideration and the distances between those buildings.

In this *Roadmap*, two different types of "district" heating systems are addressed:

1. **COMMUNITY DISTRICT PROJECTS** where there are several large anchor loads (buildings of 50,000 SF or more) and multiple owners.
2. **CAMPUS PROJECTS** where there are multiple buildings with one owner that are closer together.

If you are interested in a Community District Project, **go to ▶ P1f**. If you are interested in a campus project, **go to ▶ P1g**.

The biomass plant at Middlebury College in Vermont operates at increased efficiency by using the excess pressure from the steam to co-generate approximately 3-5 million kilowatt-hours of electricity per year. And, the heat from the exhaust is used to pre-heat water going into the boiler.

P1f. Community District Projects

Smaller individual residential and commercial buildings, even in large groups, rarely present a high enough energy load density to make for a practical district energy project. Instead, **anchor loads** need to be identified to define a potential project. Anchor loads should have relatively large, consistent, and predictable energy use patterns.

Anchor loads for a community district project could include buildings such as schools, state or municipally owned facilities of many types (including office buildings & courthouses), hospitals, and industrial facilities. Generally an **anchor load** for a community district project **should be more than 50,000 SF with a minimum heat load of at least 2 MMBH.** The larger the quantity of anchor buildings in a community the more likely it will be that a district heating system will be feasible. You must identify at least 2 anchor buildings to assess the feasibility of a community district project.

There are three main factors that go into determining whether an anchor load should be included in a district heating project:

1. Size of the building (SF of heated area)
2. Distance between the building and the biomass plant (or another anchor building)
3. The cost of underground piping (trench foot)

Once good potential anchors have been identified, the energy loads of the smaller energy users on the route between anchor loads and the biomass plant can be added to the total project energy load for consideration.

Buildings that would otherwise present good anchor loads but are too far from other anchor loads to justify the piping cost should be considered for a woodchip or pellet system for that individual facility.

Once you have decided which anchor loads (major buildings) you want to include, you will need to identify the site for the biomass plant (approximately 1-2 acres) and then evaluate the distance between the anchor load that is furthest from the site and the biomass plant. There is a direct correlation between the size/capacity of the anchor loads and the distance between them. The larger the heat load is of an anchor building, the greater the allowable distance between the building and the plant, particularly if there is a high density of smaller users in between. Once good potential anchor buildings and the biomass plant site have been identified, you can add the smaller buildings to the analysis.

The cost of buried distribution piping rages from $150 to $700 per trench foot depending on local conditions. Local estimates for the cost of installing buried distribution piping, square footage of each of the buildings, and the distances between buildings will need to be obtained early on in the process of evaluating district heating to help determine whether or not district heating will work at a particular location. The maximum distance between anchor buildings will be site specific and depend largely upon the cost of piping installation. Once estimates have been gathered for piping costs, you can determine a feasible distance between anchors for your community. The cost of piping between anchors needs to be lower than the cost of installing stand-alone biomass plants for each anchor site.

To identify anchor load and define the multi-building are for your community district project,
go to ▶ P1h.

Maintenance on the woodchip boiler at Crotched Mountain Rehabiliation Center in Greenfield, New Hampshire.

P1g. Campus / Multi-Building Projects with Single Owner

Anchor loads for a campus district system, where all of the facilities are under the same ownership (such as a school campus or multiple-building complex) can be practical with much smaller anchor loads (a minimum of 5,000 SF) because the districts tend to be more compact, the cost of distribution piping per trench foot is lower and the process for an energy project under single ownership is much simpler. A campus district heating project still generally requires some buildings with heating loads that are greater than residential scale.

The three main factors that go into determining whether an anchor load should be included in a campus district heating project are the same as in a community district project:

1. Size of the building (SF of heated area)
2. Distance between the building and the biomass plant (or another anchor building)
3. The cost of underground piping (trench foot)

You will need to identify the site for the biomass plant(approximately 1-2 acres) and then evaluate the distance between the farthest anchor building on the campus and the biomass plant. On a campus you may not have a lot of choices for locating the biomass plant. If you do have options, you want to select a location that is central to the most number of buildings.

The cost of buried distribution piping rages from $150 to $700 per trench foot depending on local conditions. Local estimates for the cost of installing buried distribution piping, square footage of each of the buildings, and the distances between buildings will need to be obtained early on in the process of evaluating district heating to help determine whether or not district heating will work at a particular location. The maximum distance between campus buildings will be site specific and depend largely upon the cost of piping installation. Once estimates have been gathered for piping costs, you can determine a feasible distance between campus buildings to be included. The cost of piping between anchors needs to be lower than the cost of installing stand-alone biomass plants for each anchor site.

To determine which campus buildings should be included in a district heating project, **Go to ▶ P1h.**

P1h. Identifying your Multi-Building Area Anchor Loads

Complete the table below to identify the potential anchor loads for the project.

Instructions: Defining Multi-Building Area - Anchor Loads

COLUMN 1: List the names of buildings to be included in the project as anchor loads (**see ▶ P1f. Community District Projects** for information on selecting anchor loads).

COLUMN 2: List the square footage of each "anchor" building. Someone in the facilities department should be able to tell you the square footage of the building, or sometimes this information is recorded at the town offices. (**See ▶ P2a. Building Use and Size** for instructions on measuring the building yourself.)

COLUMN 3: Select a likely location for the biomass plant (this is for a preliminary analysis). Are the anchor buildings on:

- ☐ One side of the biomass plant → Enter the distance (in feet) between the proposed biomass plant site and the farthest anchor load (see example 2).
- ☐ More than one side of the biomass plant → Enter the distance (in feet) between the proposed biomass plant site and the farthest anchor load on each side of the plant (see example 1).

You can use a program like Google Earth to get an estimated distance between buildings: **http://earth.google.com/**

COLUMN 4: Estimate the cost per trench foot for distribution piping. (You can base this number on the cost of water or sewer lines in the district - contact the town manager or engineer or facility director to get this cost. If you are unable to get quotes for distribution piping at this time you can use the average of $400 per trench foot.)

COLUMN 5: Multiply the cost per trench foot (column 4) by the distance to the farthest anchor load(s) listed in column 3 to get an estimate for total piping costs. If anchor loads are on more than one side of the biomass plant, multiply cost of piping per trench foot (column 4) by each distance listed in column 3 and add these together for the total piping costs.

P1h-1. DEFINING MULTI-BUILDING AREA ANCHOR LOADS PART ONE

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Building Name	**Building Size (SF)**	**Distance between Biomass Plant & Farthest Anchor Load**	**Cost of Distribution Piping per Trench Foot**	**Total Cost of Distribution Piping**

Instructions: Defining Multi-Building Area Anchor Loads

COLUMN 1: Enter total square footage (sum of all building square footage from column 2 of previous table)

COLUMN 2: Enter the total Distribution Cost from column 5 of previous table.

COLUMN 3: Divide Total SF (column 1) by Total distribution Cost (column 2) for the SF-to-Distribution Cost Ratio.

P1h-2. DEFINING MULTI-BUILDING AREA ANCHOR LOADS PART TWO

COLUMN 1		COLUMN 2		COLUMN 3
Total SF	**Divided by**	**Total Distribution Cost**	**=**	**SF-to-Distribution Cost Ratio**

If the SF-to-Distribution Cost Ratio is 0.1 or greater, then it makes sense to assess this multi-building area for district heating. Go to ▶ P1j. Building Ownership.

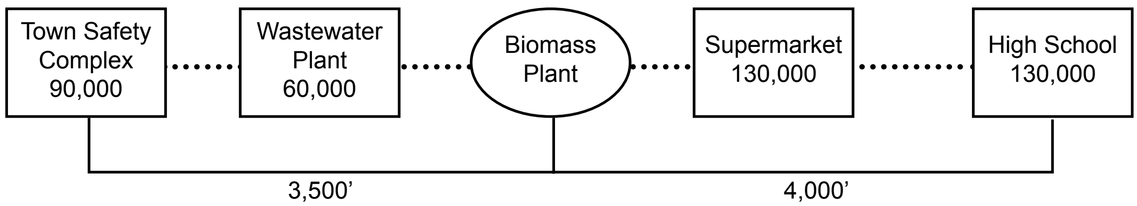
ROADBLOCK

If the the SF-to-Distribution Cost Ratio is less than 0.1, then further evaluation of the district needs to be done. You can:

1. **Identify additional heating loads on the distribution piping route that will increase the total square footage of the district. Add these loads to Table P1h1 and recalculate the SF-to-Distribution Cost Ratio.**
2. **Remove the Anchor load that is farthest from the biomass plant from consideration and recalculate the SF-to-Distribution Cost Ratio**
3. **Identify a more centralized location for the biomass plant (that reduces the distance between the plant and the farthest anchor load(s)).**

EXAMPLE 1. Community District Heat

A community is considering a community district heating project. There is space adjacent to the wastewater treatment plant for a biomass plant. It is believed the anchor loads will be the high school, the village super-market, the wastewater treatment plant, and the town safety complex.



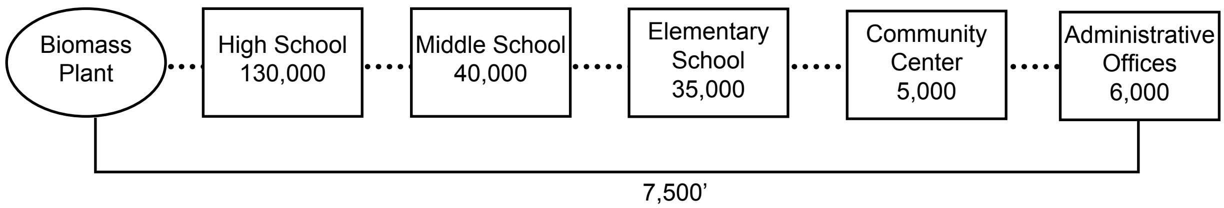
<table>
<tr><th colspan="5">P1h-1 EXAMPLE. DEFINING MULTI-BUILDING AREA ANCHOR LOADS PART ONE</th></tr>
<tr><th>COLUMN 1</th><th>COLUMN 2</th><th>COLUMN 3</th><th>COLUMN 4</th><th>COLUMN 5</th></tr>
<tr><th>Building Name</th><th>Building Size (SF)</th><th>Distance between Biomass Plant & Farthest Anchor Load</th><th>Cost of Distribution Piping per Trench Foot ($)</th><th>Total Cost of Distribution Piping</th></tr>
<tr><td>High School</td><td>75,000</td><td>4,000</td><td rowspan="4">400</td><td rowspan="4">(400 x 4,000 = 1,600,000) + (400 x 3,500 = 1,400,000) = $3,000,000</td></tr>
<tr><td>Supermarket</td><td>130,000</td><td></td></tr>
<tr><td>Wastewater Plant</td><td>60,000</td><td></td></tr>
<tr><td>Safety Complex</td><td>90,000</td><td>3,500</td></tr>
</table>

<table>
<tr><th colspan="5">P1h-2 EXAMPLE. DEFINING MULTI-BUILDING AREA ANCHOR LOADS PART TWO</th></tr>
<tr><th>COLUMN 1</th><th colspan="3">COLUMN 2</th><th>COLUMN 3</th></tr>
<tr><th>Total SF</th><th rowspan="2">Divided by</th><th>Total Distribution Cost</th><th rowspan="2">=</th><th>SF-to-Distribution Cost Ratio</th></tr>
<tr><td>355,000</td><td>3,000,000</td><td>0.12</td></tr>
</table>

In this example it makes sense to assess this potential district for biomass heat because the SF-to-Distribu-tion Cost Ratio is greater than 0.1.

EXAMPLE 2. Campus District Heat

The district is considering a campus district heat complex at the Regional School Complex that includes a high school, middle school, elementary school, administrative offices building, and a community center. There is space behind the high school to locate the biomass system.



P1h-1 EXAMPLE. DEFINING MULTI-BUILDING AREA ANCHOR LOADS PART ONE

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Building Name	**Building Size (SF)**	**Distance between Biomass Plant & Farthest Anchor Load**	**Cost of Distribution Piping per Trench Foot ($)**	**Total Cost of Distribution Piping**
High School	*80,000*	*7,500*		
Middle School	*40,000*			
Elementary School	*35,000*		*250*	*(250 x 7,500) = $1,875,000*
Community Center	*5,000*			
Administrative Office Building	*6,000*			

P1h-2 EXAMPLE. DEFINING MULTI-BUILDING AREA ANCHOR LOADS PART TWO

COLUMN 1		COLUMN 2		COLUMN 3
Total SF	**Divided by**	**Total Distribution Cost**	**=**	**SF-to-Distribution Cost Ratio**
166,000		*166,000*		*0.09*

*In this example, the ratio is less than 0.1 so it would not make sense to move forward with a campus district heating project that included these buildings. On further review it was found that the administrative office building was too far from the biomass plant. If this building was removed from the list the total SF to be heated will be reduced to 160,000 SF and the distance between the farthest anchor building and the biomass plant will be reduced to 5,000 feet. The revised ratio will be (160,000/(5000 *250))=0.13. This shows us that it would make sense to consider this campus district heating project, excluding the administrative office building.*

P1i. Building Ownership

It is important to identify who owns each building being considered for biomass. The owner will be able to help you answer important questions about the building and its current fuel use and heating systems. The owner will need to be involved in making any decisions about making changes to the building's heating system. For a district project you can begin by identifying the following information for anchor load buildings only.

If the building is owned by a corporate entity, the town, or another type of governing body it will be important to find out:

- Who pays the fuel bills?
- Who maintains the current heating system?
- Who makes decisions about capital projects?

Instructions: Important Contact Information

For each anchor load building, identify the owner, the person who pays the fuel bills, the person who maintains the current heating system, and each person's contact information.

P1j. IMPORTANT CONTACT INFORMATION
BUILDING NAME
OWNER NAME Contact Info
BILL PAYER NAME Contact Info
MAINTENANCE NAME Contact Info
OTHER IMPORTANT CONTACT Contact Info

P1j. District Cooling / Chilling Systems

The majority of district heating systems provide heat for conditioned space though distribution systems using hot water. The facilities connected to the district system can utilize the hot water for cooling in summer months or for their process requirements by installing hot water based vapor adsorption systems. Absorption chillers utilize waste heat to provide cold water for air conditioning and other process requirements. If there are facilities in your community that are willing to install such vapor adsorption systems for cooling applications and have substantial cooling or process heat requirements, it may improve the overall economics of the district heating project.

The cooling applications based on hot water are not found to be cost effective unless the source of heat is based on waste heat. Hence it is recommended that the community should consider heating only projects initially. If the community continues to be interested in a cooling project, you should discuss this with your consultant during the feasibility study stage

▶ Assess

Section P1. Project Characteristics

You have now completed section P1. Project Characteristics.

Were you able to identify a single building or district (with viable anchor loads) to evaluate?

Yes ☐ **No** ☐

Yes ➔ GO

No ➔ ROADBLOCK

If you were able to identify a biomass project to evaluate, transfer the information you have collected into the Project Characteristics summary worksheet. You can now:

1. **Continue collecting information** about this project to further clarify its feasibility (**Go to ▶ P2-P7**).
2. Assess whether the project will help you meet one or more **community goals**. **Go to ▶ Community Goals** to select a goal to evaluate.

1. If you were not able to identify a **single building** to evaluate, you can **move around this roadblock** by working with community members to identify potential facilities for biomass. Repeat section P1a with a new set of potential buildings.
2. If you were not able to identify a **biomass district** with sufficient anchor loads you can **move around this roadblock** by evaluating one or more single facilities. **Go to ▶ P1a to evaluate a single building or facility**.

P2. Building Information

[Add Tab Here]

P2. Building Information

P2. Building Information

P2. Building Information

You will need to collect information about each building you would like to consider for a biomass project. If you do not know which building(s) you would like to evaluate, go to ► P1a. Selecting a Project. If you are considering a district system, collect information for anchor buildings first (go to ► P1h to identify anchor buildings).

IN THIS SECTION

P2a. Building Use and Size

Knowing how the building is used helps determine its space heat requirements. It will also help you compare the building(s) you are looking at to buildings with similar uses. It is important to know the building size so that you can make some basic assumptions about the efficiency of the building and the type and size of biomass system that makes sense for this building.

Instructions: Building Use and Size

COLUMN 1: List each building being considered for the biomass project.

COLUMN 2: List the building use. If the building has multiple uses list each use in its own row.

COLUMN 3: List building size in SF. If the building has multiple uses, list the estimated size for each use and then the total size. See P2a-2 for instructions on measuring a building.

P2a-1. BUILDING USE AND SIZE

COLUMN 1	COLUMN 2	COLUMN 3
Building Name	**Building Use**	**Building Size**

P2a-1 EXAMPLE. **BUILDING USE AND SIZE**

COLUMN 1	COLUMN 2	COLUMN 3
Building Name	**Building Use**	**Building Size**
Community Center	*Administrative Offices*	*1,500 SF*
	Meeting Spaces, etc.	*6,500 SF*
Total		*8,000 SF*

Often the owner of the building or the facilities director will be able to tell you the size of the building. If this is not the case, the size of the building may be available at the town offices. If you are not able to find the size of the building, you can take a rough measurement yourself.

Use the table below to determine the size of the building through measuring.

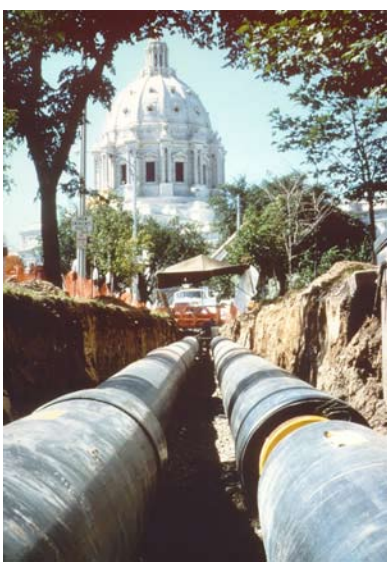
Instructions: Building Measurements

Measure the length and width of buildings using a measure. The approximate length and width of buildings can also be measured by walking along the length, counting steps and considering 3 feet between two steps for a male and 2.5 feet for a female.

P2a-2: BUILDING MEASUREMENTS

Building Name	Length L (in ft)	Width W (in ft)	# of Stories (N)	SF L*W*N
Example – Town Hall	*50*	*40*	*3*	*6,000*

Images courtesy of Urecon.



Pre-insulated hot water piping is used in many district energy projects.

P2b. Type of Construction / Renovation

It is often less costly to incorporate a biomass project into another project such as new construction, building expansion, or building renovation than it is as a stand-alone project. If a construction/expansion/renovation project is planned over the next 3-5 years, then there is probably sufficient time to incorporate biomass into the plans. If construction is planned to begin within 6 months, it may be too late to consider a biomass alternative. If there are no plans for an addition, renovation or new construction, the construction associated with a biomass system will be limited to housing the biomass boiler, fuel storage and any distribution system upgrades that are required.

You will need to talk with the building owner to determine if there are any future plans for the building that include additions, renovations, and/or retrofits.

Instructions: Type of Project

In the table below, identify each building being considered, what type of project it will be, and the timeframe for the project:

NP................. No Plans for addition, major renovation, retrofit, or new construction

NC................. New Construction (A building or complex that has not yet been built)

Add............... An Addition to an existing building

MR................. Major Renovation or interior remodeling

Retro............. Retrofit of the heating units and/or distribution systems

P2b. TYPE OF PROJECT

Building Name	Building Status•	When will the new construction or renovations take place?			
		Within the next year	Within the next 2 years	Within 3-5 years	More than 5 years

*NP, NC, Add., MR, Retro.

P2c. Building Information Summary

Gather data collected above in this summary table.

P2c. BUILDING INFORMATION SUMMARY				
Building Name	Building Use	Building Size	Building Status•	Time Frame

•NP, NC, Add., MR, Retro.






Biomass can be an option for heating a variety of buildings types, including schools, campuses, hospitals, prisons, public buildings, community district energy, multi-family or senior housing, government buildings and complexes, commercial or office buildings, farms and greenhouses, and smaller industrial parks.

► Assess

Section P2. Building Information

You have now completed section P2. Building Information. Transfer the information you have collected into the Building Information summary worksheet. You can now:

Continue collecting information about this project to further clarify its feasibility (Go to ► P3-P7).

OR

Assess whether the project will help you meet one or more community goals. Go to ► Community Goals to select a goal to evaluate.

This Roadmap was produced by Yellow Wood Associates and the Biomass Energy Resource Center for the North Country RC&D.

P3. Existing Fuel Use

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P3. Existing Fuel Use

This Roadmap was produced by Yellow Wood Associates and the Biomass Energy Resource Center for the North Country RC&D.

P3. Existing Fuel Use

► Project Characteristics

► Building Information

► Existing Fuel Use

► Existing Heating and Distribution System

► Biomass Energy System

► Biomass Fuel

► Emissions, Permitting, and Air Quality

► EVALUATE A BIOMASS PROJECT 3

P3. Existing Fuel Use

Knowing the type, quantity and cost of fuel currently used to heat the building or buildings under consideration will help you determine whether or not it makes sense to pursue a biomass system. The best way to do this is to review all heating bills for the building(s) for the past two years. Collect the heating bills for each type of fuel used to heat each building. You may be able to collect bills directly from the building's owner or you may need the owner to give permission to the utility company or fuel supplier to release the data to you.

NOTE ON NEW CONSTRUCTION: **If the building(s) you are considering for biomass heat have not yet been built, you will not be able to determine existing heat and/or energy use from past bills. If the building or buildings are in the design stage you should be able to speak with the engineers or project developers to determine what the heat load will be and ask them to estimate the anticipated annual fuel use. You can estimate cost based on the current cost per unit of fuel.**

IN THIS SECTION

P3a. Heating Fuel Type and Usage

Knowing the type of fuel used helps to determine both the efficiency of the current system and the potential cost difference between the current fuel(s) and biomass fuel. If more than one type of fuel is used to heat the building, try to determine the square footage of conditioned space for each type of fuel.

Instructions: Heating Fuel Type and Annual Usage

COLUMN 1: List each building being considered for biomass heat.

COLUMN 2: List each fuel type used to heat the building (if there is more than one fuel type per building leave a blank row between buildings to total fuel usage by building).

COLUMN 3: List average annual usage for each fuel type (see Fuel Usage worksheet for determining average annual usage by fuel type).

COLUMN 4: Multiply the average annual usage (column 3) by the net heating value of the fuel (see P3a-5 Heating Values worksheet on page 183) to determine the average annual heat load.

P3a-1. HEATING FUEL TYPE AND ANNUAL USAGE

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4
Building	**Fuel Type**	**Average Annual Usage***	**Average Annual Heat Load (MMBtu)**

*Units: Natural Gas = therms, dekatherms, cubic feet, or MMBtu; Propane and Fuel Oil = Gallons

EXAMPLE: *This example evaluates a 100,000 SF school that uses fuel oil for heat and a 50,000 SF computer center that uses propane for heat.*

P3a-1 EXAMPLE. **HEATING FUEL TYPE AND ANNUAL USAGE**

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4
Building	**Fuel Type**	**Average Annual Usage***	**Average Annual Heat Load (MMBtu)**
School	*Fuel Oil*	*100,000 gallons*	*11,500*
Computer Center	*Propane*	*45,000 gallons*	*3,240*

Determining Average Annual Usage if the Building Uses Natural Gas, Propane, or Fuel Oil for Heat

To find the average annual usage add up the amount of fuel used each year for the past 2 years and divide by 2.

FOR EXAMPLE: If the building used 13,000 gallons of propane in year one and 16,000 gallons of propane in year 2, the average annual fuel usage is 14,500 gallons of propane.

P3a-2. NATURAL GAS, PROPANE, FUEL OIL USAGE WORKSHEET

		BUILDING 1	BUILDING 2	BUILDING 3
A	Total Fuel Used in Year 1			
B	Total Fuel Used in Year 2			
C	Total Fuel Used (A + B)			
D	**Average Annual Fuel Use (line C divided by 2)**			

NOTE: **If the building uses natural gas or propane for institutional or commercial cooking as well as heating it will be important to try to determine how much is used for this function and subtract it from the average annual fuel use used for heating. Sometimes the cooking fuel will come from a different tank and will have a different bill. If the cooking fuel does not come from a different tank/bill, talk with the system operator and ask them to estimate what percentage of the fuel is used for cooking. Subtract this amount from the total annual average.**

Determining Average Annual Usage if the Building Uses Electric Heat

Because electricity is most likely used for other functions in the building (like lighting, equipment, etc.) determining how much electricity is used for heat is a little trickier than with other fuels. A good general guideline is to review the electric bills and find the month with the lowest kWh. This will most likely be in late spring or fall when there should be little or no electricity used for heating or cooling. The kWh used in this month will represent the amount of electricity used to power other building functions. By subtracting this amount from the months the building is heated you can get a good estimate of how much electricity is used for heating.

Look at the electric bills for the building to identify non-heat kWh.

Which month has the lowest kWh in Year One? What were the kWh used in that month?

____

Which month has the lowest kWh in Year Two? What were the kWh used in that month?

____

Fill in the following worksheet to estimate the kWh used for heat.

P3a-3. ELECTRIC HEAT USAGE WORKSHEET PART 1

	YEAR ONE				YEAR TWO			
	Total kWh			Heating kWh	Total kWh			Heating kWh
January		Minus non-heat kWh	=			Minus non-heat kWh	=	
February								
March								
April								
May								
June								
July								
August								
September								
October								
November								
December								
Total								

P3a-4. ELECTRIC HEAT USAGE WORKSHEET PART 2

A	Total kWh Used in Year One for Heat	
B	Total kWh Used in Year Two for Heat	
C	Total kWh Used (add Lines A and B)	
D	Average Annual kWh Use (Line C divided by 2)	

Instructions: Determine Your Net Heating Values Worksheet

COLUMN 1: List each existing fuel type used to heat the building(s) being considered.

COLUMN 2: List current annual usage (see P3a).

COLUMN 3: List the Net Heating Value for each type of fuel.

P3a-5. NET HEATING VALUES

Fuel Type	Net Heating Value
Fuel Oil	0.115 MMBtu/gallon
Propane	0.072 MMBtu/gallon
Natural Gas	0.82 MMBtu/1,000 ft^3
Electricity	0.003 MMBtu/kWh

COLUMN 4: Multiply the current annual usage (column 2) by the appropriate Net Heating Value.

P3a-6. DETERMINE YOUR NET HEATING VALUES WORKSHEET

COLUMN 1	COLUMN 2		COLUMN 3		COLUMN 4
Fuel Type	Annual Usage		Net Heating Value		Annual Heat Load
		x		=	

P3a-6 EXAMPLE. **DETERMINE YOUR NET HEATING VALUES WORKSHEET**

COLUMN 1	COLUMN 2		COLUMN 3		COLUMN 4
Fuel Type	Annual Usage		Net Heating Value		Annual Heat Load
Fuel Oil	*100,000 gallons*	x	*0.115*	=	*11,500*
Propane	*45,000 gallons*		*0.072*		*3,240*

P3b. Domestic Hot Water

A biomass heat system can often be used to heat domestic hot water (DHW). **If DHW is included in the overall heating bills for the building (it is heated by the same system that provides space heat), you can skip this section.** If the DHW comes from a different fuel source than the building heat, or from a different tank/bill, collect 2 years of bills for the DHW for each building being considered for a biomass system. If electricity is used for DHW, talk with the system operator and ask them to estimate how much of electricity is used for DHW.

If the data for DHW fuel usage is not available, you can estimate the DHW usage as a percentage of the space heat. Based on a recent study by the Biomass Energy Resource Center for a community district heating system in New England area, the DHW usage ranges from 3% to 18% of the heat used for space heating, with an average of 11%.

Instructions: Domestic Hot Water Fuel Type and Annual Usage

List the fuel type and average annual fuel usage for hot water for each building being considered for a biomass project.

COLUMN 1: List each building being considered for biomass heat.

COLUMN 2: List each fuel type used to heat the domestic hot water.

COLUMN 3: List average annual usage for fuel used to heat hot water (see instructions above for determining average annual usage by fuel type).

COLUMN 4: Multiply the average annual usage (column 3) by the net heating value of the fuel (see table below) to determine the average annual heat load.

NOTE: **If you are unable to determine the average annual usage for domestic hot water, you can use 11% of the building's heat load. Multiply column 4 from Table P3a. Heating Fuel Type and Annual Usage by 11% to estimate average annual DHW load.**

P3b-1. DOMESTIC HOT WATER FUEL TYPE AND ANNUAL USAGE

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4
Building	Fuel Type	Average Annual Usage*	Average Annual DHW Load (MMBtu)

*Units: Natural Gas = Therms, Dekatherms, Cubic Feet, and MMBtu; Propane and Fuel Oil = Gallons; Electricity = kWh

P3b-2. NET HEATING VALUES

FUEL TYPE	NET HEATING VALUE
Fuel Oil	0.115 MMBtu/gallon
Propane	0.072 MMBtu/gallon
Natural Gas	0.82 MMBtu / 1,000 ft^3
Electricity	0.003 MMBtu/kWh

Steam or hot water can be circulated in buried piping networks to deliver heat and domestic hot water to entire communities.

P3c. Fuel Cost

Understanding the current cost of your heating fuel will help to determine whether or not a biomass heat system will reduce your fuel costs.

What is the current average annual cost of heating the building(s) you are considering for a biomass heat system?

Instructions: Existing Fuel Costs

COLUMN 1: List the name of each building. If domestic hot water is heated by an independent source, list hot water as a line item in column 1.

COLUMN 2: List the type of fuel currently used to heat the building and hot water.

COLUMN 3: List the average annual cost spent on each type of fuel. See worksheets on the following pages for determining cost information.

COLUMN 4: Divide the average annual cost (column 3) by average annual usage (see P3a and P3b to determine the average cost per unit).

P3c-1. EXISTING FUEL COSTS

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4
Building	**Fuel Type**	**Average Annual Fuel Cost**	**Average Cost per Unit**

EXAMPLE: This example evaluates a school that uses fuel oil for heat, has an additional fuel oil tank for hot water; and a computer center that uses one propane tank to provide heat and hot water.

P3c EXAMPLE. **EXISTING FUEL COSTS**

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4
Building	**Fuel Type**	**Average Annual Fuel Cost**	**Average Cost per Unit**
School (Space Heating)	*Fuel Oil*	*$250,000*	*$2.50*
School (Hot Water)	*Fuel Oil*	*$50,000*	*$2.50*
Computer Center (Space Heating + Hot Water)	*Propane*	*$90,000*	*$2.00*

Determining Costs with Natural Gas, Propane, and Fuel Oil

P3c-2. NATURAL GAS, PROPANE, FUEL OIL COST WORKSHEET

		BUILDING 1		BUILDING 2		BUILDING 3	
		Heat	Water	Heat	Water	Heat	Water
A	Total Paid for Fuel in Year 1						
B	Total Paid for Fuel in Year 2						
C	Average Annual Fuel Cost (line A plus line B divided by 2)						
D	Average cost per unit (divide total paid (line A) by total used (table P3a))						

Determining Costs with Electric

Because electricity is most likely used for other functions in the building (like lighting, equipment, etc.) determining how much electricity is used for heat is a little trickier than other fuels. To determine cost related to electric heat, follow the steps below:

COLUMN 1: List the total kWh for Year 1 and Year 2 (see section A2).

COLUMN 2: List kWh used for heat in Year 1 and Year 2 (see section A2).

COLUMN 3: Divide column 2 by column 1 to get the % of total electricity used for heat.

COLUMN 4: Enter the total amount paid for electricity in Year 1 and Year 2 (add up bills).

COLUMN 5: Multiply Column 4 by Column 3 for the total paid each year for heat.

COLUMN 6: Divide Column 5 by Column 2 for the average cost per kWh paid for heat.

P3c-3. ELECTRIC HEAT COST WORKSHEET

	COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6
	Total kWh	kWh Used for Heat / Cooling	% of Electricity Used for Heat / Cooling	Total Paid for Electricity	Total Paid for Electric Heat / Cooling	Average Cost per kWh for Heat / Cooling
Year 1						
Year 2						
Average						

P3d. Thermal Efficiency

Before deciding whether to move forward with a biomass heating project, it is important to determine the efficiency of the building. If the building you are considering for biomass is not thermally efficient it is important to address efficiency issues before pursuing biomass. The average building in the region uses approximately 63,500 Btus per SF annually, equivalent to 0.46 gallons of oil annually per SF. Individual use may vary greatly depending on such factors as the age of the heating system, the degree of insulation, and the age and quality of windows and doors.

To determine whether or not your building is thermally efficient complete Table P3d.

Instructions: Thermal Efficiency

COLUMN 1: List each building.

COLUMN2: List average annual heating fuel usage (**see ▶ P3a. Heating Fuel Type and Annual Usage table**).

COLUMN 3: List SF of building (**see ▶ P2a. Building Use and Size table**).

NOTE: If the building uses more than one type of fuel, list that building twice and complete columns 2-6 for each fuel type/section of building.

COLUMN 4: Divide the fuel used (column 2) by the SF (column 3).

COLUMN 5: Multiply column 4 by the heating value of the fuel type to convert to Btu per SF:

HEATING VALUES

Fuel Oil = 138,000 Btu/gallon

Propane = 91,300 Btu/gallon

Natural Gas = 1,025 Btu/cubic foot

Electricity = 3,412 Btu/kWh

COLUMN 6: Determine the efficiency of the building:

Less than 40,000 Btu/SF = VERY EFFICIENT

40,000 – 90,000 Btu/SF = AVERAGE EFFICIENCY

More than 90,000 Btu/SF = INEFFICIENT

P3d. THERMAL EFFICIENCY

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6
Building	Average Annual Fuel Usage	SF	Fuel / SF	Btu / SF	Efficiency

ROADBLOCK

If the building is rated "inefficient" then it is important to address the efficiency issues of the building before pursuing a biomass project. To move around this roadblock, use the energy efficiency links at the end of this section to learn more about improving building efficiency. You can also work with a professional energy auditor to identify the most cost-efficient way to address thermal efficiency issues.

EXAMPLE: *This example looks at a Community Center that uses an average of 24,000 gallons of fuel oil to heat 60,000 SF of space.*

P3d EXAMPLE. **THERMAL EFFICIENCY**

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6
Building	Average Annual Fuel Usage	SF	Fuel / SF	Btu / SF	Efficiency
Community Center P1	*24,000 gal*	*60,000*	*0.4 gal*	*55,200*	*AVERAGE*

This table shows that the community center is in the average thermal efficiency range.

P3e. Summary

Complete the summary table below with information from preceding tables in section P3. (Columns with the shaded background in preceding tables show which informtion should be transferred to the summary table.)

Instructions: Summary

COLUMN 1: List each building being considered. For individual biomass systems leave a blank row between buildings with multiple fuel types (after the last fuel type) to total the Average Annual Fuel Bill (column 7).

For **multi-building / district biomass systems**, total Average Annual Heat Load (column 5) Average Annual Fuel Bill (column 7) for all buildings in the last row.

COLUMN 2: List SF of conditioned space.

COLUMN 3: List each type of fuel used.

COLUMN 4: Combine your heat and hot water (by fuel type) for total average annual fuel usage.

COLUMN 5: Total your heat and hot water heat loads for each building.

COLUMN 6: List average cost of fuel (by fuel type).

COLUMN 7: Combine your heat and hot water bills for total average annual fuel bill.

COLUMN 8: List thermal efficiency rating for each building.

P3e. SUMMARY

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8
Building	SF of Conditioned Space	Type of Fuel	Average Annual Fuel Usage	Average Annual Heat Load	Average Cost per Unit	Average Annual Fuel Cost	Thermal Efficiency

Links

Energy Management Tools

EPA Portfolio Manager – This free tool from the Environmental Protection Agency allows you to track and assess energy and water consumption in one or more buildings.

http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager

Energy Management Priorities: A self-assessment tool

http://www.mass.gov/Eoca/docs/doer/esmart-energy-management-priorities.pdf

RETScreen International Energy Efficiency Analysis Software

http://www.retscreen.net/ang/energy_efficiency_projects.php

Energy Efficiency Resources

List of NH State Energy Efficiency Programs

http://www.nh.gov/oep/programs/energy/resources.htm

Reports about NH State Energy Efficiency Programs

http://www.puc.nh.gov/Electric/coreenergyefficiencyprograms.htm

NH Municipal Energy Assistance Program (NHMEAP)

http://www.nhenergy.org/index.php?title=New_Hampshire_Municipal_Energy_Assistance_Program

NH Energy Efficiency and Sustainable Energy Board (EESB)

http://www.puc.nh.gov/EESE.htm

NH Local Government Center: Office of Energy Efficiency

http://www.nhlgc.org/resources/energyefficiency.asp

► Assess

Section P3. Existing Fuel Use

You have now completed section P3. Existing Fuel Use. Based on the information you have collected:

Does the project have an average annual fuel bill of more than $2,500?

Yes ☐ **No** ☐

Is the project you are evaluating Thermally Efficient?

Yes ☐ **No** ☐

Yes ➔ GO

If you answered yes to both of these questions, transfer the information you have collected into the Existing Fuel Use summary worksheet. You can now:

1. **Continue collecting information** about this project to further clarify its feasibility (**Go to ► P4-P7**).
2. Assess whether the project will help you meet one or more community goals. **Go to ► Community Goals** to select a goal to evaluate.

No ➔ ROADBLOCK

If any of the buildings you are evaluating do not have an annual fuel bill of $2,500 or greater, you can:

1. Decide to continue evaluation of this project. See choices under GO.
2. **Select a different facility or district to evaluate** if you are still interested in pursuing a biomass project in your community. **Go to ► P1a. Selecting a Project**.

If any of the buildings you are evaluating are not thermally efficient you can:

1. Try to **move around the roadblock** of thermal efficiency using the links on the following page to access efficiency resources in NH. Once you have taken measures to improve the building's thermal efficiency, you can move forward with evaluating the potential of a biomass system for this facility.
2. **Select a different facility or district to evaluate** if you are still interested in pursuing a biomass project in your community. **Go to ► P1a. Selecting a Project**.
3. **Continue collecting information** on this project to further clarify its feasibility (**Go to ► P4**).

P4. Existing Heating and Distribution System

P4. Existing Heating and Distribution System

[Add Tab Here]

P4. Existing Heating and Distribution System

► Project Characteristics

► Building Information

► Existing Fuel Use

► Existing Heating and Distribution System

► Biomass Energy System

► Biomass Fuel

► Emissions, Permitting, and Air Quality

► EVALUATE A BIOMASS PROJECT 4

P4. Existing Heating and Distribution System

This section will assist you in organizing information about the existing heating and distribution systems in the buildings you are considering converting to biomass heat. Understanding the existing heating and distribution systems is critical. Not all systems convert with equal ease to biomass applications. This information will also help determine what heating systems need to remain in place for back up. The modifications required to be carried out in the distribution system inside the building will also depend on the existing system.

When a biomass boiler is installed for heat, it is recommended that the existing boiler(s) or heat source(s) be maintained both as an emergency standby and for potential use during shoulder seasons when the heat requirments will be too small to operate a biomass system efficiently. The control systems of the existing heat source and the biomass boiler can be interconnected and programmed. The biomass boiler can be programmed as the prime boiler and if the heat provided is not sufficient, the existing boiler will automatically come on line to provide the required heat. The person who maintains the heating system should be able to help you answer all of the questions included in this section.

NOTE ON NEW CONSTRUCTION: **If the building(s) you are considering for biomass heat have not yet been built, you will need to work with the architects and engineers to identify the proposed heating and distribution systems. A back-up boiler is not required in new construction that will be connected to a district heating system (this system will have its own back-up), but it is required for a new construction that will be using an individual system.**

IN THIS SECTION

Single Building/Individual Systems

District/Campus Heating

SINGLE BUILDING / INDIVIDUAL SYSTEMS

P4a. Existing Heating Equipment (One Building/Individual Systems)

Does the building have (check one):

- ☐ **One heating plant in one location?**
- ☐ **Different heating plants in different locations?**
- ☐ **Individual, room by room heating systems?**

List each system separately in the table below.

Identify the existing heating equipment (and if there is more than one system per building what portion of the building it heats).

P4a. EXISTING HEATING EQUIPMENT

Building / Portion of the Building	Type of Heating System *	Size of Heating Equipment	Fuel Type	Age of System**	Condition (Poor, Fair, Good, Excellent)

*Hot water boiler, Steam boiler, Hot air furnace, Electric baseboard, Electric duct coils, Rooftop package units, Heat pumps.

**If you do not know the exact age of the system, approximate to within 5 or 10 years.

P4a EXAMPLE. **EXISTING HEATING EQUIPMENT**

Building / Portion of the Building	Type of Heating System *	Size of Heating Equipment	Fuel Type	Age of System**	Condition (Poor, Fair, Good, Excellent)
School/Gym	*Hot Water Boiler*	*140,000 BTH*	*Propane*	*15*	*Good*
Rest of School	*Hot Water Boiler*	*3.5 MMBTH*	*Fuel Oil*	*28*	*Fair*

SINGLE BUILDING / INDIVIDUAL SYSTEMS

P4b. Heat Distribution System

The way heat is distributed in a building affects the ease of converting to biomass If existing heat is currently piped through a hot water (hydronic) or steam system it will be much easier to convert the existing system to a biomass system. If the existing system does not currently use a hydronic or steam distribution system, the project will need to include a new heating distribution system.

How is heat distributed to rooms (check all that apply)?

☐ Hot Water

☐ Steam

☐ Ducted Air

☐ Electric Resistance

SINGLE BUILDING / INDIVIDUAL SYSTEMS

P4c. Heating and Distribution Summary

Complete this table with information collected from sections P4a and P4b.

P4c. HEATING AND DISTRIBUTION SUMMARY

Building Name	Number of Heating Plants / Locations?*	Type of Heating System	Type of Fuel	Age of System	Condition of System	How is Heat Distributed to Rooms?

* Central = Central Heating System
Multiple = Multiple plants, multiple locations
Room = Room-by-room heating

DISTRICT / CAMPUS HEAT

When considering district heat, the details of heating and distribution systems for individual buildings will be required to determine whether or not it will be possible for each of the anchor load buildings to interconnect with the district heating system. At this stage it is most important to understand the existing distribution system of each anchor load building.

P4d. District Heat with Existing Central Heating Plant

If the district is not currently served by a single/central heating plant, go to P4e. If the district is already served by a single heating plant, answer the following questions:

P4d. CENTRAL HEATING PLANT EQUIPMENT SUMMARY

	How Is Heat Generated?*	Type of Fuel	Age of System	Condition (Poor, Fair, Good, Excellent)	How Is Heat Distributed to Buildings?	Do Individual Buildings Have Back-Up Heating Systems?
Heating System 1						
Heating System 2						
Heating System 3						

*Hot water boiler, steam boiler

P4e. District Heat without Existing Central Heating Plant

If the district you are considering is not currently heated by a central plant, complete the table below.

Instructions: District Heating Equipment Summary

COLUMN 1: List each anchor load building.

COLUMN 2: How is the heat generated? (Hot water boiler, Steam boiler, Hot air furnace, Electric baseboard, Electric duct coils, Rooftop package units, Heat pumps.) List all that apply.

COLUMN 3: How is the Heat Distributed? (Hot Water, Steam, Ducted Air, Electric Resistance).

COLUMN 4: Is the domestic hot water heated from a central boiler? (Yes/No).

P4e. DISTRICT HEATING EQUIPMENT SUMMARY

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4
Building	Heat Generation	Heat Distribution	Domestic Hot Water

► Assess

Section P4. Existing Heating and Distribution System

You have now completed section P4. Existing Heating and Distribution System. Based on the information you have collected:

Does the building/project have a central heating system?

Yes ☐ **No** ☐

Does the building/project have hot water or steam distribution?

Yes ☐ **No** ☐

Yes ➔ GO

If the building(s) you are evaluating for a biomass project have a central heating system and hot water or steam distribution, transfer the information you have collected into the Existing Distribution System summary worksheet. You can now:

1. **Continue collecting information** about this project to further clarify its feasibility. (**Go to ► P5-P7**).
2. Assess whether the project will help you meet one or more **community goals**. **Go to ► Community Goals** to select a goal to evaluate.

No ➔ ROADBLOCK

If you answered no to at least one of these questions, it is less likely that this biomass project will be viable. You can:

1. Try to **move around the roadblock**. You will need to install a new hot water distribution system – contact a local engineering firm to provide an cost estimate for installing a hydronic distribution system and add this cost to the capital cost of the project (see section P5h. Biomass System Capital Cost).
2. **Select a different facility or district to evaluate** if you are still interested in pursuing a biomass project in your community (**Go to ► P1a Selecting a Project)**.
3. Continue collecting information about this project to further clarify its feasibility (**Go to ► P5**).

P5. Biomass Energy System

[Add Tab Here]

This Roadmap was produced by Yellow Wood Associates and the Biomass Energy Resource Center for the North Country RC&D.

P5. Biomass Energy System

▶ Project Characteristics

▶ Building Information

▶ Existing Fuel Use

▶ Existing Heating and Distribution System

▶ Biomass Energy System

▶ Biomass Fuel

▶ Emissions, Permitting, and Air Quality

▶ EVALUATE A BIOMASS PROJECT 5

P5. Biomass Energy System

The exact type of biomass energy system will not be selected for your project until you are at a later planning stage, however understanding the basic characteristics of different types of systems along with the site and fuel requirements of your project is an important step in evaluating whether or not a biomass energy system makes sense for the site(s) you are considering. It is also important to identify the champion or champions in your community who are committed to exploring biomass as an alternative.

IN THIS SECTION

P5a. Champion

Having a community or institutional champion for the biomass project is an important factor in the success of a biomass energy project. This champion could take the form of a key decision-maker who is interested in the technology and invested in the concept of biomass energy, or simply an interested and committed citizen who has political "capital" in the community and may be a member of an energy or conservation committee. Community plans that support biomass or investment in the reduction of greenhouse gases are a sign of community commitment, but no substitute for an individual champion or group of champions.

Is there a biomass champion for this project?

If yes, provide contact information for that person or a link to the community documentation of biomass support. You will want to keep this person informed of the results of your *Roadmap* exploration.

Community Champion

Name:

Contact Information:

P5b. Biomass Heating Systems

There are two main types of biomass heating systems, woodchip systems and wood pellet systems. Both types of systems burn woody biomass to create hot water or steam heat for heating. Below is a table summarizing the types of systems, and then more detailed information about each type of system.

P5b. BIOMASS HEAT SYSTEMS SUMMARY

	TYPICAL WOODCHIP SYSTEMS		TYPICAL WOOD PELLET SYSTEMS
	Fully Automated	Semi Automated	
Primary Fuel	Green woodchips (mill or forest residue, 25-50% MC)		Wood pellets (6% MC)
Energy Output	Hot water or steam (boiler system)		
Conditioned Space	More than 100,000 SF	Between 50,000 and 100,000 SF	Up to 50,000 SF
Boiler Output (size)	2–60 MMBTH	0.5 – 3.0 MMBTH (or larger)	100,000 BTH to 2 MMBTH
Fuel Storage	Below-grade concrete bin (min. capacity 3000 cu. ft.)	Slab-on-grade building (overhead door for delivery)	Silo
Fuel Handling	Automated from bin to combustion (no operator labor)	Tractor with front-end bucket, from pile to day bin (performed by operator, once or twice daily). Automated from day bin to combustion chamber (no operator labor)	Automated from silo to combustion (no operator labor)
Operator Work Load	Up to 30 minutes daily	Up to 1 hour daily	Approximately 15-20 minutes daily
Combustion Control	PLC-based panel, Automated control of fuel feed and combustion air rates	Electronic control panel (minimum), Automated, tuned control of fuel and combustion air	PLC-based panel, Automated control of fuel feed and combustion air rates
Stack Size	Average 60-75 ft. Height will depend on system size, prevailing winds and local topography. Engineers designing the system will use dispersion modeling to properly size a stack for the system.		6ft above roof to 75 ft. Height will depend on local regulations.
Stack Emission Control	Depending on the size of the boiler cyclone and Bag house or electrostatic precipitator required. Must meet applicable state regulations if any	None required (unless required by state regulations) Must meet applicable state regulations, if any	
Ash Removal	Manual or automated		
Space Required for Boiler	1,000 – 15,000 SF (depending on system size)	1,500 – 4,500 SF (depending on size of system)	200 SF
Space Required for Fuel Storage	6 SF/ton*		Outside storage silo, approximately 150 SF
Approximate System Cost	$1 million - $20 million	$200,000 - $1 million	$150,000 - $600,000

*See section P5e to determine required fuel storage space.

Woodchip Systems

Woodchip systems burn green woodchips (with 25-50% moisture content) and are sized to serve spaces larger than 50,000 SF. These systems require space for both the boiler (between 1,000 and 15,000 SF depending on the size) and for woodchip storage (see section P5e to determine required fuel storage space).

There are two main types of woodchip systems: automated systems and semi-automated systems. Automated systems are more common and have an automated fuel handling system that delivers the woodchips directly from the storage bin to the combustion chamber, requiring no operator labor, while semi-automated systems require the operator to move chips from the main storage to a day bin once or twice a day.

Wood Pellet Systems

Wood pellet systems burn wood pellets that are made primarily from compacted sawdust (produced as a byproduct of sawmilling). Pellet systems are smaller than woodchip systems and serve smaller spaces. These systems have a lower startup cost than woodchip systems, but pellets are a more expensive fuel. The ideal size range for the economics for pellet systems currently is in the 100,000 BTH to 1.5 MMBTH size range. Pellet systems offer some additional advantages over woodchip systems, including a smaller footprint area than larger woodchip systems required to handle and combust the bulkier woodchip fuel. Research into grass and other types of pellets may lead to increased diversity of fuel options in the future.

Woodchip Systems

Fully Automated

Fully automated systems are generally cost effective for projects over 3 MMBH. For systems under 3 MMBH, a pellet system may present a most cost-effective option. Systems larger than 2 MMBTH may still wish to consider a pellet system if there are space constraints for either the combustion system or fuel storage.

Semi Automated

Semi-automated systems present a good alternative to fully automated systems where the economics of a fully automated system are difficult, and where there is an under-utilized maintenance staff.

Will you be using a woodchip or wood pellet system?

If you are heating more than 50,000 SF of space you will likely be using a woodchip system. If you are heating less than 50,000 SF of space, there is no exact equation for choosing between a woodchip or wood pellet system. If you will be heating less than 50,000 SF of space, use the Biomass Heat System Summary to help decide which type of system you prefer.

☐ We will be evaluating a **wood pellet** system

☐ We will be evaluating a **woodchip** system

P5c. System Size

Generally, to meet the space heating needs of a building in New Hampshire, a biomass boiler will be sized in the range of 30-40 BTH per SF of conditioned space.

Instructions: Estimated Size of Biomass Boiler Required

COLUMN 1: List buildings being evaluated for a biomass system.

COLUMN 2: List the total SF of conditioned space in each building.

For individual systems determine the boiler size for each building.

For one system serving multiple buildings total the SF of all buildings that will be connected to the system.

COLUMN 3: Multiply the SF of conditioned space (column 2) by 35 to get the system size in BTH.

COLUMN 4: Divide column 3 by 1,000,000 to get the estimated boiler size in MMBTH (the common unit for sizing).

P5c. ESTIMATED SIZE OF BIOMASS BOILER REQUIRED

COLUMN 1 Building Name	COLUMN 2 SF				COLUMN 3 System Size (BTH)				COLUMN 4 Size of Boiler Required (MMBTH)
		x	35 BTH	=		÷	1,000,000	=	

EXAMPLE: *In this example, the woodchip boiler is being used to heat a 70,000 SF high school and a 30,000 SF elementary school. Multiply 100,000 SF by 35 Btu to determine the approximate size boiler needed.*

P5c EXAMPLE. **ESTIMATED SIZE OF BIOMASS BOILER REQUIRED**

COLUMN 1 Building Name	COLUMN 2 SF				COLUMN 3 System Size (BTH)				COLUMN 4 Size of Boiler Required (MMBTH)
High School	*70,000*	x	35 BTH	=		÷	1,000,000	=	
Elementary School	*30,000*								*3.5 MMBTH*
Total	*100,000*				*3,500,000*				

These two buildings will require a system that is approximately 3.5 MMBTH.

P5d. Woodchip Storage

If you are evaluating a wood pellet system, **go to ▶ P5f.**

NOTE: The following worksheet is for fully automated systems. If you are assessing a semi-automated system, the storage of woodchips will be slab on grade storage. If live bottom trucks are used to deliver the woodchips, the volume of storage will be 3,300 cubic feet. Assuming the height of the storage pile is 10 feet, the minimum storage area will be 330 SF (approximately 17 feet by 20 feet).

Now that you know the approximate size of the system required you can estimate the size of woodchip storage bin the system will need. Keep these requirements in mind when determining the bin size required for woodchip storage:

- The bin should hold at least 5 days worth of fuel.
- The height of the bin is limited to 12 feet by the local site conditions and cost of excavation.
- The internal width of the bin will be approximately 15 feet and the external width will be approximately 20 feet. This includes space for the required fuel handling equipment.
- In order to increase the size of the storage bin, in most cases, the length of the bin is the only variable.
- The minimum size of the bin needs to take into account the capacity of the delivery truck. A live bottom truck will deliver about 2500 cubic feet (25 tons) in a single delivery. This means that the bin should be at least 3,300 cubic feet (1.33 times the delivery load) even for smaller systems.

Instructions: Woodchip Storage Bin Size

COLUMN 1: Boiler Size (**see ▶ P5c System Size**).

COLUMN 2: Multiply the boiler size (column 1) x 24 (hours) x 5 (days) do determine the heat output that is required for a 5 day period.

COLUMN 3: Divide heat output (column 2) by 6.72 (this assumes 9.1 MMBtu/ton of woodchips and a boiler efficiency of 75%) to determine the 5-day demand of woodchips in tons (round up to the closest ton)

COLUMN 4: Multiply the 5-day woodchip requirement (column 3) x 2000 (to convert tons to pounds) and then divide by 30 (this is the average density of woodchips per cubic foot)

(Column 3) x 2000 ÷ 30 = Column 4

COLUMN 5: Divide column 4 by 12 (the height of the bin) to get the area required

COLUMN 6: Divide column 5 by 15 (the maximum length of the bin) to get the bin width required (repeat for each biomass boiler)

P5d. WOODCHIP STORAGE BIN SIZE

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6
Boiler Size (MMBTH)	Heat Output (MMBtu)	5-Day Woodchip Supply (tons)	Volume Required (ft^3)	Area Required (SF)	Minimum Length Required (ft)

The woodchip storage bin will have minimum internal dimensions of 12 feet deep by 15 feet wide by ____ (column 6) feet long. Add 5 feet to the width and 5 feet to the length for minimum external dimensions.

EXAMPLE. *This example assumes the community is using a 3.5 MMBTH woodchip boiler to heat the high school and the elementary school.*

P5d EXAMPLE. **WOODCHIP STORAGE BIN SIZE**

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6
Boiler Size (MMBTH)	Heat Output (MMBtu)	5-Day Woodchip Supply (tons)	Volume Required (ft^3)	Area Required (SF)	Minimum Length Required (ft)
3.5	*420*	*68*	*4,500*	*378*	*25.2*

The table above shows the required internal dimensions of the woodchip storage bin for the two schools. The external dimensions will be an additional 5 feet in width and 5 feet in length. Thus the minimum size woodchip storage bin required to serve the high school and the elementary school is 12 feet by 20 feet by 30 feet.

There is a variety of wood fuel storage options that are suitable to a wide range of site situations.

P5e. Frequency of Deliveries

Now you can estimate the maximum number of truckloads you will need during the peak (coldest) heating week. Woodchips are commonly delivered in tractor trailers; it is important to be aware of how woodchip delivery may impact traffic flow and other circulation patterns on the site.

Instructions: Number of Truckload Deliveries

COLUMN 1: List the Boiler Size from P5c.

COLUMN 2: Multiply the boiler size (column 1) x 24 (hours) to determine the heat output that is required per day.

COLUMN 3: Divide heat output (column 2) by 6.72 (this assumes 9.1 MMBtu/ton of woodchips and a boiler efficiency of 74%) to determine the daily demand of woodchips in tons.

COLUMN 4: Multiply 1-day supply (column 4) by 7 (to get to weekly supply need).

COLUMN 5: Divide column 4 by 25 tons (one truckload). Round up since trucks will not deliver partial loads.

P5e. NUMBER OF TRUCKLOAD DELIVERIES

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Boiler Size (MMBTH)	Heat Output (MMBtu / day)	1-Day Woodchip Supply (tons)	Weekly Woodchip Supply	# of Truckloads per week

EXAMPLE. *The woodchip boiler to heat a high school and an elementary school will use a 3.5 MMBtu boiler.*

P5e EXAMPLE. **NUMBER OF TRUCKLOAD DELIVERIES**

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Boiler Size (MMBTH)	Heat Output (MMBtu/day)	1-Day Woodchip Supply (tons)	Weekly Woodchip Supply	# of Truckloads per week
3.5	*84*	*13.6*	*95.2*	*4*

The 2-school biomass system will require a maximum of 4 (rounded up from 3.4) delivery trips per week during peak season.

P5f. Site Requirements for Wood Pellet Systems

If you are evaluating a woodchip system, skip this section**.**

Wood pellet boilers generally require **200 SF** plus space for pellet storage. Fuel can be delivered in individual bags, pallets or as a bulk delivery into a pellet silo. If the fuel is delivered on pallets it will be necessary to have equipment (usually a small forklift) for moving the pallet of fuel. It is highly recommended and most common to get delivery of wood pellets in bulk by trucks (similar to trucks used for grains) delivering the pellets directly into a silo. Typically pellet storage silo is placed outside the boiler building. The pellets are then augured automatically from the silo into the pellet boiler. The silo storage will require a **10' x 10' concrete slab (100 SF) and it will be approximately 35 feet tall**.

Pellet System = 200 SF

Pellet Storage =100 SF

P5g. Biomass System Location

Different types of systems will have different site requirements – these include space for the new biomass heating system, fuel storage and access for fuel delivery – and each community will have different aesthetic requirements in regards to their biomass energy system. Some important issues to consider when determining the location of the biomass energy system are:

- **Where is the existing boiler room? Can a biomass boiler room be added close by?**
- **If the biomass system will be in a new structure, what will it look like, who will be able to see it?**
- **Will the fuel storage be above or below ground?**
- **If the fuel storage is above ground, what will it look like, who will be able to see it?**
- **If the system requires a smoke stack, how tall will it be? What is the best location for this stack?**
- **What type of truck will be delivering the fuel? What are the requirements for that truck, such as turning radius? How many tons of fuel can this truck carry?**
- **How often will fuel be delivered to the site?**
- **Can the fuel storage be located so delivery is not disruptive to existing traffic flow or site usage?**

Taking these into consideration, can you identify one or more locations for the biomass system?

Yes ☐ **No** ☐

If yes, enter location(s) here: ____

You can use Google Maps **(http://maps.google.com/)** to look at an aerial view of the site, identify potential locations for the biomass system and fuel storage, and confirm that there is a clear route for delivery trucks.

P5h. Biomass System Capital Cost

When considering the cost of the biomass system you will need to consider the cost of the biomass boiler as well as the building to house the boiler, if required, and the wood fuel storage. If it is necessary to upgrade or change your heating distribution system this will be an additional capital cost. Distribution system upgrades will need to be assessed by a professional engineer. Determining precise estimates of system cost is beyond the scope of this *Roadmap*. Cost estimates would be prepared as part of a pre-feasibility study and confirmed with a full feasibility study. However, you can use the following tables to estimate a rough capital cost at this time. Select the appropriate table to complete based on the type of system (woodchip or wood pellet) you are evaluating.

Woodchip System Capital Cost

To estimate a rough capital cost for a woodchip system you will need to complete the table below.

Instructions: Woodchip System Capital Cost

COLUMN 1: List woodchip system size in MMBTH [see P5c].

COLUMN2: Multiply system size (column 1) by $300,000 for the estimated cost of the system.

COLUMN 3: Complete columns 3 and 4 for systems serving multiple buildings only. In column 3 list distribution piping cost from table P1h-1.

COLUMN 4: Add distribution cost (column 3) to system cost (column 2) for total capital cost.

P5h-1. WOODCHIP SYSTEM CAPITAL COST

COLUMN 1				COLUMN 2	For multi-building systems only			
						COLUMN 3		COLUMN 4
System Size (MMBTH)	x	$300,000	=	Biomass System Capital Cost	+	Distribution Piping Cost	=	Total Capital Cost

EXAMPLE: *In this example, the two schools will require a 3.5 MMBTH woodchip boiler. The local estimate for buried piping is $200 per trench foot and the distance between the boiler plant and the farthest load is 350 feet.*

P5h-1 EXAMPLE. **WOODCHIP SYSTEM CAPITAL COST**

COLUMN 1				COLUMN 2	For multi-building systems only			
						COLUMN 3		COLUMN 4
System Size (MMBTH)	x	$300,000	=	Biomass System Capital Cost	+	Distribution Piping Cost	=	Total Capital Cost
3.5				*$1,050,000*		*$70,000*		*$1,120,000*

Wood Pellet System Capital Cost

To estimate a rough capital cost for a wood pellet system you will need to complete the table below.

Instructions: Wood Pellet System Capital Cost

COLUMN 1: List wood pellet system size in MMBTH [see P5c].

COLUMN 2: Multiply system size (column 1) by $500,000 for the estimated cost of the system.

COLUMN 3: Add system cost (column 2) to storage cost (column 3) for total capital cost.

P5h-2. WOOD PELLET SYSTEM CAPITAL COST

COLUMN 1				COLUMN 2		Bulk Fuel Storage		COLUMN 3
System Size (MMBTH)	x	$500,000	=	Biomass System Capital Cost	+	$30,000	=	Total Capital Cost

P5h-2 EXAMPLE. **WOOD PELLET SYSTEM CAPITAL COST**

COLUMN 1				COLUMN 2		Bulk Fuel Storage		COLUMN 3
System Size (MMBTH)	x	$500,000	=	Biomass System Capital Cost	+	$30,000	=	Total Capital Cost
.75				*$375,000*		*$30,000*		*$405,000*

If evaluating a 750,000 BTH (or .75 MMBTH) system, the capital cost will be approximately $405,000.

P5i. Summary

Complete the summary table below with information from preceding tables in section P5. (Columns with the shaded background in preceding tables show which information should be transferred to the summary table.)

P5i. BIOMASS ENERGY SYSTEM SUMMARY	
Champion (Yes / No)	
Champion Contact Info	
Type of System (Woodchip / Pellet)	
Size of System	
Space Required for Woodchip Storage	
Maximum # of Woodchip Deliveries per Week	
System Location	
Capital Cost	

▶ Assess

Section P5. Biomass Energy System

You have now completed section P5. Biomass Energy System. Based on the information you have collected:

Were you able to identify one or more potential sites for the biomass system?

Yes ☐ **No** ☐

Yes ➔ GO

If you have identified one or more sites for the biomass system (boiler house and wood fuel storage), you can:

1. **Continue collecting information** about this project to further clarify its feasibility (**Go to ▶ P6-P7**).
2. Assess whether the project will help you meet one or more **community goals**. **Go to ▶ Community Goals** to select a goal to evaluate.

No ➔ ROADBLOCK

If you were not able to identify a site for the biomass system, it is less likely that this biomass project will be viable. You can:

1. Try to **move around the roadblock**. For a district system, you can work with the community and town officials to try to identify locations for the biomass system. Remember that the best location is close to multiple anchor loads. If you are evaluating a single building and there is limited space and/or access, remember that pellet systems require less space.
2. **Select a different facility or district** to evaluate if you are still interested in pursuing a biomass project in your community. **Go to ▶ P1a. Selecting a Project**.
3. **Continue collecting information** about this project to further clarify its feasibility (**Go to ▶ P6**).

P6. Biomass Fuel

[Add Tab Here]

P6. Biomass Fuel

P6. Biomass Fuel

This Roadmap was produced by Yellow Wood Associates and the Biomass Energy Resource Center for the North Country RC&D.

► EVALUATE A BIOMASS PROJECT 6

P6. Biomass Fuel

It is important to understand biomass fuel availability when evaluating a biomass project. It is best to find a source of biomass fuel within 75 miles of your site to reduce costs and emissions associated with the transportation of the biomass fuel. It is also best to locate more than one potential supplier to ensure competitive pricing and so that you have the security of knowing there will be back-up in case of interruption from the primary supplier.

IN THIS SECTION

P6a. Sustainability of Fuel Supply

In years past, a majority of woodchips used for community heating systems came from the leftover wood produced from sawmills. Therefore, at that time, a decision to install another system did not directly result in more wood cut from the region's forests. Today, a large majority of woodchip fuel for new heating systems will come directly from harvested low-grade wood as the supply of chips from sawmills has dwindled while demand for chips has risen.

Given the direct connection to increased harvesting of low-grade wood, the sustainability of the fuel supply is a critical consideration that should be examined. There are two main ways in which the question of sustainability should be explored:

1. At the landscape level where one asks "are our region's forests growing as much wood as we are planning to take?"
2. At the stand level where foresters, loggers, and landowners must make decisions and take measures to reduce impacts of periodic harvesting.

To address the first point, a resource assessment needs to be conducted to verify that there are sufficient forest resources to sustainably supply wood fuel over time given the numerous other demands on our forests and all the values they provide (see links at the end of section P6 for more information on conducting a resource assessment). At the forest stand level, there is relatively little control communities seeking to install wood energy systems have over the decisions foresters, loggers and landowners make about how they manage and harvest specific stands.

At this time in New Hampshire, for smaller thermal systems, there are no mandatory standards governing where woodchips come from or how they are to be harvested. Despite the overall lack of control communities have over stand level management voluntary wood sourcing or "procurement" standards could be designed and used to help ensure wood fuel is sourced from local and well-managed forests. These voluntary procurement standards should include a certain level of verification to make sure that these standards are met. Decision-makers should decide how they define "sustainable" and what their objectives are when procuring wood. Examples of objectives identified by a community and incorporated into voluntary procurement standards include:

- **Sourcing wood from a defined local wood procurement area**
- **Purchasing woodchips that were produced by loggers who were trained and accredited to certain professional standards**
- **Purchasing woodchips or wood pellets that come from third-party certified sources**

Fuel suppliers can be selected based on their ability to meet these objectives, and a third party can be hired to verify that these objectives are being met.

What, if any, procurement standards will your community follow?

____

____

In addition to procurement standards, the community can define wood fuel sourcing criteria. The table below lists a range of sourcing criteria that a community can use to source some portion of their wood fuel supply. You can use this table either by checking each source criteria the community will follow, or by writing in the percentage of wood that should come from these different activity levels (for example, you could indicate that 100% of wood must come from forest management harvesting marked and overseen by a professional forester).

WOOD FUEL WILL COME FROM (CHECK ALL THAT APPLY OR INDICATE %)			
From land clearing activity for development		From forest management harvesting conducted in accordance with any and all state laws and AMPs	
From land clearing jobs for agriculture		From forest management harvesting marked and overseen by a professional forester	
From generic forest management harvesting		From forest management harvests conducted by a professional logger accredited by a Master Logger Program	
From forest management harvesting with a management plan		From Third-Party certified sources including but not limited to FSC, SFI, or Tree Farm	
From forest management harvesting with a management plan written/approved by a professional forester		From within ____ miles of the facility (fill in distance)	

Forest Sustainability

Forest sustainability needs to be examined both at the regional landscape level and on the ground. Harvesting, particularly for biomass energy, should be developed within the regional forest's growth capacity. Additionally, the forestry practices and harvesting methods being applied locally should not adversely impact the long-term health and productivity of that region's forests.

Wood fuel supply assessments can assess whether harvesting is happening within the growth capacity of the region's forests. Yet, determining whether on-the-ground forest management is sustainable is much more difficult to address: Each forest and its management is unique and can be highly complex. Certain harvest intensity and techniques used on one forest may be considered sustainable while the same intensity and techniques used on a different forest may be far from sustainable.

As the stewards of the forests, foresters prescribe management that balances the landowner's objectives with the health of the forests. There are several emerging certification systems to ensure that management plans and harvesting are sustainable. Many of these certification systems set standards that must be met and use independent auditors to verify compliance.

In the end, people define forest sustainability in varying ways. Foresters themselves debate the answers to such key questions as, "What is the appropriate amount of wood to remove for a healthy forest? Should all tree tops from harvests be left, or only some?"

There are no blanket answers—the answer is always site specific and depends on numerous complex factors. Both regional and local fuel supply assessments are critical components to studying the viability of any biomass energy project.

Regional Wood Fuel Availability

New Hampshire has a mature forest products industry and a developing wood energy market. Woodchips and wood pellet feedstocks have historically been a by-product of timber harvesting in the woods, lumber production at sawmills, and clean wood waste recycling efforts from communities.

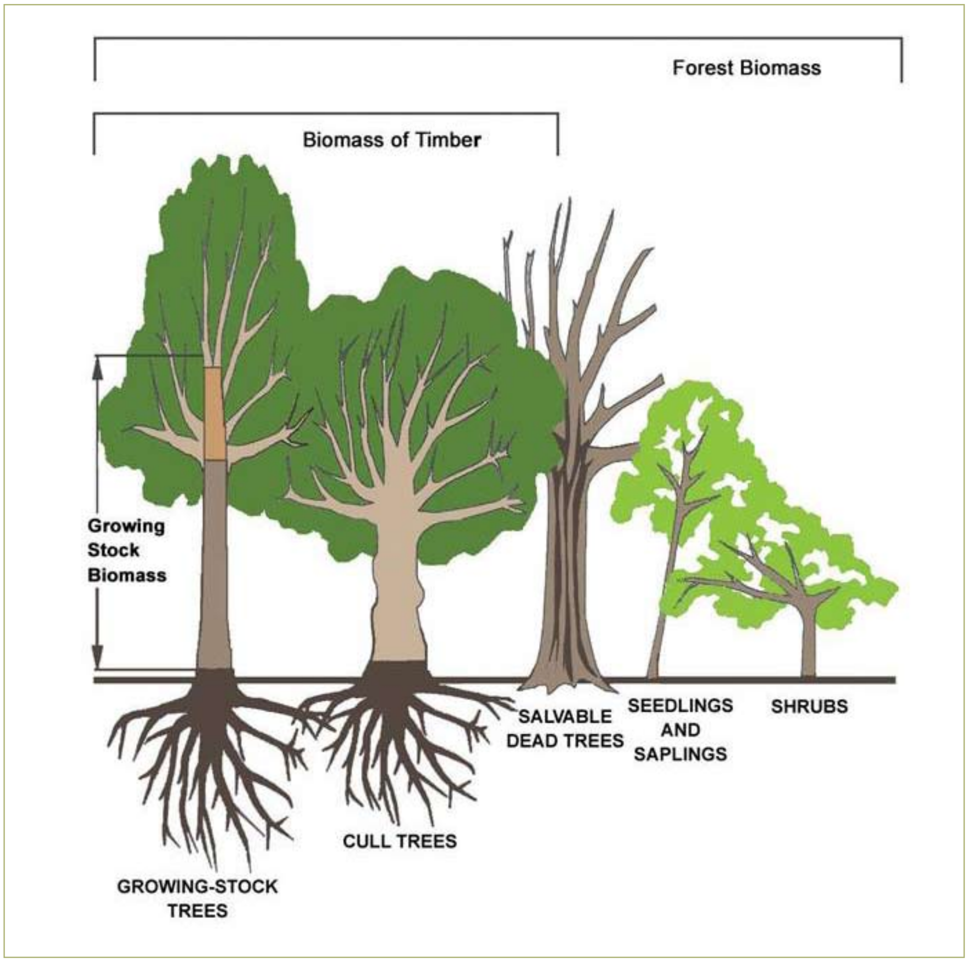
Historically, there has been sufficient supply of wood by-products such as sawdust, chips, and bark generated by the forest products industry to meet the demand for wood fuels. Over recent years, the demand for wood fuels has grown dramatically while the by-product supply has decreased due to general downturn in the forest products industry. Woodchip and sawdust supply from sawmills is extremely tight in New Hampshire today and sawmills are unlikely to respond to increased demand by producing more by-product.

In recent years, increased market demand for chips as fuel and decreased sawmill activity has prompted a gradual shift toward woodchips sourced as a commodity wood fuel harvested directly from the forest rather than a by-product produced from higher value wood harvesting and processing. Despite the downturn in by-product supply of woodchips, logging contractors have encouragingly responded to the recent surge in demand for wood fuels produced as a primary product. Low-grade logs or pulpwood that would historically have gone to regional pulpmills now is a major feedstock for woodchip and pellet production. While some wood fuel sourced for community biomass systems or pellet production may be by-product material, a majority of the supply will likely come directly from harvesting low-grade wood from regional forestland.

Potential Sources

SAWMILLS. The business of sawing round logs into dimensional lumber produces a significant amount of by-product wood (slabs which can be chipped, bark, and sawdust). Because logs are debarked before sawing the chips, mill chips are very clean and have relatively low ash content. Mill chips are also commonly screened to remove over-sized stringers and fines. These “mill” or “paper” chips are excellent fuel for biomass heating systems.

WHOLE-TREE HARVESTING. Commercial harvesting of sawlogs and pulpwood removes the main stem or bole of the tree from the woods and leaves the tops and limbs either scattered in the woods near the stump or in a large pile at the log landing. Whole-tree harvesting—mechanized harvesting where entire trees are dragged (skidded) from the stump to the central log landing instead of just the log—requires the tops and limbs be removed and piled at the log landing. This leftover wood can be chipped into biomass fuel commonly known as whole-tree chips. In some cases entire trees, not just the tops and limbs, are fed to the chipper to produce whole-tree chips. Chipped tops and limbs from whole-tree harvesting are the most cost-effective source of woodchips however, there are many harvest jobs where whole-tree harvesting may not be suitable. Whole-tree harvests require wider skid roads and require more space at the log landing. Additionally, retaining the top and limb wood in the forest helps return nutrients and organic matter to the forest soil to ensure long-term productivity and forest health.

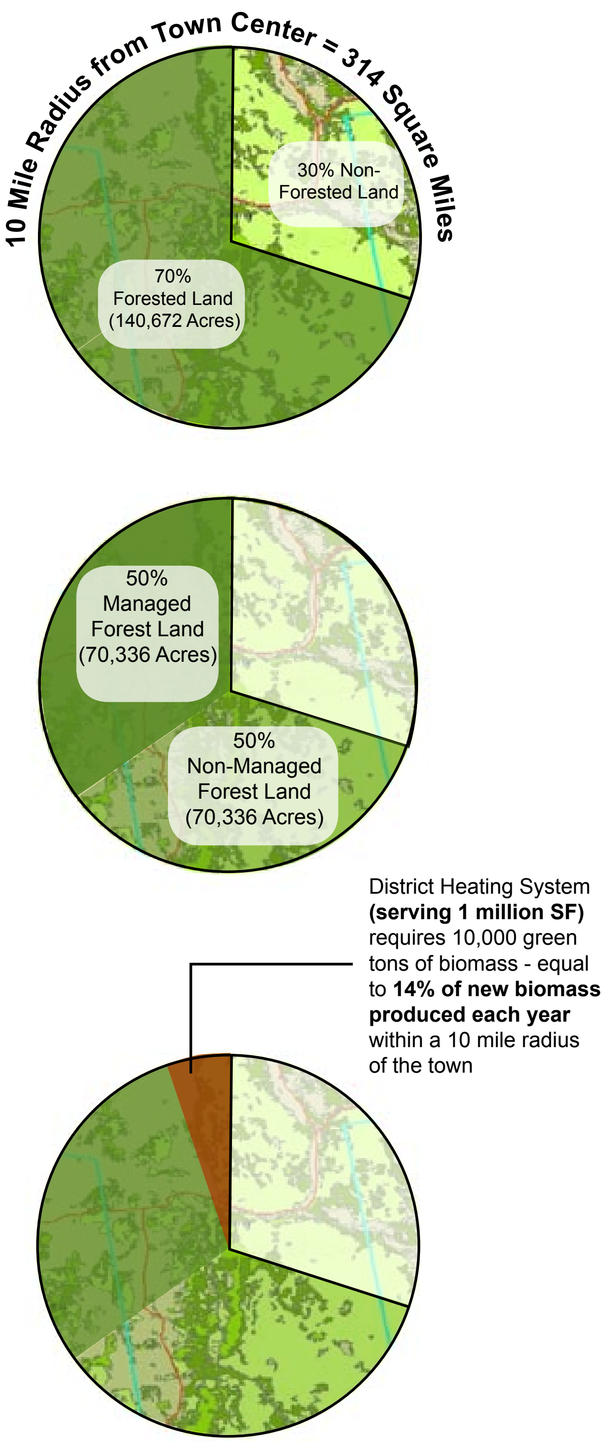


Forest biomass can include a wide range of potential sources for wood fuel; however, the appropriate material depends on numerous factors that should be evaluated by a professional forester.

BOLE CHIPS (CHIPPED PULPWOOD). Bole chips are produced from low-grade tree stems or pulpwood. The difference between whole-tree chips and bole chips is that bole chips do not include the branches or foliage. When the trees are harvested the limbs are removed and the slash is left on the ground in the woods or at the log landing (depending on where the tree is de-limbed). While bole chips can make for higher quality fuel and help forest soil health by returning a portion of the biomass and nutrients to the soil, they are significantly more expensive than sawmill chips and whole-tree chips, both of which are by-products. In the past, sawlog prices were high enough that low-grade wood could be extracted at the same time as sawlogs and still be profitable for the logger and pay the landowner stumpage. With recent drops in the sawlog market, however, low-grade wood like pulp, chips and firewood can no longer rely on subsidized costs—this low-grade wood must pay its own way out of the woods.

WOODCHIP BROKERS. Woodchip brokers offer several advantages over sourcing woodchip fuel directly from the various sources. Brokers are able to pool volumes of chips from multiple sources to meet market demand. In many cases, brokers also provide increased supply reliability by immediately drawing upon different suppliers should one supply source experience an interruption to their operations.

Conceptualization of Forest Resource Required to Supply a Small District Heating Project in a New Hampshire Community



This diagram graphically represents the amount of sustainably harvested forest-land required to supply a small district heating project (serving approximately 1 million SF of heated space in the community) in relation to a 10-mile radius from the town. (Typically, a radius of 30 miles is considered for the wood basket for a biomass project.)

This conceptualization assumes:

- A typical New Hampshire Forest has 100 green tons per acre of wood inventory.
- The typical net annual growth rate of a New Hampshire forest is 2%, producing 2 new green tons per acre per year.
- Half of the growth is high-quality wood and the other half is low-quality wood, the latter of which is best suited for biomass heat or other low-value uses.
- Within a 10 mile radius of a New Hampshire town center, 70% of the land (140,672 acres) is forested.
- Half of the forested land (70,336 acres) is sustainably managed.
- The sustainably managed land will produce approximately 70,336 green tons of biomass each year (7 times more than would be required to serve a small district heating system).

P6b. Type of Biomass Fuel

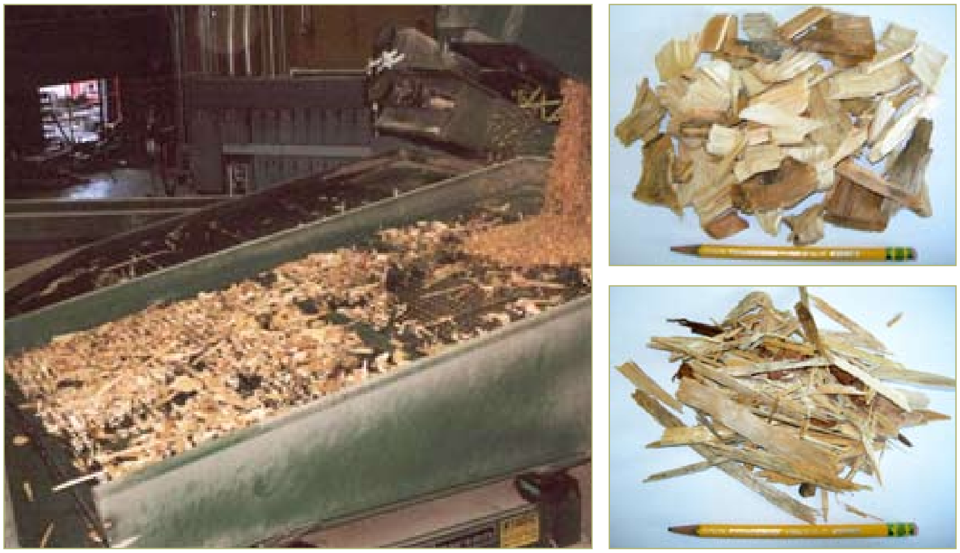
In order to answer questions about your biomass fuel supply, you will first need to determine the type of biomass fuel your system will require and the amount you will need. The type of fuel you use is based on the type of biomass system you choose to install. Biomass fuels can include woodchips, wood pellets, agricultural residues (like corn Stover) or dedicated energy crops (like willow or grasses). This chapter is focused on woodchips and wood pellets. For information on other biomass fuel types and sources, please contact your local university agriculture extension office. (You can find your local extension office at: **http://extension.unh.edu/Agric/Agric.htm**)

Will you be using woodchips or wood pellets?

- ☐ **Woodchips**
- ☐ **Wood pellets**

(Go to ▶ Section P5. Biomass System to determine which type of biomass fuel you will be using.)

Typical woodchip (left image) and pellet storage options.



Biomass heating systems will function and perform better with a high-quality fuel. Chip shape, size, and uniformity are important factors affecting fuel quality (preferred chips are top right).

The Importance of Quality Wood Fuel

Not all biomass heating systems will require the same quality of fuel, so matching the right fuel source and quality to the right system and application is extremely important. There are many sources of wood that can be processed into woodchips or pellets and there are equally as many ways in which the wood can be harvested, processed, loaded, transported and received, all of which can impact the overall quality of the wood fuel.

Biomass heating systems will function and perform better with a high-quality fuel that the particular system is designed to use. Systems that are fueled with consistent, uniformly sized fuel experience fewer mechanical jams of the fuel feeding equipment. Systems that are fed cleaner wood fuel (fuel that is free of bark, needles, dirt and debris) produce less ash and can burn longer without maintenance and ash removal.

The species of tree that the wood fuel came from can make a difference in a wood fuel's value. Softwoods typically have a higher Btu content than hardwoods on a dry weight basis. The major factors that vary among species are the moisture content and the density of the wood. Additionally, certain species have higher oil contents in their wood which can boost the Btu/lb properties. Most Northeastern hardwood species have a higher heating value (HHV) of about 8,400 Btu per dry pound.

WOODCHIP QUALITY. Chips are a refined wood fuel that is suitable for use in fully automated feed systems. There are numerous factors that affect the properties of woodchips and their overall quality for use as fuel. The most important parameters governing a chip's overall quality for use as a heating fuel are woodchip shape, size, moisture content, mineral content, cleanliness, and energy content. In general, a woodchip should be consistent in shape and size, about the size of a match book, and consistent in moisture content, with an acceptable range of 35-55% moisture. Ideally woodchips should be bark free and clean without excessive dust or other contaminants.

WOODCHIP AVAILABILITY. Woodchips are typically purchased by the green ton. They are delivered to institutional wood energy users by tractor trailer; each trailer typically holds 25 tons of green woodchips. These trailers are equipped with self-unloading systems so that the woodchips can be dumped directly into the storage bin, from where they are conveyed into the boiler.

Woodchips have historically been almost exclusively a by-product of timber harvesting in the woods, lumber production at sawmills, and clean wood waste recycling efforts from communities. In recent years increased market demand for woodchips as fuel and decreased sawmill activity has prompted a gradual shift towards woodchips sourced as a commodity wood fuel harvested directly from the forest, rather than a by-product produced from higher-value wood harvesting and processing. A wood resource assessment should be conducted for any proposed biomass energy project to quantify the availability of woodchips as both a residue and a commodity.

WOOD PELLET QUALITY. Wood pellets have higher energy content by weight (roughly 8084 Btu per pound at 6% moisture content) than woodchips (roughly 4500 – 5000 Btu per lb at 50% moisture). Pellets provide clean, consistent, and uniformly-sized fuel. This results in fewer mechanical jams, less ash produced (and therefore less time spent on removing ash), and longer periods of maintenance-free burn time.

Pellets are usually manufactured from by-product wood fibers from the forest products industry, such as sawdust and shavings, which are dried and extruded through pellet dies under high heat and pressure. Pellets can also be made using woodchips and/or non-woody plant material. Natural plant lignin in the pellet material is melted during the extrusion process and holds the pellets together without glues or additives. Like woodchips, the quality of pellets also is governed by size, density, amount of fines, chlorides content, ash and mineral content, moisture content, and heating value.

Wood pellets are of uniform size and shape (between 1 and 1-1/2 inches in length by approximately 1/4 to 5/16 inches in diameter) that makes them easy to store and use in fuel augering systems. Wood pellets also take up much less space in storage than other biomass fuels because they are relatively dry and densified compared to woodchips. They have consistent hardness and energy content (minimum 40 pounds/cubic foot). Wood pellet quality is rated voluntarily by the Pellet Fuels Institute. For more information on pellet quality, go to **www.pelletheat.org**.

WOOD PELLET AVAILABILITY. For the residential market, wood pellets are sold in 40-pound bags at farm supply or hardware stores. Small commercial- or institutional-scale applications of the type being discussed here, however, require bulk delivery and storage. There is an increasing number of wood pellet manufacturers who are either beginning to offer or are expanding an existing bulk delivery service. These companies can deliver bulk pellets using grain- or feed-type trucks that deliver the pellets into a storage silo via augering equipment or pneumatic blower systems. There are several wood pellet manufacturers in the NH area, some with the capacity of supplying bulk quantities of fuel. A resource assessment can determine the actual quantity of fuel available to a proposed biomass energy project.

Some pellet suppliers have dedicated bulk-delivery vehicles. Others may use subcontracted grain haulers to provide bulk deliveries.

P6c. Amount of Biomass Fuel Required

To determine your average annual usage of biomass fuel, complete the table below.

Instructions: Amount of Biomass Fuel Required

COLUMN 1: List each building being considered for biomass heat.

COLUMN 2: List each type of existing fuel used (if you are using more than one type of fuel leave a blank row to total required biomass by building).

COLUMN 3: List the current or existing average annual usage of each fuel type [**go to** ▶ **P3. Existing Fuel Use**].

COLUMN 4: Multiply column 3 by 85% (see Appendix A for assumptions).

COLUMN 5: Use the table **P6. Converting to Biomass Fuels** and the required worksheet to determine the replacement ratio of biomass to your existing heating fuel(s).

Divide the amount of existing fuel to be replaced (column 4) by the unit displaced per ton of woodchips or wood pellets, depending on the type of biomass fuel you will be using.) If more than one type of heating fuel is used, add the numbers in column 5 for the total amount of biomass required for each building.

P6c-1. AMOUNT OF BIOMASS FUEL REQUIRED

COLUMN 1 Building	COLUMN 2 Existing Fuel Type	COLUMN 3 Existing Fuel Use	COLUMN 4 Existing Amount of Fuel to Be Replaced	COLUMN 5 Required Biomass (tons)

P6c-1 EXAMPLE. **AMOUNT OF BIOMASS FUEL REQUIRED**

COLUMN 1 Building	COLUMN 2 Fuel Type	COLUMN 3 Existing Use	COLUMN 4 Existing Amount of Fuel to Be Replaced	COLUMN 5 Required Biomass (tons)
School	*Fuel Oil*	*10,000 gallons*	*8,500 gallons*	*145*
Town Hall	*Propane*	*8,000 gallons*	*6,800 gallons*	*73*

In this example, the school will require 145 tons of woodchips each year and the town hall will require 73 tons of woodchips each year.

P6c-2. CONVERTING TO BIOMASS FUEL

Fuel Type	Unit	Unit Displaced per Ton of Woodchips	Unit Displaced per Ton of Wood Pellets
Natural Gas	Dekatherm (1 Dekatherm = 1,000 ft³)	8.19	15.70
Oil	1 gallon	58.63	112.36
Propane	1 gallon	93.11	178.44
Electric	1 kWh	3,500	4,775
Woodchips	1 ton	1	1.92
Wood Pellets	1 ton	0.52	1

P6c-3. REQUIRED BIOMASS WORKSHEET

Existing Fuel	÷	Displaced per Ton of Wood	=	Required Biomass (Tons)

P6c-3. EXAMPLE. **REQUIRED BIOMASS WORKSHEET**

Existing Fuel	÷	Displaced per Ton of Wood	=	Required Biomass (Tons)
85,000 gallons		*58.63*		*145*

In this example, the school currently uses 10,000 gallons of fuel oil. 85% of that (8,500 gallons) will be replaced by woodchips. The school will use approximately 145 tons of woodchips to replace the 8,500 gallons of fuel oil.

P6d. Biomass Suppliers

Now that you know the type of fuel you will need and the average quantity, you can find out how many biomass suppliers there are in your region and whether or not they can meet your needs. Issues to consider when assessing biomass fuel providers:

1. **DISTANCE FROM THE PROJECT SITE.** The closer a supplier is to your project site, the less you will have to pay to transport the fuel, the more reliable the supply, and the greater impact on local economic development.
2. **LONG-TERM CONTRACTS.** Access to a long-term contract with a supplier will increase price stability.
3. **SELF-UNLOADING TRAILER (WOODCHIPS ONLY).** The use of a self-unloading trailer allows for easier and more efficient delivery of woodchips. Expensive equipment or time-consuming and costly methods would be required if walking-floor trailers are not used.
4. **BULK/SILO PELLET DELIVERY (PELLETS ONLY).** Commercial or institutional-scale pellet applications will require bulk pellet delivery (not bags). Potential pellet suppliers will need to have a delivery truck capable of delivering bulk quantities of pellets.
5. **MAXIMUM/MINIMUM DELIVERIES.** Make sure that the maximum or minimum delivery requirements will suit the needs of your project [**go to ▶ P5. Biomass Energy System**].
6. **SOURCES OF WOOD.** Knowing the source of your wood fuel is key to addressing community goals around energy independence, energy reliability and strengthening the local economy [▶ G1, G2, and G7] as well as answer questions about sustainable wood supply.
7. **WOOD HARVESTING.** Understanding the types of harvesting the wood fuel comes from helps to answer questions about sustainable wood supply and strengthening the local economy.

Live-bottom trailer: A self-unloading tractor trailer with a hydraulically operated moving floor used to push the biomass fuel load out the back of the trailer. It is typically filled directly by the chipper in the mill or in the woods.

The best way to identify potential biomass fuel providers is to work with one of the following resources to get access to the most up-to-date information on wood fuel providers in your area:

- NH Cooperative Extension Division of Forests and Trees
  http://extension.unh.edu/Forestry/Forestry.htm.
  (see links at the end of this section for contact information of local extension offices)
- NH Division of Forests and Lands
  http://www.nhdfl.org/
- Biomass Energy Resource Center
  www.biomasscenter.org
- Pellet Fuels Institute
  www.pelletheat.org

You will want to identify all of the biomass providers in your area and ask them the following questions. Enter collected information into table on next page.

- What type of woodchips do you provide? (Woodchips Only)
- What standard of pellet do you offer? (Pellets Only)
- What is the price per ton of fuel delivered to _____________ (the location of the proposed project)?
- Do you enter into long-term contracts? _______
- Are you able to provide _____ (average annual amount of biomass fuel) amount per year? If the answer is no, determine what percentage they will be able to cover.
- Do you have a self-unloading trailer to deliver woodchips with? (Woodchips only)
- Do you do bulk/silo pellet delivery? (Pellets only)
- Do you have minimum or maximum delivery requirements?
- What are the sources of the wood?
- What type of harvesting does the wood typically come from?
- Other sustainability questions that you have developed based on your sustainability guidelines (**see ▶ P6a. Sustainability of Fuel Supply**).

Use this table to gather information about each potential provider.

P6d. BIOMASS FUEL PROVIDER INFORMATION				
Fuel Provider				
Contact Name				
Contact Info				
Distance from Project Site				
Type of Fuel				
Cost per Ton				
Long-term Contracts				
Can Provide the Amount Required (%)				
Self-Unloading Trailer				
Bulk / Silo Pellet Delivery				
Minimum / Maximum				
What Are the Sources of the Wood?				
What Type of Harvesting Does the Wood Typically Come from?				
Other Sustainability Criteria				

How many fuel providers do you have in your area that will meet the needs of your project?

____

How many fuel providers do you have in your area that can provide locally sourced and sustainably harvested wood fuel?

____

P6e. Summary

Transfer data from the preceding sections of P6 to the summary table below:

P6e. SUMMARY

Sustainability		Building Name	Type of Biomass (Woodchips, Pellets)	Estimated Amount of Biomass Required	# of Fuel Providers that Meet your Requirements
Procurement Standards (list)	Harvesting Practices (list)				

Woodchips are a coarser, bulkier, and less energy-dense fuel than pellets and require larger augers and motors in fuel feeding systems.

Links

Northern Forest Biomass Energy Action Plan
http://www.biomasscenter.org/pdfs/NFBEI.pdf

Vermont Wood Fuel Supply Study (includes surrounding NH counties)
http://www.biomasscenter.org/services/technical-services/biomass-resource-supply-services/vermont-wood-fuel-supply-study.html

New Hampshire Division of Forest and Lands
http://www.nhdfl.org/

USDA Forest Inventory and Analysis National Program
http://fia.fs.fed.us/

Sustainability Criteria (Renewable Fuels Roadmap and Sustainable Biomass Feedstock Supply for New York):
http://www.nyserda.org/publications/renewablefuelsroadmap/Appendix_K_Sustainability_Criteria.pdf

Woody Biomass Removal Case Studies
http://www.forestguild.org/publications/forest_wisdom/Wisdom11.pdf

An Assessment of Biomass Harvesting Guidelines
http://www.forestguild.org/publications/research/2009/biomass_guidelines.pdf

Meeting the Needs of Communities and Forests: The Development of a Biomass Energy System in Richford, Vermont
http://www.ncfcnfr.net/Richford.pdf

Forest Inventory and Analysis National Program
http://fia.fs.fed.us/program-features/rpa/

Society for the Protection of New Hampshire Forests
http://www.spnhf.org/research/research-projects.asp

New Hampshire Cooperative Extension - Forests and Trees

The NH Cooperative Extension - Forest and Trees has a forester in each county as well as a central office: http://extension.unh.edu/Forestry/Forestry.htm. Contact information for current county extension offices at time of publication is listed below.

- **Belknap County**
  36 County Drive, Laconia, NH 03246-2900; 603-527-5475
  http://extension.unh.edu/Counties/Belknap/ForestandWildlifeResources.htm
- **Carroll County**
  73 Main Street, P.O. Box 1480, Conway, NH 03818; 603-447-3834
  http://extension.unh.edu/staffbios//index.cfm?fuseaction=display.list&county_id=2
- **Cheshire County**
  800 Park Avenue, Keene, NH 03431; 603-352-4550
  http://extension.unh.edu/Counties/Cheshire/ForestryandWildlife.htm
- **Coos County**
  629A Main Street, Lancaster, NH 03584-9612; 603-788-4961
  http://extension.unh.edu/staffbios//index.cfm?fuseaction=display.list&county_id=4
- **Grafton County**
  1930s Nursing Home Building, 3855 Dartmouth College Hwy, North Haverhill, NH 03774; 603-787-6944
  http://extension.unh.edu/staffbios//index.cfm?fuseaction=display.list&county_id=5
- **Hillsborough County**
  329 Mast Road, Goffstown, NH 03045; 603-641-6060
  http://extension.unh.edu/Counties/Hillsboro/Hillsboro.htm
- **Merrimack County**
  315 Daniel Webster Hwy, Boscawen, NH 03303; 603-796-2151
  http://extension.unh.edu/Counties/Merrimack/TimF.htm
- **Rockingham County**
  113 North Road, Brentwood, NH 03833-6623; 603-679-5616
  http://extension.unh.edu/Counties/Rockingham/FrstAWld.htm
- **Strafford County**
  268 County Farm Road, Dover, NH 03820; 603-749-4445
  http://extension.unh.edu/Counties/Strafford/ForestryResourcesStraffordCounty.htm
- **Sullivan County**
  24 Main Street, Newport, NH 03773; 603-863-9200
  http://extension.unh.edu/Counties/Sullivan/Forestry-SullivanCounty.htm

► Assess

Section P6. Biomass Fuel

You have now completed section P6. Biomass Fuel. Based on the information you have collected:

Are there one or more fuel providers that will meet your requirements for:

Type of Fuel	**Yes**	☐	**No**	☐
Amount of Fuel	**Yes**	☐	**No**	☐
Distance from Project Site	**Yes**	☐	**No**	☐
Delivery Type	**Yes**	☐	**No**	☐
Wood Sourcing	**Yes**	☐	**No**	☐
Wood Harvesting Practices	**Yes**	☐	**No**	☐

Yes ➔ GO

If you answered yes to all of these questions, transfer the information you have collected into the Biomass Fuel Supply summary worksheet. You can now:

1. **Continue collecting information** about this project to further clarify its feasibility (**Go to ► P7**).
2. Assess whether the project will help you meet one or more **community goals**. **Go to ► Community Goals** to select a goal to evaluate.

No ➔ ROADBLOCK

If you answered no to at least one of these questions it is less likely that this is a feasible biomass project for your community. You can:

1. Try to **move around this roadblock** by working with the State Forester's Office or your local Cooperative Extension to help identify a fuel provider that can meet the needs of the project and the community. **Go to ► P6d. Biomass Suppliers** to find contact information for these resources.
2. **Continue collecting information** about this project to further clarify its feasibility (**Go to ► P7**).

P7. Emissions, Permitting, and Air Quality

[Add Tab Here]

P7. Emissions, Permitting, and Air Quality

P7. Emissions, Permitting, and Air Quality

► Project Characteristics

► Building Information

► Existing Fuel Use

► Existing Heating and Distribution System

► Biomass Energy System

► Biomass Fuel

► Emissions, Permitting, and Air Quality

► EVALUATE A BIOMASS PROJECT 7

P7. Emissions, Permitting, and Air Quality

It is important for a community to understand the emission and air-quality ramifications of a biomass system before deciding whether to move forward with a project. These topics are on the minds of many community members and it will be difficult for a project to move forward without having a good understanding of how a biomass system will affect the community's air quality.

Permitting is also an important component to understand before moving forward. Permitting requirements may impact the type, size, and location of a biomass system and you will want to understand the potential impact of permitting before moving forward with a project.

IN THIS SECTION

P7a. Air Emissions

Any community or facility interested in biomass energy systems wants to know the answer to the question, "What comes out of the chimney?" The emissions of biomass combustion systems are different than emissions of natural gas, propane or oil combustion systems. Modern industrial or community scale woodchip systems are not just a bigger version of a residential wood stove. In fact modern biomass energy systems utilize highly engineered sophisticated combustion technologies, emission control devices, and properly sited stacks, enabling them to burn cleaner and emit less. For more information on air emissions, go to page 243.

P7b. Permitting

It is important to understand all of the potential environmental requirements for your biomass project as well as which state and local permits will be required.

Air Quality Permitting

Current New Hampshire requirements limit emissions particulate matter to 0.3 lb/MMBtu and apply to systems that are larger than 2 MMBtu. Systems of this size will have features that address air emissions. New EPA regulations set limits for Particulate Matter (PM) and Carbon Monoxide (CO). See New EPA Regulations (page 245) for more information. Regulations are being updated all of the time so it is important to check for the most up-to-date regulations and requirements.

The New Hampshire Department of Environmental Services has an overview of the permitting process on its website containing current information on which biomass systems will require an air permit. **http://des.nh.gov/organization/divisions/air/pehb/apps/categories/overview.htm**

The New Hampshire Code of Administrative Rules contains air permitting guidelines for biomass systems in Chapter ENV-A 2000: Fuel Burning Devices: **http://des.nh.gov/organization/commissioner/legal/rules/documents/env-a2000.pdf**

Environmental Impacts of Construction

The New Hampshire Department of Environmental Services (DES) requires any construction project which disturbs one or more acres of land, or, creates less than one acre of disturbance but is part of a larger "common plan of development or sale" totaling that many acres of disturbance, to obtain a Construction General Permit. More information on the Construction General Permit can be found at: **http://des.nh.gov/organization/divisions/water/stormwater/construction_g_p.htm**

If the project proposes to disturb more than 100,000 SF of contiguous terrain (50,000 SF, if any portion of the project is within the protected shoreland), or disturbs an area having a grade of 25% or greater within 50 feet of any surface water, then an Alteration of Terrain permit must be obtained. More information can be found at: **http://des.nh.gov/organization/divisions/water/aot/index.htm**

If the site is less than one acre and requires construction dewatering (removal of water from solid material or soil by wet classification, centrifugation, filtration, or similar solid-liquid separation processes) of groundwater intrusion and/or storm water accumulation and short-term and long-term dewatering of foundation sumps into waters of the State of New Hampshire, the necessary permit can be found at: **http://www.epa.gov/region01/npdes/dewatering.html**

Air Emissions

In terms of health impacts from wood combustion, particulate matter (PM) is the air pollutant of greatest concern. Relatively small PM, 10 micrometers or less in diameter, is called PM10.

Small PM is of greater concern for human health than larger PM, since small particles remain airborne for longer distances and can be inhaled deep within the lungs. Increasingly, concern about very fine particulates (2.5 microns and smaller) is receiving attention by health and environmental officials for the same reasons.

Oxides of sulfur (SOx), oxides of nitrogen (NOx), carbon monoxide (CO), and volatile organic compounds (VOCs) are other air pollutants of concern emitted during fuel combustion. Modern wood systems emit more SO_2 than natural gas, but have less than 2% the SO_2 emissions of fuel oil and about 50% the SO_2 emissions of propane. Wood, propane and fuel oil combustion have similar levels of NOx emissions, while natural gas produces lower levels of nitrogen oxides. All fuel combustion processes produce carbon monoxide. The level produced by wood combustion depends very much on how well the system is tuned. This, in addition to PM, is a good reason to make sure the stack is tall enough to disperse any emissions away from ground level. VOCs are a large family of air pollutants, some of which are produced by fuel combustion. Some are toxic and others are carcinogenic. In addition, VOCs elevate ozone and smog levels in the lower atmosphere, causing respiratory problems. Both wood and oil combustion produce VOCs—wood is higher in some compounds and oil is higher in others. VOC emissions can be minimized with good combustion practices.

Many modern types of emission control equipment, capable of reducing particulate matter emissions from 50-99%, are commercially available in the US. The most common emission control equipment technologies are **baghouses**, **cyclones**, multi-cyclones, electrostatic precipitators, and **wet scrubbers**. Appropriate emission control equipment technologies should be identified in consultation with local air-quality regulators.

Construction on wetlands should be avoided, however, if it is unavoidable that the project site is located on a wetland or other surface water resource and requires dredging, filling, and/or construction, it may be subject to the DES Wetland Mitigation Program. If the impact is significant, the permittee is required to conduct one (or more) of the following:

1. Restoring a previously existing wetland
2. Creating a new wetland
3. Preserving land (at least 50% upland) to protect the values of the adjacent wetlands or water resource.

More information can be found at the Wetland Mitigation Program website: **http://des.nh.gov/organization/divisions/water/wetlands/wmp/index.htm**

Potential Traffic Requirements

Truck traffic for woodchip deliveries is usually less frequent than that for other school supplies delivered by tractor trailer. For other institutional or commercial facilities that burn biomass, the number of deliveries may be comparable to or higher than that of schools, depending on the size of the facility and its heating requirements. The majority of tractor trailers that are authorized to travel on interstates are also able to drive on secondary roads. In some instances, depending on the season, bridge heights and bridge and road weight limits, roads may be impassable, in which case the truck would need to find an alternative route. However, building sites typically have multiple options for truck routing and therefore traffic permitting is generally unnecessary. If the tractor trailer is considered overweight or overheight, see the New Hampshire Department of Transportation website: **http://www.nh.gov/dot/org/operations/highwaymaintenance/overhaul/index.htm**

Brownfield Regulations

The New Hampshire DES Brownfield Program promotes the development of brownfield sites, which are typically properties that have been abandoned or underutilized due to existing environmental contamination. These sites are often overlooked or avoided entirely in favor of pristine land, or greenfields, such as pastures and forests. In an attempt to mitigate further unnecessary development of greenfields, the DES sponsors the following programs: Brownfields Covenant Program, Brownfields Assessment Program, Brownfields Cleanup Revolving Loan Fund (as of July 2010, the Brownfield Cleanup Revolving Loan Fund is not accepting applications), and DES/Grantee Brownfields Partnership. The Brownfield Covenant Program provides incentives in the form of liability protections for the investigation, cleanup, and redevelopment of contaminated properties by persons who did not cause or contribute to the contamination. For further questions pertaining to property eligibility and application for eligibility determination, please see: **http://des.nh.gov/organization/commissioner/pip/factsheets/rem/documents/rem-8.pdf**

Historic Preservation Regulations

If the property is currently in, or eligible to be in, the National Register of Historic Places you will need to consider the potential impacts of the project on the historic nature of the site. In accordance with Section 106 of the National Historic Preservation Act of 1966, all federally funded, licensed, or assisted projects in the state of New Hampshire are required to consider the potential impacts of their project(s) on the historical resources of the site, including but not limited to effects upon historical, architectural, or archaeological integrity, significance, and values. These impacts must be presented to the State Historic Preservation Officer (SHPO) of the Division of Historical Resources for further identification and evaluation. Many biomass projects have been successfully constructed on historic preservation sites. For more information on project review and compliance,see: **http://www.nh.gov/nhdhr/review/106intro.html**

Flood Plain Regulations

New Hampshire's Office of Energy and Planning (OEP) runs the Floodplain Management Program to provide information about flooding and the National Flood Insurance Program (NFIP) to local officials, lenders, realtors, businesses, and stakeholders. Communities participating in NFIP adopt regulations from one of five state model floodplain ordinances dependent upon information contained in the community's floodplain map which is issued by the Federal Emergency Management Agency (FEMA). As is stated in Section III of the State Model Floodplain Ordinances, "All proposed development in any special flood hazard area shall require a permit." Permits can be downloaded from the New Hampshire Floodplain Management – Floodplain Regulations page at **http://www.nh.gov/oep/programs/floodplainmanagement/regulations/applications_and_certificates.htm**

New EPA Regulations

On April 29, 2010, the Environmental Protection Agency (EPA) issued a proposed rule that would reduce emissions of toxic air pollutants from existing and new industrial, commercial and institutional boilers located at area source or major source facilities. An area source facility emits or has the potential to emit less than 10 tons per year (tpy) of any single air toxic or less than 25 tpy of any combination of air toxics. A major source facility emits or has the potential to emit 10 or more tpy of any single air toxic or 25 tpy or more of any combination of air toxics.

The proposal would set different requirements for large and small boilers at the area source facility. Large boilers have a heat input capacity equal to or greater than 10 MMBTH and small boilers have a heat input capacity less than 10 MMBTH. The biomass fired new boilers would need to meet limits for PM and CO. For a major source facility, EPA has identified 11 different subcategories of boilers and process heaters based on the design of the various types of units. The proposed rule would include specific requirements for each subcategory. Details and updates will be posted at **www.epa.gov/airquality/combustion.**

P7c. Air Quality

Any biomass system greater than 2 MMBTH in size will require an air quality permit from the New Hampshire Department of Environmental Services. Particulate matter tends to be the emission from biomass systems of most concern to air quality. Compliance with air permits is not generally a problem for biomass systems utilizing available and affordable emissions control technologies and a properly sited stack. The air quality permitting process should be initiated well before initial construction begins.

P7d. Indoor Air Quality

Indoor Air Quality, like energy efficiency, is an important issue to consider when evaluating any heating or cooling system. While a biomass system does not specifically impact indoor air quality, a community should be sure that HVAC equipment has been appropriately designed to provide good indoor air quality in the buildings that are being assessed for a biomass system. If a building being assessed currently suffers from poor indoor air quality, this issue should be addressed before, or simultaneously with, the design and construction of a biomass system.

New Hampshire Department of Environmental Services (DES) has an implemental Indoor Air Quality (IAQ) program. The principal responsibility of the program includes evaluation of IAQ reports for state-leased and state-owned buildings submitted to determine the buildings' compliance with IAQ requirements. New Hampshire Indoor Air Quality resources can be found at: **http://des.nh.gov/organization/divisions/air/pehb/ehs/iaqp/index.htm.**

Does the building currently have any Indoor Air-Quality issues?

☐ **Yes**

☐ **No**

If yes, what are they?

____

____

____

ROADBLOCK

If the building currently has Indoor Air-Quality (IAQ) Problems, it is important to address the IAQ issues before or during the design of a biomass project. To learn more about Indoor Air Quality and how to address IAQ problems, see the links at the end of this section.

P7e. District Air Emissions

One advantage of biomass district energy systems is that air quality improves—as does community livability—when emissions from a single, well-managed plant replace uncontrolled stack emissions from boilers and furnaces in many individual buildings. In addition, district heating systems are of a size which makes it possible and economically feasible to install the best available technology and emissions control equipment that is typically not feasible in individual building heating systems.

Communities considering biomass district energy systems have benefitted greatly from consultation with their local Air Quality regulators. The New Hampshire Air Resources Division (ARD) is responsible for achieving and maintaining air quality in New Hampshire that is protective of public health and the natural environment. ARD is committed to promoting cost-effective, sensible strategies and control measures to address the many complex and inter-related air quality issues facing the state. Your local ARD representatives can easily be contacted thought the New Hampshire Department of Environmental Services website: **http://des.nh.gov/organization/divisions/air/index.htm**

P7f. District Heating Zoning

A lot of approximately one to five acres would be required for a biomass plant for a municipal-sized district system, including fuel storage and truck access. Smaller district systems would require less space. Project planners should make sure that local zoning regulations will permit construction of a biomass plant within a reasonable distance of the proposed district that will be utilizing the heat.

Many town offices have zoning ordinances available on their town website, or it may be necessary to contact the town planning offices (or town clerk if the municipality does not have a town planning office) by phone or in person if this information is not available online.

Ideally, town and city government, including the municipal authorities regulating local zoning ordinances, will be a part of the project planning team.

P7g. Summary of Emissions, Permitting, and Air Quality

Are there currently any Indoor Air Quality Issues in the building or buildings being assessed for a biomass system?

- ☐ **Yes**
- ☐ **No**

Do current New Hampshire Air Emission requirements apply to your system?

- ☐ **Yes**
- ☐ **No**

What local permits are required for installing a biomass energy system?

____

____

____

What state permits are required for installing a biomass energy system?

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____

____

What are the zoning regulations that will apply to your district biomass system?

____

____

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Links

Approaches to Permitting Wood Fired Boilers in Vermont and New Hampshire
http://www.rsginc.com/assets/InsightsResources/Approaches-to-Permitting-Wood-Fired-Boilers.pdf

NH Public Utilities Commission 900 – Net Metering for Customer-Owned Renewable Energy Generation Resources of 100 Kilowatts or Less
http://www.dsireusa.org/documents/Incentives/NH01R.PDF

NH Statutes: LXIV: Planning and Zoning
http://www.gencourt.state.nh.us/rsa/html/NHTOC/NHTOC-LXIV.htm

New Hampshire's Air-Quality Guidelines
www.des.nh.gov

Indoor Air Quality

New Hampshire Code of Administrative Rules Chapter ENV-A 300 defines Ambient Air-Quality Standards
http://des.nh.gov/organization/commissioner/legal/rules/documents/env-a300.pdf.

NH Indoor Air-Quality resources
http://des.nh.gov/organization/divisions/air/pehb/ehs/iaqp/index.htm

Indoor Air-Quality Scientific Findings Resource Bank
http://www.iaqscience.lbl.gov/

Indoor Air-Quality in Large Buildings (EPA)
http://www.epa.gov/iaq/largebldgs/index.html

Indoor Air-Quality Tools for Schools Program (EPA)
http://www.epa.gov/iaq/schools/index.html

▶ Transition

from Evaluate a Biomass Project to Next Steps

Congratulations! You have now reached the end of the Evaluate a Biomass Project section of the *Roadmap*.

Does this biomass project make sense in your community?

Yes ☐ **No** ☐

Yes ➔ GO

No ➔ ROADBLOCK

If the project you have been evaluating appears to be viable, you can:

1. Assess whether the project will help your community **achieve one or more energy-related goals**. You can, **Go to ▶ Community Goals** to select a goal to evaluate.

OR

Enter information you have already collected into the Community Goals Summary Worksheets to identify which goals the project is likely to achieve - **Go to ▶ Community Goals Summary Worksheets**.

2. Learn more about **how to move this project forward.** If you feel you have collected all of the possible information about this project, **Go to ▶ Next Steps** to learn what your community can do next to continue to evaluate this biomass project.

If the project doesn't appear to be viable and you are still interested in pursuing a biomass project, you can:

1. Try to **move around the roadblock(s)**. Many sections of the *Roadmap* identify potential areas that might create a roadblock to a biomass project and suggestions for how to move around these roadblocks. Remember as energy costs, regulations and technologies continue to change, a project that does not currently meet the goals of your community may do so in the future.
2. **Evaluate** whether **a different facility or district** will be more viable in your community if you are still interested in pursuing a biomass project. If you have another project in mind you can begin to collect information about this facility or district. Remember some of the information you have already collected (like Biomass Fuel Source) may be relevant for more than one project. You do not need to collect this information again. If you are unsure about which facility or district in your community to evaluate, Go to ▶ P1a. Selecting a Project.

Next Steps

[Add Tab Here]

Next Steps

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Next Steps

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Next Steps

Following completion of the *Roadmap*, if you determine that your community has a biomass project that is likely to be viable and wish to move toward implementation, a range of public outreach and education, community capacity, technical work, financing, and logistical issues will need to be addressed. In this section, these major categories of implementation are outlined. Communities will need internal capacity and staffing and one or more development partners to move forward effectively.

IN THIS SECTION

NS1. Pre-Feasibility Study and Fuel Supply Assessment

Pre-feasibility studies are project specific, but generally address the potential and feasibility of combined heat and power (CHP), identification of anchor loads and quantification of their energy requirements, potential location of the biomass district heating plant, identification of smaller loads on route connecting the biomass plant to the anchor loads, GIS mapping of loads, preliminary cost estimation, and cash flow analysis. In addition, pre-feasibility work must include an assessment that quantifies existing and potential volumes of biomass fuels available to a community from area forests and agricultural lands on an ecologically and economically sustainable basis. Communities that have completed the *Roadmap* are likely to save money on pre-feasibility to the extent that they can provide their consultant with the necessary baseline information.

Committee members should use information gathered during the *Roadmap* process to define a scope of work for the pre-feasibility study, taking into account what is already known and decisions that the community has already made, and what still needs to be investigated and evaluated by the firm performing the pre-feasibility study. A request for proposals and qualifications should be issued by the community (see page 255 for more information on RFPs). Some funding sources will have specific requirements about where and how the RFP will be issued. Once the RFP has been issued, the community should evaluate proposals to hire the best team at the best cost for the best project possible. Much of the data gathered in the *Roadmap* will be useful in the pre-feasibility study, although the community should be prepared to gather additional data as requested by the firm performing the study.

NS2. Resource Assessment

Communities will need to perform a comprehensive resource assessment building on the fuel supply assessment completed in the pre-feasibility study. Depending on the size of the project, wood fuel procurement standards such as those employed by biomass power plants, verifying the source and harvesting methods of biomass fuels, may be required by state regulations. Even if such a plan is not required, communities may voluntarily develop procurement standards in order to support sustainable forestry. Communities should develop relationships with both main and backup fuel suppliers and formulate procurement strategies and guidelines in conjunction with potential suppliers.

NS3. Community Outreach & Education

Based on community goals and vision for the biomass project and the outcome of the pre-feasibility study, community leaders will have to conduct initial outreach to residents, businesses, and town officials (select board, energy committee, school board, etc.). The goal of this outreach is to provide basic information on what biomass district energy is, how it works, community and individual costs and benefits, and specific information on project ideas for their community. This work can be done through community forums and information sessions, individual meetings with major businesses, and door-to-door outreach to home owners. See Four Good Reasons to Seek Broad Community Engagement on page 33 for more ideas. To conduct this outreach, community leaders will also need access to biomass experts (and informational materials) who can provide information and presentations on community scaled biomass energy options. Community leaders will need support regarding the logistics of conducting community forums and information sessions and possibly some limited funding for space rental and meeting costs.

NS4. Formal Commitment and Leadership Entity

Following on the results of the pre-feasibility study, if a community chooses to move forward with a biomass project, it will have to make some level of formal commitment and identify a leadership entity to move the project forward. Commitment can be achieved through direction of the select board, town council, or other appropriate governing body. Possibilities for a leadership entity include the town itself via dedicated staff, an NGO partner, outside consultants working for the town, or other creative arrangements.

NS5. Development Partner(s)

To design, engineer, purchase, construct, install, and commission a biomass system, a community will need to select one or more development partners to complete the following tasks:

- **DESIGN & ENGINEERING.** Following completion of pre-feasibility work, full project feasibility, design and engineering work will need to be completed. This work is much more in-depth and detailed than the initial assessments provided in the pre-feasibility study and will generate specific project design and full engineering to prepare for construction.
- **PERMITTING.** Identification and completion of all necessary permit applications to secure all necessary permits for construction and operation of the biomass system.
- **VENDOR SELECTION AND EQUIPMENT PURCHASE.** Identification and purchase of desired equipment including piping, boilers, and energy transfer stations for residential and commercial customers and other items as required.

Requests for Qualifications (RFQ) and Requests for Proposals (RFP)

When a community is looking for professional help in assessing, designing or building the biomass system it is common to issue a Request for Qualifications (RFQ) or a Request for Proposals (RFP) to help determine who should be contracted to help with these tasks.

An RFQ is requesting interested firms to provide their qualifications to complete a well-defined task. The response to an RFQ will include the experience of the firm, references and examples of previous work that is similar to the task to be completed. Issuing an RFQ is a fairly simple process and will generally result in responses of 1 to 10 pages.

An RFP is requesting interested firms to provide a proposal for how they would complete a less well-defined task or answer a question the community needs help answering. (You might issue an RFP for conducting a resource assessment or to hire a consultant to help inform the public about the biomass project.) Responding firms will provide a proposal for how they would go about completing the task in addition to providing their qualifications for completing the work. Both writing and responding to an RFP are more labor intensive then writing or responding to an RFQ.

Some communities will use a two-step process issuing an RFQ first and then issuing an RFP to a short list of firms selected through the RFQ process. There are many examples and templates on the internet that provide guidelines for writing RFQs and RFPs.

- **CONSTRUCTION AND INSTALLATION.** Contracting and overseeing construction of the system and ensuring successful completion and operating capacity.
- **COMMISSIONING.** Testing the system to ensure that performance meets expectations.

NS6. Financing

Individual building biomass systems and Multiple building systems range in cost from approximately $1 million to $ 5 million to several million dollars respectively. The district biomass systems are capital intensive and can cost from around $10 million for smaller applications to upwards of $20 million for smaller cities and more for larger projects depending on the size and scope of the system and the ownership model. Consequently, securing necessary financing is a major hurdle for communities and will require a combination of loans, grants, incentives and subscription fees from a range of public and private sources. This is a major area of work that will require the town working closely with the development partner, NGO partners, banks, and state and federal government officials. For more information on funding opportunities see Appendix C.

NS7. Selection of Engineers and Vendors

Once the community gets the favorable results of feasibility study, one of the next steps is to select a design engineer and biomass system vendor. This selection process can be done through an RFP or RFQ process and the community will select the required engineers and vendors based on the response to this process. The selected bidder will be fully responsible for the design, manufacture, and performance of the equipment it supplies and installs. The RFP or bid documents can include performance specifications, which specify what the system must be able to do, but not exactly how any particular manufacturer's system will meet the performance standards set forth in the specifications. One purpose of the performance specifications is to provide a bidding atmosphere in which each bidder is able to propose its system as they have designed and manufactured it, with no requirements that would weaken its integrity as a system. Another purpose of the process is to provide a level playing field which allows bidders of systems with substantive differences to bid fairly against each other in a way that does not discriminate against any bidder. The Biomass Energy Resource Center (BERC) has copyrighted RFP documents and bid documents available for a fee. For more information on accessing these documents, contact BERC at (802) 223-7770.

Additional Implementation Considerations for District Heating Systems

NS8. Ownership Model for District Heating System

The appropriate structure for any given district heating facility is dependent on many factors and no one structure will work for all communities or projects. The various ownership options include the following public and private structure as well as creative public-private partnerships:

MUNICIPAL OWNERSHIP. Ownership by one or more municipal governments as appropriate to the extent of the service area.

A municipal ownership model of a district energy facility means ownership by one or more municipal governments. Municipal ownership can take the form of an entire facility or portions thereof, such as the underlying land or the distribution piping network. A municipality is authorized by law to own and operate a facility, including issuing indebtedness.

The extent or location, or the service area, of a facility may require more than one municipality to participate in the facility. Many models for municipal cooperation exist.

The viability of any municipal model rests on a determination that the district energy facility will be of community benefit and have community support. There must be the political will to communicate that benefit to the public and then to carry out the development and operation of such a facility. There are many successful models of municipalities operating their own water and sewer utilities or electric departments as well as other similar services such as cable and internet access. The viability of developing a district energy facility would follow the same path as such existing models of governmental services.

The greatest disadvantages to a municipal model are the political hurdles that must be overcome in approving a facility. The political climate, such as the view of public versus private services, within municipal government as well as the population generally can be determinative.

PRIVATE OWNERSHIP. A private ownership model can take various forms; those most typically used are a for-profit corporation or a limited liability company. These forms of ownership rely on private capital and are generally seen as the opposite of a Municipal model; however, a municipality can participate in the development and operation of even a privately-owned facility. The municipality may be a financial stakeholder or the owner of some of the physical infrastructure, such as the land or the means of distribution.

- **Corporation.** The most common private ownership entity is the corporation. Corporations are generally private, as opposed to public, entities. However, it is possible to make a corporation more of a community enterprise. Possibilities include either a private for-profit corporation or a community non-profit corporation. The concept of community corporations is still relatively novel but involves setting parameters such as residential restrictions providing that only community members can own shares. The viability of a district energy facility formed as a corporation would depend largely on the size of the community to be served and the cost of the facility.

- **Non-Profit Corporation (501C3).** If community ownership is a desirable goal for a district energy project, it may be appropriate to consider a non-profit corporation structured as a mutual benefit corporation as opposed to the commonly understood public benefit corporation. A mutual benefit non-profit corporation is organized for the benefit of a limited number of owners as opposed to the public in general. It is not the commonly known 501(c)(3) entity that holds a special tax-advantaged status granted by the Internal Revenue Service. Consideration would need to be given to the goals of the project, such as whether it is intended to service a limited number of participating users or will sell energy beyond its ownership.

- **Limited Liability Corporation (LLC).** This type of entity provides limited liability protection like a corporation, but has pass-through tax characteristics like a general partnership. It is a flexible option that allows for sharing financial and management rights with members and member-owners.

  An LLC offers great flexibility in attributing financial and management rights to members, thus allowing for novel structures that recognize the roles and expectations of different member owners. The viability of a district energy facility formed as an LLC, like a corporate structure, would depend largely on the size of the community to be served and the cost of the facility.

- **Cooperative Ownership.** Cooperatives are generally owned by their members, are often not-for-profit, and are structured to be governed by the members. A cooperative is an entity often used to permit either the producers or consumers of a product to jointly own the means of production or distribution of that product. Such products include energy. Participation by members is a desirable characteristic to many people and could work well in an appropriately-sized district energy project.

- **Community Energy Trust.** The concept of a community energy trust is based on allowing a community to own and operate its own renewable energy project. The premise is that renewable resources belong to everyone and should be held in trust for current and future generations. While the concept is attractive, unfortunately there are very few examples of operating entities using this type of model and thus there are few answers to many of the fundamental structural questions about ownership, governance and other responsibilities. These questions may lead one to default back to the more commonly used ownership structures. The trust concept is employed by, and best understood by reference to, community land trusts, a concept widely used in New England. However, such trusts are typically organized as non-profit corporations. The concept of a community energy trust may simply be different packaging of an already existing and understood type of entity.

- **Public/Private Partnership Model.** The municipal and private ownership options noted above can be applied in creative partnership depending on project specifics and community preferences and needs. The two models are not mutually exclusive and employing elements of both models could be beneficial in any number of projects. For example, private ownership of a facility may mesh well with public ownership of the means of transmission/distribution. While, in a given situation, it may be most beneficial to construct a facility through private means on privately owned land, it may still be beneficial for a municipality to own the means of transmission/distribution. The municipality may be better suited to overcome the obstacles to ownership of a transmission/distribution system that overlaps a large number of publicly and/or privately owned properties.

NS9. Community Outreach & Subscription Process for District Heating System

Following a community decision to move forward with a district biomass heating project, additional public outreach and education will have to be conducted to increase understanding of the project and secure residential and business subscribers. An intensive and individual door-to-door program will need to underpin this effort, delivered by dedicated staff who are both knowledgeable about biomass energy and trusted within the community. This process will take time, dedication and resources.

Appendices

Appendices

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► APPENDIX A

Amount of Existing Fuel Use Replaced by Biomass

Throughout the *Roadmap*, we recommend estimating that biomass fuel will replace 85% of your existing fuel use (and the additional 15% of fuel requirements will continue to be met by fossil fuel use). Eighty-five percent biomass use is an average assumption made in the field of biomass heat and has been confirmed by many existing biomass users.

For single building projects with an existing fossil fuel system, this system remains in use as a back up to meet the other 15% of energy needs. For new building construction with a single building system, it is always recommended that a backup fossil fuel system is also installed. For district heating systems, the district heating plant installs a fully-redundant fossil fuel system and it is the district plant which relies on this fossil fuel system for approximately 15% of its head load. It is very rare that customers on a district heating system need to rely on their currently installed heating system for backup. Most district heating customers remove their heating systems and are able to utilize the space for other uses. The capital costs of installing a redundant fossil fuel system are built into the economic feasibility for district heating systems, while the costs of continuing to maintain and operate existing fossil fuel systems are factored into the economic feasibility of single building biomass systems.

Why can't we meet all of our heating needs with biomass fuel?

There are several factors that make it very difficult to use 100% biomass energy:

1. Efficiency. Biomass systems have a fairly low "turn down ratio", meaning that a biomass system can only be used at a high percentage of its actual capacity. This means that if a system is sized to meet your winter heating needs (the coldest days) it will function very poorly during the spring and fall shoulder seasons. On the flip side, if a system is sized to perform effectively on warmer days in the spring and fall, it will not be able to meet the demand of your winter heating needs. If your community decides to move forward with a biomass heating project you will work with a design engineer to determine what size biomass boiler makes the most sense for the building(s) you will be heating.

2. Redundancy. Most engineers recommend full redundancy of systems for times when the biomass system may be down for maintenance or repairs or if there is an interruption in the supply of wood fuel. It is possible to have a second biomass system as a back-up but this does not make a lot of sense economically as these systems tend to be more expensive.

While it is technically possible to use 100% wood fuel it is not advisable to target 100% of energy from biomass. Use of other renewables can also be considered but the increase in capital cost would be substantial. It is recommended that a community start with 85% replacement of fossil fuels. Once the biomass sytem has been implemented, the community can begin to think about the best ways to further decrease, or eliminate, dependence on fossil fuels.

► APPENDIX B

Combined Heat and Power (CHP)

Combined heat and power (CHP), or cogeneration, is the on-site generation of electricity and the recovery of useable heat produced during electric generation. The recovered heat can be used for space heating or other demands for thermal energy.

Biomass can be used to produce electricity as well as thermal energy. While power generation alone from biomass achieves approximately 25% efficiency, meaning that only 25% of the energy stored in the wood will be captured, when a system combines power generation with a thermal (heat) load, it approaches 75% efficiency and provides two different energy products: heat and electricity. The 75% efficiency levels are achieved only when all of the exhaust heat from the plant is utilized effectively. It is important to note that it is rarely possible to utilize all of the waste heat on year round basis from CHP plant.

Like a district heating system, CHP systems can be an efficient form of municipal infrastructure and expand the benefits of biomass energy by economies of scale. When a project involves generation of power, the plant will need to be interconnected with the power grid so it is important for the project owners to discuss the feasibility of grid interconnection with local utilities. Because CHP equipment adds significant project expense, with currently available technologies and energy markets, power generation is not generally economically feasible at system sizes less than 16 MMBH. At 16 MMBH plant size, utilization of all of the exhaust heat by the nearby community is a challenge.

Typically, thermal energy requirements are met by using a boiler to make heat, while electricity is purchased from the grid. Cogeneration allows a facility to produce heat and provide some or all of its electric requirements on-site. By design, CHP is intended to improve the overall efficiency of fuel use, reduce total emissions, and save the facility money.

The most efficient way to design a CHP plant is to focus on thermal, rather than power, needs. This approach ensures the greatest fuel efficiency, meaning the amount of useful power recovered from the fuel being used is maximized. It also provides the lowest possible operating costs and reduces greenhouse gas emissions.

CHP is not a single technology but an integrated energy system that can be modified depending on the energy needs of the end user. Biomass CHP uses the same combustion equipment, but employs the thermal energy to produce electrical power before recapturing heat at the back end of the electrical generation process. In addition to the need for added space and equipment, biomass CHP will require added operation and maintenance time, and as much as a full-time staff person to manage the system, make sure the boiler is cleaned, to monitor outputs, and to operate the system efficiently. These tasks also require a person who is technically competent and able to manage the system for efficiency and maximum output. In addition a licensed operator, certified to operate high pressure boilers, is required to be present 24 hours a day for operation of the CHP plant. This can lead to high Operation and Maintenance (O&M) costs for operating the plant.

CHP systems can be more efficient (and thus a better use of the heating fuel) ONLY if all the exhaust heat is effectively utilized by the nearby community on a year-round basis (as noted above this is often challenging). Such systems can be considerably more expensive and complex to permit and install. Currently the threshold for cost-effectiveness for CHP projects is close to 16 MMBH. As technologies improve and energy markets fluctuate, this threshold is subject to change and should be reviewed in the pre-feasibility stage of study.

Should we examine CHP in our pre-feasibility study?

There are two factors that help determine if CHP may be a viable option for a biomass energy project:

- Peak load of the system (MMBH)
- Total annual hours of operation

The economics for CHP work on economies of scale; the more possible hours at the highest thermal load produce the most energy product and the best economics.

Currently, the boiler size threshold where CHP starts to make sense economically is on the scale of a medium-sized college campus (greater than 16 MMBH).

Biomass systems that only operate to provide space heat in the winter months typically do not operate for enough hours for CHP to be feasible. Facilities that have a year-round, or nearly year-round, demand for thermal energy for chilling or industrial process heat are more likely to operate enough hours out of the year to make CHP viable.

If the system under consideration has relatively long hours of operation and a large thermal load, CHP should be considered in the pre-feasibility stage of study.

CHP technologies are developing, with more options becoming available at more size ranges. The thresholds at which CHP makes sense will continue to evolve with changing technologies and energy markets.

Facilities that are interested in CHP where it is not feasible under current economics may want to consider the capacity for expansion in their thermal projects to accommodate CHP in the future.

► APPENDIX C

Funding Opportunities

Identifying potential funding opportunities is an important component of any biomass project. Funding is often provided by the beneficiaries of a biomass project through private financing or bonding. However, other sources of funding may also be available.

Funding opportunities can come in the form of grants, loans, or tax incentives. Grants require a competitive proposal, and, if a grant is received, there are typically administrative and reporting requirements to fulfill. Loans require that they be paid back over time. Tax incentives and other forms of funding each come with specific restrictions and obligations. Funding often requires a local match of dollars and/or services. There is no free lunch. It is important to thoroughly understand obligations required of the funding recipient before accepting any form of funding.

There are some opportunities available through the federal government and additional opportunities specific to New Hampshire. The potential funding opportunities are continuously changing, so it is important to create or update your list of potential opportunities as you get closer to laying out project financing.

Funding may be available for different phases of project development including pre-feasibility studies, feasibility studies, and implementation. The level of funding required goes up with each phase. Funding for pre-feasibility studies typically pays for a qualified consultant to identify anchor loads and smaller loads, and prepare a preliminary cost estimation, estimation of payback period, and cash flow analysis. Pre-feasibility studies may also include a resource assessment and/or supply assessment. Communities that have completed the *Roadmap* are likely to save money on pre-feasibility to the extent that they can provide their consultant with accurate baseline information. Funding for feasibility studies typically covers more detailed design and engineering studies that result in project specific plans that form the basis for purchasing equipment and construction. Funding for implementation typically covers the cost of equipment (capital costs), construction (including retrofits) and may also cover the costs of permitting and commissioning (making sure everything works as intended).

The following section identifies current (at the time of publication) grants, loans, and tax incentives as well as some more general places to check for financing opportunities.

IN THIS SECTION

I. Federal Grants, Loans & Tax Incentives

American Recovery and Reinvestment Act (ARRA)

Under the ARRA there are several potential sources of funding for both grants and loans.

- **ENERGY EFFICIENCY AND CONSERVATION BLOCK GRANT PROGRAM.** The Energy Efficiency and Conservation Block Grant (EECBG) Program provides federal grants to local government, Indian tribes, states, and U.S. territories. A total of $3.2 billion was appropriated for the EECBG Program for fiscal year 2009. Activities eligible for funding include energy distribution technologies that significantly increase energy efficiency, including distributed generation, CHP, and district heating and cooling systems. **http://www1.eere.energy.gov/wip/eecbg.html**

- **DEPARTMENT OF ENERGY SOLICITATIONS / FUNDING OPPORTUNITIES SPECIFIC TO CHP / DISTRICT ENERGY FACILITIES.** One source of ARRA funding is Department of Energy solicitations, or Funding Opportunities Announcements (FOA) that are specific to district energy and CHP facilities. For example, in June 2009 the Department of Energy released a solicitation for cost-shared CHP, waste heat recovery, district energy, and industrial energy efficiency projects under ARRA. The solicitation sought proposals that identify, design, and implement energy efficient technologies and systems for institutional entities, including institutions of higher education and public school districts, local government, and municipal utilities. **http://www.energy.gov/recovery/funding.htm; http://www1.eere.energy.gov/financing/business.html**

  The Department of Energy has also issued other solicitations which may be applicable to district energy facilities, some of which are not funded by ARRA funds. For example, the **Industrial Technologies Program (ITP)**, part of DOE's Office of Energy Efficiency and Renewable Energy, recently released a funding opportunity for or up to $40 million in research, development and demonstration of combined heat and power (CHP) systems, based on annual appropriations, not ARRA funds. **http://www1.eere.energy.gov/industry/**

- **QUALIFIED SCHOOL CONSTRUCTION BONDS.** Qualified School Construction Bonds (QSCB) are authorized under the ARRA of 2009. This tax credit bond program allows state and local governments to finance public school construction projects and other eligible costs for public schools with interest-free borrowings. These tax credit bond programs provide this federal subsidy by giving those who buy these bonds a federal tax credit that essentially allows state and local governments to issue these bonds with little or no interest cost. Once a school district has received authority to issue the USCB from the state, a bank lends the funds directly to the school district. The school district pays back only the principal of the loan while the bank receives an annual Federal Tax Credit in lieu of the school district paying interest. QSCBs are not grants they are bonds that act as 0 interest loans. **http://www.education.nh.gov/recovery/qscb.htm**

- **STATE DISTRIBUTION OF ARRA FUNDS.** Further funding from the ARRA may be available through the State of New Hampshire. Please see the state funding opportunities section for more information.

2008 Farm Bill

- **COMMUNITY WOOD ENERGY PROGRAM.** The Community Wood Energy Program provides grants to state and local governments to develop community wood energy plans and to acquire or upgrade wood energy systems. The bill authorizes funds in the amount of $5 million per year from FY 2009 through FY 2012. While this program has not yet been funded by Congress, efforts continue to secure appropriations.

- **BUSINESS AND INDUSTRY (B&I) GUARANTEED LOAN PROGRAM, ADMINISTERED BY USDA RURAL DEVELOPMENT.** The purpose of the B&I Guaranteed Loan Program is to improve, develop, or finance business, industry, and employment and improve the economic and environmental climate in rural communities. A borrower may be a cooperative, corporation, partnership, or other legal entity organized and operated on a profit or nonprofit basis; an Indian tribe on a Federal or State reservation or other federally-recognized tribal group; a public body; or an individual. A borrower may be eligible if they are engaged in, or proposing to engage in, a business that will reduce reliance on nonrenewable energy resources by encouraging the development and construction of renewable energy systems. **http://www.rurdev.usda.gov/rbs/busp/b&i_gar.htm**

- **USDA RURAL ENERGY FOR AMERICA PROGRAM (REAP).** To help agricultural producers and rural small businesses purchase and install RE systems and energy efficiency improvements. Eligible Small Businesses are to be located in a rural area and cannot exceed Small Business Administration (SBA) size standards by NAICS code. **http://www.sba.gov/idc/groups/public/documents/sba_homepage/serv_sstd_tablepdf.pdf)**

  Eligible technologies include wind, solar, biomass, geothermal, hydrogen, small hydro, and energy efficiency. The projects are limited to commercial and pre-commercial (no R&D). Residential property is not eligible for REAP grants or loans.

  Grant. The grant can cover up to 25% of eligible project costs with a minimum grant amount of $2,500 and a maximum grant amount of $500,000.

  Guaranteed Loan. Guaranteed loans can be used for working capital, land acquisition and costs related to the Renewable Energy system. Loans can cover a maximum of 75% of project costs. The maximum loan amount is $25 million. Borrower equity of 15% is required for guaranteed loans less than $600,000 and 25% for guaranteed loans greater than $600,000 (some borrower equity can be covered by a REAP grant, see below).

  Combination Grant / Guaranteed Loans. Combination Grant and Guaranteed Loans cannot exceed 75% of total project costs. The minimum combine funding level is $80,000 with the grant covering a minimum of $20,000. The grant amount contributes to the borrower equity percentage in the project. **http://www.rurdev.usda.gov/rbs/farmbill/index.html**

- **ENERGY INDEPENDENCE AND SECURITY ACT OF 2007.** Sec. 471 of the Energy Independence and Security Act of 2007 authorizes a program for Energy Efficiency and Sustainability Grants for implementing or improving district energy systems, combined heat and power applications, production of energy from renewable resources, developing sources of thermal energy and other applications. These funds would leverage investments by eligible public sector entities including institutions of high education, local governments, municipal utilities and public school districts or a designee of one of those entities. The Act, although not yet funded by Congress, authorizes $250 million for grants and $500 million for loans under this program for FY2009-2013. The program provides for: Technical Assistance Grants to assist eligible institutional entities in identifying, designing, and implementing sustainable energy infrastructure projects; Grants and Loans for Energy Efficiency Improvement and Energy Sustainability for projects to improve energy efficiency on the grounds and facilities of qualifying institutional entities; and Grants for Innovation in Energy Sustainability. **http://www.epa.gov/chp/documents/chp_energybill.pdf**

- **ENERGY POLICY ACT OF 2005.** Another major source of federal loan and grant funding is Energy Policy Act of 2005 (EPACT), which created several types of renewable energy incentives. The first is the Clean Renewable Energy Bond (CREB) program, which provides "tax-credit" bonds to renewable energy projects. The 2009 ARRA allocated an addition $1.6 billion for this program. In addition to the CREB program, US Department of Energy (DOE) released its second round of solicitations for $10 billion in loan guarantees for energy efficiency, renewable energy, and advanced transmission and distribution projects under Title XVII of EPACT 2005. A broad range of projects are eligible for funding. ARRA, extended the authority of the DOE to issue loan guarantees and appropriated $6 billion for this program. Under this legislation, the DOE may enter into guarantees until September 30, 2011. **http://www.nreca.org/documents/publicpolicy/cleanrenewableenergybonds.pdf; http://www.lgprogram.energy.gov/features.html**

- **USDA RURAL DEVELOPMENT LOAN GUARANTEES GRANT AND LOAN GUARANTEE.** Funds are available to help agricultural producers and rural small businesses reduce energy costs and consumption by subsidizing energy efficiency improvements as well as renewable energy production from wind, solar, biomass, or geothermal sources. Grant funds up to 25% of project costs are available, capped at $500,000 for renewable energy projects and $250,000 for energy efficiency projects. **http://www.rurdev.usda.gov/vt/** (New Hampshire office).

Federal Tax Incentives

- **FEDERAL RENEWABLE ENERGY PRODUCTION TAX CREDIT.** The production tax credit is an inflation-adjusted tax credit for electricity produced from qualifying renewable energy sources or technologies. EPACT 2005 expanded the types of qualifying sources and systems (U.S. DOE, 2007). Three different rates of tax credits are available for producers of energy from biomass. A credit of 1.5 cents per kilowatt-hour (kWh) is available for facilities that use wood from trees planted for energy use (closed-loop biomass). If the wood is mixed with coal in a co-firing facility, the 1.5 cents credit is reduced to match the ratio of wood fuel used. Using waste wood from any source enables facilities to earn 0.75 cents per kilowatt-hour (kWh) in tax credits. For the year 2005, the credit was adjusted for inflation to make the credit 1.9 cents per kWh for wind energy, closed-loop biomass, geothermal and solar, and 0.9 cents per kWh for open-loop biomass (NRBP, 2005).

- **ENERGY-EFFICIENT COMMERCIAL BUILDINGS TAX DEDUCTION .** The federal Energy Policy Act of 2005 established a tax deduction for energy-efficient commercial buildings applicable to qualifying systems and buildings placed in service from January 1, 2006, through December 31, 2007. This deduction was subsequently extended through 2008, and then again through 2013 by Section 303 of the federal Energy Improvement and Extension Act of 2008 (H.R. 1424, Division B), enacted in October 2008.

  A tax deduction of $1.80 per SF is available to owners of new or existing buildings who install (1) interior lighting; (2) building envelope, or (3) heating, cooling, ventilation, or hot water systems that reduce the building's total energy and power cost by 50% or more in comparison to a building meeting minimum requirements set by ASHRAE Standard 90.1-2001. Energy savings must be calculated using qualified computer software approved by the IRS.

  Deductions of $0.60 per SF are available to owners of buildings in which individual lighting, building envelope, or heating and cooling systems meet target levels that would reasonably contribute to an overall building savings of 50% if additional systems were installed. **http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US40F&re=1&ee=1**

- **RENEWABLE ELECTRICITY PRODUCTION TAX CREDIT (PTC).** The federal renewable electricity production tax credit (PTC) is a per-kilowatt-hour tax credit for electricity generated by qualified energy resources and sold by the taxpayer to an unrelated person during the taxable year. Originally enacted in 1992, the PTC has been renewed and expanded numerous times, most recently by H.R. 1424 (Div. B, Sec. 101 & 102) in October 2008 and again by H.R. 1 (Div. B, Section 1101 & 1102) in February 2009.

  The October 2008 legislation extended the in-service deadlines for all qualifying renewable technologies; expanded the list of qualifying resources to include marine and hydrokinetic resources, such as wave, tidal, current and ocean thermal; and made changes to the definitions of several qualifying resources and facilities. The effective dates of these changes vary. Marine and hydrokinetic energy production is eligible as of the date the legislation was enacted (October 3, 2008), as is the incremental energy production associated with expansions of biomass facilities. A change in the definition of "trash facility" no longer requires that such facilities burn trash, and is also effective immediately. One further provision redefining the term "non-hydroelectric dam," took effect December 31, 2008.

  The February 2009 legislation revised the credit by: (1) extending the in-service deadline for most eligible technologies by three years (two years for marine and hydrokinetic resources); and (2) allowing facilities that qualify for the PTC to opt instead to take the federal business energy investment credit (ITC) or an equivalent cash grant from the U.S. Department of Treasury. The ITC or grant for PTC-eligible technologies is generally equal to 30% of eligible costs. **http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US13F&re=1&ee=1**

- **NEW MARKET TAX CREDITS.** The most applicable federal tax credit program for community district energy programs is the New Markets Tax Credit (NMTC) Program. The purpose of the NMTC program is to encourage development that would benefit low income people and communities. It provides a tax credit against Federal income taxes for up to 39% of the cost of the investment, and is claimed over a seven-year credit allowance period. Eligibility for this program is very site specific. NMTC program information can be found at: **http://www.cdfifund.gov/what_we_do/programs_id.asp?programID=5**

II. Links to Federal Funding Sources

Environmental Protection Agency
http://epa.gov/statelocalclimate/local/activities/funding-options.html

Database of State Incentives for Renewables and Efficiency
http://www.dsireusa.org/

Department of Energy, Office of Energy Efficiency and Renewable Energy
http://www.eere.energy.gov/

USDA Renewable Energy Programs
http://www.energymatrix.usda.gov/

Department of Energy, ARRA Renewable Energy Funding Opportunities
http://www.energy.gov/recovery/renewablefunding.htm#BIOMASS

Federal Grants Wire (a free resource for federal grants, government grants and loans)
http://www.federalgrantswire.com/about-us.html

III. Loan Sources

There are numerous low-interest and other loan sources that could be used for biomass energy.

Commercial loans may be available from one or a consortium of banks. District heating systems, which have been well-established and seen as low-risk in Europe for decades, are a new concept in the United States. In the current economy it is un-known how commercial lenders will view community district energy loan applications. Local banks may be more interested in supporting these projects on the basis of local economic development and stimulus to the local economy. Banks may be incentivized by federal low-interest loan and loan guarantee programs available from a number of federal agencies, including USDA Rural Development, or through advances for community and economic development through the Federal Home Loan Bank available for its member banks.

- **GENERAL OBLIGATION BONDS.** If a community wishes to promote the district energy system, it may use its bonding authority by issuing general obligation bonds or revenue bonds. General Obligation bonds are backed by the full faith and credit of the municipality, and revenue bonds are issued on the strength of the project finances and repaid from them. **http://www.nh.gov/treasury/Divisions/DM/goDocs.htm**

- **QUALIFIED ENERGY CONSERVATION BONDS.** The Emergency Economic Stabilization Act passed in the fall of 2008 includes a new category of tax credit bonds called "Qualified Energy Conservation Bonds" (QECBs). QECBs are expected to perform as no-interest bonds for the end user. The bondholder will receive federal tax credits in lieu of traditional interest. QECBs can support a variety of energy conservation and possible renewable energy purposes including capital expenditures for publicly-owned buildings and certain demonstration projects. QECBs could possibly be used as a finance source for district energy projects. As a new federal program, the applicability of QECBs will not be certain until the IRS issues rules.

Some advantages of QECBs include:

- Low-cost source of bond financing.
- Could be targeted for district energy conversions by the State of New Hampshire.
- Could be source of funds for School Sustainable Energy Fund.

Some disadvantages of QECBs include:

- QECBs are a new initiative – bond buyers as well as professional advisers are not yet familiar with the program. There will be a learning curve required to for these parties to become familiar and comfortable with the requirements of these bonds.
- The IRS has not yet published program guidance. It is uncertain when the funds and the credit will actually be available. If the program is operated like CREBS, there may be a need to respond relatively quickly once guidance is published.
- Bond buyers must have a tax liability, which the credit can offset. Current market conditions have created a smaller pool of taxpayers who can make use of credits.
- School heating conversions could be competing with lots of other eligible uses.
- Relatively limited timeframe and amount of funding, although this could change.

http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=US51F&re=1&ee=1

In addition to the traditional loan sources described above, there are constantly evolving less-traditional and new approaches that could be creatively combined in innovative ways to finance the debt portion of the capital requirements of a biomass project. Current non-traditional loan sources should be evaluated at the time that funding for the project is being acquired.

IV. New Hampshire State-Level Grant and Loan Opportunities

State level funding opportunities for biomass is an emerging arena that is constantly evolving. The current status of state grant and loan availability will depend on many factors including availability of state funds, the status of federal programs and available funding, and evolution of national energy policy.

The **New Hampshire Charitable Foundation** offers many different types of grants. Some are available on a statewide basis, while others are more regional or local in nature. **http://www.nhcf.org/Page.aspx?pid=183**

The **New Hampshire Community Finance Development Authority** offers grants to projects that will improve regional economics and energy efficiency. **http://www.nhcdfa.org/web/index.html**

The **NH Renewable Energy and Energy Efficiency Loans & Municipal Energy Reduction Fund** are loans funded by the EPA. These loans are available for biomass projects on a competitive basis. **http://www.epa.gov/chp/funding/funding/newnhrenewableenergyandenergye.html**

The **New England Grassroots Environment Fund** provides grants to groups working on community level issues in the New England states. The grants are intended to support community groups who represent the most exciting energy in the environmental movement and are not being reached by traditional funders. **http://grassrootsfund.org/grants/small_grants/**

The **New Hampshire Community Loan Fund** serves as a catalyst, leveraging financial, human, and civic resources to enable traditionally underserved people to participate more fully in New Hampshire's economy. **http://www.nhclf.org/about/index.html**

The **Enterprise Energy Fund** is a low-interest loan and grant program available to businesses and nonprofit organizations to help finance energy improvements and renewable energy projects in their buildings. The goals of the fund are reduction of energy costs and consumption and promotion of economic recovery and job creation. This program is funded by the ARRA. **http://www.nhcdfa.org/web/erp/eef/eef_overview.html**

The **Community Development and Finance Authority (CDBG) economic development grants** provide funds through eleven NH Regional Development Corporations to municipalities and counties which can be used to build or upgrade publicly owned infrastructure. **http://www.nhcdfa.org/web/cdbg/cdbg_grants.html#Studies%20Grants%20anchor**

Local Economic Development Councils may be able to provide loans and/or assistance with securing money through other opportunities for the biomass project. You should contact your local economic development council to find out about opportunities in your community. Below is a list of some of the Economic Development Councils in New Hampshire:

- CRDC Statewide Economic Development Organization - **http://www.crdc-nh.com/about_us.html**
- Grafton County Economic Development Council - **http://www.graftoncountyedc.org/**
- Belknap County Economic Development Council - **http://www.bcedc.org/**
- Monadnock Economic Development Corporation - **http://www.monadnock-development.org/index.html**
- Nashua Office of Economic Development - **http://www.nashuanh.gov/CityGovernment/Departments/EconomicDevelopment/tabid/145/Default.aspx**
- Manchester Economic Development Office - **www.manchesternh.gov/economy**
- Pease Development Authority - **http://www.peasedev.org/index/index.asp**
- Dover Industrial Development - **http://www.ci.dover.nh.us/edhome.htm**
- Rockingham Economic Development Corporation - **http://www.redc.com/**
- Business Enterprise Development Corporation - **www.bedco.org**
- North Country Investment Corporation - **www.ncic.org**
- COOS Economic Development Corporation - (603) 788-3900
- North Country Council - **www.nccouncil.org**

V. Additional Funding Opportunities

ENERGY SAVINGS PERFORMANCE CONTRACTS (ESPC). The Energy Saving Performance Contracts are used to finance project costs by borrowing against future energy cost savings. The ESPC contract between the building owners and the Energy Service Company (ESCO) allows the building owners to use guaranteed cost savings from the biomass project to pay off the loan that financed the biomass project. In addition to financing, other services can be bundled into the contract including design and project management. To find more about ESCOs, contact a representative at the NH Office of Energy and Planning (DOEP) **http://www.nh.gov/oep/opportunities.htm** or for general information go to: **http://www.energyservicescoalition.org/resources/5steps.htm**

SALE OF RENEWABLE ENERGY CREDITS (REC'S). New Hampshire began a renewable energy portfolio standard on January 1, 2010. Biomass CHP projects may be eligible under this program to sell REC's through the Public Utilities commission. Although this may be more properly viewed as an additional revenue stream rather than capital funding, the availability of these funds may be used to help leverage capital financing. **http://www.puc.nh.gov/Sustainable%20Energy/Renewable_Portfolio_Standard_Program.htm**

VI. Additional Financing Opportunities

MUNICIPAL LEASE. Leasing or an installment purchase program offers an alternative to debt financing. Typically, the leasing company will provide up to 100% of the capital and purchase the new equipment and its installation.Title is then passed on to the lessee who takes on the responsibility of operation and maintenance of the leased equipment. The lease will then be repaid using the cost savings in annual operating funds from the energy project. Leasing is often attractive since it can provide a financing mechanism that may not require a bond vote since it is not considered "debt." Frequently, municipal lease agreements are written with a "non-appropriation" clause which means that the obligation to make payments is subject to an annual appropriation by the school district The leasing company takes the risk that future funds may not be appropriated. If funds are not appropriated, the leasing company reclaims the equipment. (While this is much easier if the equipment is portable, municipal leasing companies have often been quite responsive to financing energy improvements and energy performance contracts.) Municipal leasing allows for 100% financing and can rely on energy savings for payments. In NH, it appears that Municipal Leasing still requires a bond vote.

VENDOR LEASING. Vendors installing a turnkey wood fuel system could work with a leasing company to provide financing to the district energy system. This allows the vendor to receive cash for the sale and the buyer to obtain financing. From the district's perspective, vendor leasing would perform similarly to municipal leasing, but may cost more.

Some advantages of vendor leasing include:

- Community could move quickly on their own.
- Vendor takes on the risk; district could be protected from faulty system.

Some disadvantages of vendor leasing include:

- Vendor debt is likely to cost more than municipal debt.
- Could leave school district with limited recourse if system does not deliver.
- May not allow for consideration and selection of best system or technology.
- Could leave environmental benefits on the table.

UTILITY ON-BILL FINANCING. A number of regions have used the collection mechanism afforded by utility bills to support financing for the installation of efficiency measures. The mechanism can be an effective tool for financing improvements that support the regulated utility's demand management activities. This may make sense if there are cost-effective conversions from natural gas to wood heat. Keep in mind that because schools are not typically seen as a credit risk and demand management activities require Public Utility Commission review and approval, this approach would undoubtedly create more bureaucracy than benefits in a school installation.

Pay as You Save (PAYS®) is a specific type of tariff installation program developed by the Energy Efficiency Institute: **http://www.paysamerica.org/What_is_PAYSr__/what_is_paysr__.html**

SALE OF HEAT – PURCHASE HEAT AGREEMENT. Purchase power agreements (PPAs) are a common mechanism used with the sale and purchase of electrical energy, particularly from renewable and CHP generators.The typical PPA model works as shown on the following page. With a PPA, third parties own the energy generator and sell the output to the customer. The customer often also provides the site for the installation of the generating system. The PPA provider is responsible for financing, installing, operating and maintaining the generating system. The PPA provider may contract with others to provide some of these services. Typically, utility regulators oversee PPAs.

A purchase heat agreement would follow the same approach but be for the sale of heat rather than power. A third-party entity would enter into a site lease agreement with the district and then purchase, install, operate, maintain and own the heating system. This entity would then sell the output – heat – to the district. International Wood Fuels, LLC is already proposing to do this with some school districts. Pricing would be based on a cost-plus charge or a fee per Btu provided. The entity selling the heat could be a consortium of school districts, a heating ventilation or air conditioning (HVAC) service provider, an ESCO, the system vendor, or the provider of capital. The provider could also make use of any available tax credits, financing incentives or environmental benefits that might not be available to a public entity like a municipality.

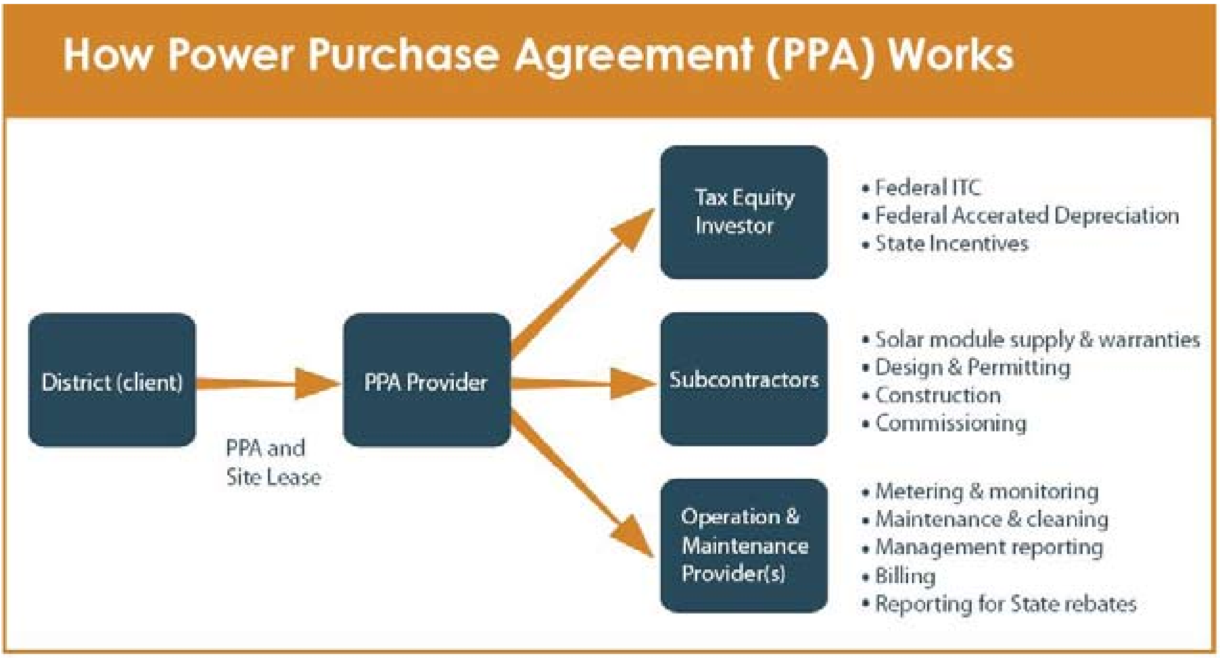


Image from Grid Neutral[1]

Some advantages of PPAs include:
- Alleviates burden of ownership, operation and maintenance from the district.
- Consumer only pays for what it actually uses – could reduce operating costs.
- Removes installation risk.
- Removes operating and maintenance obligation.
- May allow for more creative and possibly lower-cost financing through the use of tax credits and sale of environmental benefits.

Some disadvantages of PPAs include:
- If service is inadequate, could get ugly.
- May cost more if owner needs to borrow capital at higher rates.
- Owner/operator has no incentive (unless it is consortium of users) to use heat efficiently.
- May trigger revisions to statutory language and/or additional regulatory oversight.
- Requires interested 3rd party or organizing effort to create consortium.
- Creates an array of liability issues that need to be resolved.

PPA Example

MMA Renewable Ventures is a capital provider that installs renewable generation and efficiency measures and then owns and operates the renewable generation systems at their customers' facilities - **http://mmarenew.com/Solutions/customer.html**

[1] Grid Neutral: Electrical Independence for California Schools and Community Colleges, guidebook published by the California Department of General Services, December 2008 – available at http://www.documents.dgs.ca.gov/dsa/pubs/gridneutralpub.pdf

► APPENDIX D

Assumptions

Fuel Characteristics

Woodchips

- 45% Moisture content
- 16.5 MMBtu/dry ton
- Density = 30 lbs/cubic foot
- Average Carbon content (on dry basis) = 50%

Wood Pellets

- 6% Moisture content

Btu Content of Fuel

No. 2 fuel oil	138,000 per gallon
Natural gas	1,025,000 per 1000 cubic feet
Propane	91,300 per gallon
Electricity	3,412 per kilowatt-hour
Woodchips	9,075,000 per ton
Wood pellets	15,510,000 per ton

Average Seasonal Efficiency

Woodchip boiler	74%
Wood pellet boiler	83%
No. 2 oil boiler	83%
Propane boiler	79%
Natural gas boiler	80%
Electric baseboard	98%

Other Assumptions

- When one ton of carbon is burned completely it will release 3.6667 tons of CO_2.
- Woody biomass contains 50% carbon.
- Heating one SF of condition space requires 63,500 Btu (equivalent to 0.46 gallons of # 2 fuel oil).
- Domestic Hot Water can be estimated at 11% of annual fuel use for heat. This is based on similar analyses done by the Biomass Energy Resource Center on district heating systems in VT. The DHW requirements are found to be ranging from 3% to 18% of the heat requirements for space heat, with the average of 11%.

► APPENDIX E

Blank Tables

G1a. EXISTING FUEL COSTS

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7
Building	Type of Fuel	Current Annual Usage	Current Average Price	Average Annual Cost	Average Usage with Biomass System	Average Annual Cost with Biomass System

G1b. ESTIMATED SAVINGS WITH BIOMASS HEATING SYSTEM

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8
Building	Existing Fuel Type	Amount of Existing Fuel to Be Replaced	Tons Required to Replace Existing Fuel	Cost per Ton	Average Annual Cost for Biomass	Total Average Annual Cost	Estimated Savings

G1c. ESTIMATED SAVINGS WITH BIOMASS FUEL FOR A DISTRICT SYSTEM WITH AN INDEPENDENT OWNER/OPERATOR

COLUMN 1	COLUMN 2	COLUMN 3
Building	Current Annual Fuel Cost	Estimated Year-One Savings

G1d. PAYBACK PERIOD *SIMPLE* ESTIMATE

COLUMN 1		COLUMN 2		COLUMN 3
Capital Cost ($)	÷	First Year Fuel Savings ($)	=	Payback Period (Years)

G1f. LOWER ENERGY COSTS SUMMARY

Building	Current Annual Fuel Costs	Estimated Annual Fuel Costs with Biomass	Estimated Annual Fuel Savings with Biomass	Pay-Back Period	Price Stability (G1e)

G2b-1. PERCENT OF EXISTING HEATING FUEL FROM LOCAL SOURCES

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Building	Type of Fuel	Local/External	% of Total Fuel Use	Total % of Fuel from Local Sources for each Building

G2b-2. BUILDINGS WITH MULTIPLE HEATING FUELS WORKSHEET

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4
Building Zone	Type of Fuel Used	Square Footage	% of Total

G2c. ESTIMATED % OF HEATING FUEL FROM LOCAL SOURCES WITH BIOMASS SYSTEM

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Building	% of Existing Fuel from Local Sources	Local / External	Biomass = % of Total Fuel Use	Total % of Fuel from Local Sources for each Building

G2e. SUMMARY

Definition of Local	Building	% Current Heating Fuel from Local Sources	Estimated % of Heating Fuel from Local Sources with Proposed Biomass System

G3a. EXISTING HEATING FUEL AVAILABILITY

Heating Fuel	Lack of Availability (Yes / No)

G3b. EXISTING HEATING SYSTEM RELIABILITY

COLUMN 1	COLUMN 2
Heating System	Level of Reliability

G3c. BIOMASS FUEL SUPPLY RELIABILITY

	YES	NO
We have access to multiple suppliers of the type of biomass fuel we will need.		
We have access to suppliers that are willing to enter into long-term, renewable contracts for biomass fuel.		
Our community owns a wood resource that can supply the biomass fuel we will need AND our community's private landowners are interested in supplying wood fuel.		

G3e. SUMMARY

Building	Reliability of Current Heating Fuel Source	Reliability of Current Heating System(s)	Reliability of Biomass Supply		
			Multiple Suppliers	Long-Term Contracts	Community-Owned Wood Source

G4b. EXISTING CO_2 EMISSIONS

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Building	Fuel Type	Average Annual Fuel Usage	CO_2 Emissions for Fuel Type	Total Annual CO_2 Emissions

G4c. CO_2 EMISSIONS WITH BIOMASS SYSTEM

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Building	Fuel Type	Average Annual Fuel Usage	CO_2 Emissions for Fuel Type	Total Annual CO_2 Emissions

G4d. ESTIMATED ANNUAL RATE OF CO_2 EMISSIONS SAVINGS

COLUMN 1		COLUMN 2		COLUMN 3
Total Existing CO_2 Emissions (pounds)	minus	Total Estimated CO_2 Emissions with Biomass System	=	Annual CO_2 Savings (pounds)

G4e. SUMMARY

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
	EXISTING	PROPOSED	PROPOSED	PROPOSED
Building	Total Annual CO_2 Emissions	Total Estimated Annual CO_2 Emissions	Estimated Annual CO_2 Emission Savings	Estimated % Reduction on Annual CO_2 Emissions (Divide column 4 by column 2)

G5b. EXISTING % OF HEATING FUEL FROM RENEWABLE ENERGY SOURCES

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Building	Type of Fuel	Renewable / Non-Renewable Fuel	% of Total Fuel Use	Total % of Fuel from Renewable Energy for each Building

G5c. ESTIMATED % OF HEATING FUEL FROM RENEWABLE ENERGY SOURCES WITH BIOMASS HEATING SYSTEM

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Building	Type of Fuel	Renewable / Non-Renewable Fuel	% of Total Fuel Use	Total % of Fuel from Renewable Energy for each Building

G5d. SUMMARY

Do you have access to sustainably harvested biomass fuel?	Building	Current % of Fuel from Renewable Energy Sources	Estimated % of Fuel from Renewable Energy Sources with a Biomass System

G6a. EFFICIENCY OF BUILDING THERMAL ENVELOPE

Building Name	Efficiency Level

G6b-2. EFFICIENCY OF EXISTING HEATING SYSTEM	
Building Name	**System Efficiency Level**

G6d-2. EFFICIENCY OF CURRENT FUEL	
Existing Fuel	**Efficiency**

G6d-3. EFFICIENCY OF PROPOSED FUEL	
Proposed Fuel	**Efficiency**

G6f. SUMMARY

Building	Efficiency of Thermal Envelope	Efficiency of Existing Heating System	Efficiency of Existing Heating Fuel	Efficiency of Proposed Biomass Fuel

G7b. WHAT %OF THE MONEY SPENT ON HEATING FUEL CURRENTLY STAYS IN THE COMMUNITY?

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6
Building	Type of Fuel	% of Total	% of Total Local	% of Total External	Total % of Fuel $ Staying in the Local Economy

G7c. ESTIMATED % OF MONEY SPENT ON HEATING FUEL WILL STAY IN THE COMMUNITY WITH A BIOMASS SYSTEM

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6
Building	Fuel Type	% of Total	Total % of Fuel from Local Sources	Total % of Fuel from External Sources	Total % of Fuel $ Staying in the Local Economy

G7f. SUMMARY

Building	Total % of Fuel $ Staying in the Local Economy with Current Fuel Use	Total % of Fuel $ Staying in the Local Economy with Proposed Biomass System

P1b. CONSIDERING BUILDINGS TO BE INCLUDED

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7
Building Name	5,000 SF or More Conditioned Space?	$2,500 or More Annual Fuel Bill?	Propane or Fuel Oil Heat?	Steam or Hot Water Distribution?	Industrial Cooling or Chilling Demand?	Use of Industrial Process Heat?

P1c. IMPORTANT CONTACT INFORMATION
BUILDING NAME
OWNER NAME Address Phone Email
BILL PAYER NAME Phone Email
MAINTENANCE NAME Phone Email
OTHER CONTACT Name Phone Email

P1h-1. DEFINING MULTI-BUILDING AREA ANCHOR LOADS PART ONE

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Building Name	Building Size (SF)	Distance between Biomass Plant & Farthest Anchor Load	Cost of Distribution Piping per Trench Foot	Total Cost of Distribution Piping

P1h-2. DEFINING MULTI-BUILDING AREA ANCHOR LOADS PART TWO

COLUMN 1	COLUMN 2			COLUMN 3
Total SF	Divided by	Total Distribution Cost	=	SF-to-Distribution Cost Ratio

P1j. IMPORTANT CONTACT INFORMATION
BUILDING NAME
OWNER NAME Contact Info
BILL PAYER NAME Contact Info
MAINTENANCE NAME Contact Info
OTHER IMPORTANT CONTACT Contact Info

P2a-1. BUILDING USE AND SIZE

COLUMN 1	COLUMN 2	COLUMN 3
Building Name	**Building Use**	**Building Size**

P2a-2: BUILDING MEASUREMENTS

Building Name	Length L (in ft)	Width W (in ft)	# of Stories0 N	SF L*W*N
Example – Town Hall	*50*	*40*	*3*	*6,000*

P2b. TYPE OF PROJECT

Building Name	Building Status•	When will the new construction or renovations take place?			
		Within the next year	Within the next 2 years	Within 3-5 years	More than 5 years

P2c. BUILDING INFORMATION SUMMARY

Building Name	Building Use	Building Size	Building Status•	Time Frame

P3a-1. HEATING FUEL TYPE AND ANNUAL USAGE

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4
Building	Fuel Type	Average Annual Usage*	Average Annual Heat Load (MMBtu)

P3a-2. NATURAL GAS, PROPANE, FUEL OIL USAGE WORKSHEET

		BUILDING 1	BUILDING 2	BUILDING 3
A	Total Fuel Used in Year 1			
B	Total Fuel Used in Year 2			
C	Total Fuel Used (A + B)			
D	**Average Annual Fuel Use (line C divided by 2)**			

P3a-3. ELECTRIC HEAT USAGE WORKSHEET PART 1

	YEAR ONE				YEAR TWO			
	Total kWh			**Heating kWh**	**Total kWh**			**Heating kWh**
January		**Minus non-heat kWh**	**=**			**Minus non-heat kWh**	**=**	
February								
March								
April								
May								
June								
July								
August								
September								
October								
November								
December								
Total								

P3a-4. ELECTRIC HEAT USAGE WORKSHEET PART 2

A	**Total kWh Used in Year One for Heat**	
B	**Total kWh Used in Year Two for Heat**	
C	**Total kWh Used (add Lines A and B)**	
D	**Average Annual kWh Use (Line C divided by 2)**	

P3a-6. DETERMINE YOUR NET HEATING VALUES WORKSHEET

COLUMN 1	COLUMN 2		COLUMN 3		COLUMN 4
Fuel Type	Annual Usage		Net Heating Value		Annual Heat Load
		X		=	

P3b-1. DOMESTIC HOT WATER FUEL TYPE AND ANNUAL USAGE

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4
Building	Fuel Type	Average Annual Usage*	Average Annual DHW Load (MMBtu)

P3c-1. EXISTING FUEL COSTS

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4
Building	Fuel Type	Average Annual Fuel Cost	Average Cost per Unit

P3c-2. NATURAL GAS, PROPANE, FUEL OIL COST WORKSHEET

		BUILDING 1		BUILDING 2		BUILDING 3	
		Heat	Water	Heat	Water	Heat	Water
A	Total Paid for Fuel in Year 1						
B	Total Paid for Fuel in Year 2						
C	Average Annual Fuel Cost (line A plus line B divided by 2)						
D	Average cost per unit (divide total paid (line A) by total used (table P3a))						

P3c-3. ELECTRIC HEAT COST WORKSHEET

	COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6
	Total kWh	kWh Used for Heat / Cooling	% of Electric-ity Used for Heat / Cooling	Total Paid for Electricity	Total Paid for Electric Heat / Cooling	Average Cost per kWh for Heat / Cooling
Year 1						
Year 2						
Average						

P3d. THERMAL EFFICIENCY

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6
Building	Average Annual Fuel Usage	SF	Fuel / SF	Btu / SF	Efficiency

P3e. SUMMARY

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6	COLUMN 7	COLUMN 8
Building	SF of Conditioned Space	Type of Fuel	Average Annual Fuel Usage	Average Annual Heat Load	Average Cost per Unit	Average Annual Fuel Cost	Thermal Efficiency

P4a. EXISTING HEATING EQUIPMENT

Building / Portion of the Building	Type of Heating System *	Size of Heating Equipment	Fuel Type	Age of System**	Condition (Poor, Fair, Good, Excellent)

P4c. HEATING AND DISTRIBUTION SUMMARY

Building Name	Number of Heating Plants / Locations?*	Type of Heating System	Type of Fuel	Age of System	Condition of System	How is Heat Distributed to Rooms?

P4d. CENTRAL HEATING PLANT EQUIPMENT SUMMARY

	How Is Heat Generated?*	Type of Fuel	Age of System	Condition (Poor, Fair, Good, Excellent)	How Is Heat Distributed to Buildings?	Do Individual Buildings Have Back-Up Heating Systems?
Heating System 1						
Heating System 2						
Heating System 3						

P4e. DISTRICT HEATING EQUIPMENT SUMMARY

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4
Building	Heat Generation	Heat Distribution	Domestic Hot Water

P5c. ESTIMATED SIZE OF BIOMASS BOILER REQUIRED

COLUMN 1	COLUMN 2				COLUMN 3				COLUMN 4
Building Name	SF				System Size (BTH)				Size of Boiler Required (MMBTH)
		x	35 BTH	=		÷	1,000,000	=	

P5d. WOODCHIP STORAGE BIN SIZE

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6
Boiler Size (MMBTH)	Heat Output (MMBtu)	5-Day Woodchip Supply (tons)	Volume Required (ft^3)	Area Required (SF)	Minimum Length Required (ft)

P5e. NUMBER OF TRUCKLOAD DELIVERIES

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Boiler Size (MMBTH)	Heat Output (MMBtu / day)	1-Day Woodchip Supply (tons)	Weekly Woodchip Supply	# of Truckloads per week

P5h-1. WOODCHIP SYSTEM CAPITAL COST

COLUMN 1				COLUMN 2	For multi-building systems only			
						COLUMN 3		COLUMN 4
System Size (MMBTH)	x	$300,000	=	Biomass System Capital Cost	+	Distribution Piping Cost	=	Total Capital Cost

P5h-2. WOOD PELLET SYSTEM CAPITAL COST

COLUMN 1				COLUMN 2		Bulk Fuel Storage		COLUMN 3
System Size (MMBTH)	x	$500,000	=	Biomass System Capital Cost	+	$30,000	=	Total Capital Cost

P5i. BIOMASS ENERGY SYSTEM SUMMARY

Champion (Yes / No)	
Champion Contact Info	
Type of System (Woodchip / Pellet)	
Size of System	
Space Required for Woodchip Storage	
Maximum # of Woodchip Deliveries per Week	
System Location	
Capital Cost	

P6c-1. AMOUNT OF BIOMASS FUEL REQUIRED

COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5
Building	Existing Fuel Type	Existing Fuel Use	Existing Amount of Fuel to Be Replaced	Required Biomass (tons)

P6c-3. REQUIRED BIOMASS WORKSHEET

Existing Fuel	÷	Displaced per Ton of Wood	=	Required Biomass (Tons)

P6d. BIOMASS FUEL PROVIDER INFORMATION

Fuel Provider				
Contact Name				
Contact Info				
Distance from Project Site				
Type of Fuel				
Cost per Ton				
Long-term Contracts				
Can Provide the Amount Required (%)				
Self-Unloading Trailer				
Bulk / Silo Pellet Delivery				
Minimum / Maximum				
What Are the Sources of the Wood?				
What Type of Harvesting Does the Wood Typically Come from?				
Other Sustainability Criteria				

P6e. SUMMARY

Sustainability		Building Name	Type of Biomass (Woodchips, Pellets)	Estimated Amount of Biomass Required	# of Fuel Providers that Meet your Requirements
Procurement Standards (list)	Harvesting Practices (list)				

P7g. Summary of Emissions, Permitting, and Air Quality

Are there currently any Indoor Air Quality Issues in the building or buildings being assessed for a biomass system?

- ☐ **Yes**
- ☐ **No**

Do current New Hampshire Air Emission requirements apply to your system?

- ☐ **Yes**
- ☐ **No**

What local permits are required for installing a biomass energy system?

____

____

____

What state permits are required for installing a biomass energy system?

____

____

____

What are the zoning regulations that will apply to your district biomass system?

____

____

____

▶ APPENDIX F

Common Units and Biomass Heating Glossary

Gallons	**Gal**	**Common unit of measurement for liquid fuels such as Oil and Propane**
Kilowatt Hour	**kWh**	**Common unit of energy for measuring Electricity use. Equal to 1,000 watt hours**
Cubic Feet	**Ft^3**	**Common unit of measurement for Natural Gas**
Tons		**Common unit of measurement for Biomass Fuel (woodchips and pellets)**
British Thermal Units	**Btu**	**Standard unit of energy equal to the heat required to raise the temperature of one pound of water one degree Fahrenheit**
British Thermal Units per Hour	**BTH**	**A unit that characterizes the size of peak output of a boiler (equal to 1 Btu per hour)**
1 Million British Thermal Units	**MMBtu**	**Common unit of energy for boiler sizing (equal to 1 million Btus per hour)**
1 Million British Thermal Units per Hour	**MMBTH**	**A unit that characterizes the size or peak output of a boiler (equal to 1 million Btus per hour)**

ANCHOR LOAD: Buildings with large demand for heat that act as the foundation of a district heating network. Anchor loads ideally have steady heat demand throughout the day and over a year. Anchor loads are typically public sector facilities such as hospitals, prisons and universities.

APPLIANCE EFFICIENCY: The ratio of output energy to input energy when the combustion system is running under design conditions. Also called steady state efficiency.

ASHING AUGER: An auger, operated manually or by a motor, used to remove ash from the base of a furnace or boiler setting. Also called ashing screw.

BACKPRESSURE TURBINE: A type of steam turbine that produces low-pressure steam exhaust, which can be used as the source of heat for space heating or other uses.

BACKUP SYSTEM: An alternate fuel combustion system used to provide heat when the primary system is out of service or unable to meet the full heat load.

BAG HOUSE: A type of particulate removal device used with very large biomass heating plants.

BIO-GAS: A gas produced from biomass. Can be used as a combustion fuel.

BIOMASS: Any organic matter that can be burned for energy. Here used as synonymous with wood in its various forms.

BLAST TUBE: A short connecting passage between a combustor and a boiler or other heat exchanger. Hot combustion gases from the primary chamber pass through the tube, sometimes with the addition of secondary or tertiary combustion air.

BOILER: A heat exchanger used to extract heat from hot combustion gases and transfer the heat to water. The boiler output can be either hot water or, if the water is allowed to boil, steam.

BOLE CHIPS: Woodchips produced from the main stems or trunks of trees, excluding branches and tops.

BOTTOM ASH: Ash that collects under the grates of a combustion furnace.

BTU: British thermal unit, a standard unit of energy equal to the heat required to raise the temperature of one pound of water one degree Fahrenheit.

BTU METER: A device for measuring energy flow over time. Used to measure boiler heat output or energy consumption. For a hot water boiler, a Btu meter includes a water flow meter and temperature sensors that give the increase in temperature between the return water and output water.

BUCKET ELEVATOR: A solid fuel handling device that lifts the fuel vertically.

BURNBACK: Movement of flame from the combustion chamber back along the incoming fuel stream.

CALORIFIC VALUE: The energy content of a fuel, expressed in units such as Btu per pound.

CARBON BURN-OUT: The end of the combustion process in which all uncombined gaseous and solid carbon is oxidized to carbon dioxide.

CHAR: Carbon-rich combustible solids that result from pyrolysis of wood in the early stages of combustion. Char can be converted to combustible gases under certain conditions, or burned directly on the grates.

CHAR REINJECTOR: A device that collects unburned char at certain locations in large boilers and injects it back into the primary combustion zone, both to keep it from going up the stack and to capture its energy through recombustion.

CHIPPER: A large device that reduces logs, whole trees, slab wood, or lumber to chips of more or less uniform-size. Stationary chippers are used in sawmills, while trailer-mounted whole-tree chippers are used in the woods.

CHP: The acronym for 'combined heat and power.' CHP is the simultaneous production of heat and electrical power from a single fuel.

CLOSE-COUPLED GASIFIER: A biomass combustion burner that produces combustible gases under controlled conditions in the primary combustion chamber or combustor, and burns the gases to produce heat in an adjacent chamber.

COGENERATION: Combined heat and power (CHP). A term used in industrial settings, now being displaced by the more descriptive term CHP.

COMBINED-CYCLE GAS TURBINE: A type of high-efficiency turbine for burning gas to produce electricity. Can be used to burn the output bio-gas produced by a biomass gasifier.

COMBINED HEAT AND POWER (CHP): The simultaneous production of heat and electrical power from a single fuel.

COMBUSTION EFFICIENCY: The efficiency of converting available chemical energy in the fuel to heat, typically in excess of 99% in biomass burners. Efficiencies of conversion to usable heat are much lower.

COMBUSTOR: A freestanding primary combustion furnace, usually located adjacent to the boiler or heat exchanger. Exhaust gases from the combustor pass into and through the boiler before exiting to the stack.

COMMISSIONING: The process of verifying that a new heating plant meets the performance specifications called for in the installation contract.

COMPLETE COMBUSTION: Combustion in which all carbon and hydrogen in the fuel have been thoroughly reacted with oxygen, producing carbon dioxide and water vapor.

CYCLONE SEPARATOR: A flue gas particulate removal device, which creates a vortex that separates solid particles from the hot gas stream.

DAY BIN: An intermediary solid fuel storage bin that holds enough fuel to last approximately one day. Could be designed with the capacity to feed the combustion system for a weekend.

DEMAND CHARGES: A class of charges typically found in commercial and industrial electric rates. Demand charges reflect the cost placed on the utility of the maximum number and size of all the electricity-consuming devices in use at any one time during a billing period.

DESIGN/BUILD: A design and contracting process under which the contractor bears ultimate responsibility for the design and function of the equipment or system installed.

DESIGN SPECIFICATIONS: For mechanical systems, specifications (and drawings) produced by the owner's mechanical or design engineer. Design specifications become part of the contract for the installation. The designer bears ultimate responsibility for the design and function of the system.

DHW: Domestic hot water.

DIRECT-BURN SYSTEM: A biomass combustion system in which the primary combustion chamber is located under and directly connected to the combustion chamber of the boiler itself.

DISCOUNT RATE: In economic analysis, the interest rate that reflects the rate of return the owners could get if their money was invested elsewhere.

DISTRICT HEATING: The use of a single boiler plant to provide hot water or steam for heating a number of buildings in a locality.

ENERGY SERVICES COMPANY (ESCO): A company that provides a broad range of energy services to a building owner, typically including the financing and installation of energy improvements under a contract that allows some of the dollar savings to accrue to the company.

EXCESS AIR: The amount of combustion air supplied to the fire that exceeds the theoretical air requirement to give complete combustion. Expressed as a percentage.

FLY ASH: Airborne ash carried through the combustion chamber by the hot exhaust gases, and typically deposited in the passages of the boiler heat exchanger.

FLYING DUTCHMAN: A device commonly installed in round fuel silos to knock fuel down into the base of the silo, for transport by the fuel handling equipment to the combustion appliance.

FURNACE: The primary combustion chamber of a biomass burner. The term also refers to warm-air heating appliances.

GASIFICATION: The pyrolysis reaction in which heated biomass is converted to combustible gases in the primary combustion zone. Also refers to the conversion of char to combustible gases in the absence of oxygen and to the overall process of converting biomass, in an oxygen-starved environment, to combustible medium-Btu-content gases that are not immediately burned, but are cooled and cleaned to be used in a variety of ways.

GASIFIER: A combustion device that produces bio-gas from solid biomass. Also shorthand for close-coupled gasifier.

GASIFY: To convert solid biomass into combustible gas.

GRATES (OR COMBUSTION GRATES): Slotted or pinhole grates that support the burning fuel and allow air to pass up through the fuel bed from below.

GREEN BIOMASS FUEL: Biomass fuel that has not been significantly dried, with approximately the same moisture content as at harvest.

HEAT EXCHANGER: A device that transfers heat from one fluid stream to another. The most common heat exchanger in biomass combustion systems is the boiler, which transfers heat from the hot combustion gases to boiler water.

HEAT LOAD: The demand for heat of a building at any one time, typically expressed in Btus/hour or million Btus/hour. Peak heat load refers to the maximum annual demand for heat, and is used in sizing heating plants.

HEAT TRANSFER MEDIUM: A fluid (either water, steam, or air) that carries heat from the combustion system to the point of use.

HEATING CONSUMPTION: The annual total amount of heat a building requires. Can be expressed in energy units (million Btus) or fuel units (tons of biomass, gallons of oil, kilowatt hours of electricity).

HOG: Shorthand for hog mill, a device used to grind up various forms of biomass into chip-sized pieces.

HOGGED FUEL: Biomass fuel produced by grinding up various forms of wood and bark, possibly mixed with sawdust. Often refers to a variable low-quality fuel. If produced from clean, high-quality dry scrap, can be a very high-quality fuel.

HYDRONIC: Refers to a water-based heat distribution system that uses either hot water or steam.

INDUCED DRAFT FAN: A fan mounted at the discharge of the boiler, before the stack, to keep furnace pressure at the correct level and assure proper movement of flue gases up the chimney. Also called the ID fan.

INDUSTRIAL COOLING / CHILLING: The cooling of air or water to meet the thermal and/or refrigeration needs of a building.

INJECTION AUGER: The final fuel auger that moves the solid fuel into the combustion zone. In particular, an auger that forces fuel through an aperture onto the grates.

LIFE-CYCLE COST ANALYSIS: A method of economic analysis that includes all costs associated with a course of action for the lifetime of the equipment being installed. Includes price and cost inflation over time, and accounts for the time-value of money.

LIVE-BOTTOM TRAILER: A self-unloading tractor trailer with a hydraulically operated moving floor, which is used to push the biomass fuel load out the back of the trailer. Typically filled directly by the chipper in the mill or in the woods.

METERING BIN: A small bin in the fuel feed stream, just upstream of the combustion device. Allows a precise feed rate, or metering, of the fuel to the fire.

MILL CHIPS: Woodchips produced in a sawmill. Typically produced from slabwood and other unmerchantable wood from debarked green saw logs.

MMBH: A unit that characterizes the size or peak output of a boiler, equal to one million Btus per hour.

MMBtu: A unit of energy equal to one million Btus (each M represents 1,000). In boiler or system sizing, also represents 1 MMBtu per hour.

MODULATING FUEL FEED: A fuel feed system that adjusts the feed rate up or down in response to changes in the heat load.

MOISTURE CONTENT (or **MC):** For the purpose of biomass fuel, the quantity of water contained in the fuel, expressed in terms of the mass of water per unit mass of the moist specimen.

MOVING FLOOR TRAILER: See live-bottom trailer.

MULTI-CHAMBER SYSTEM: A variation on the two-chamber combustion system in which there is a connecting refractory-lined chamber between the combustor and boiler to give a longer flame path to enhance completeness of combustion.

MULTI-CLONE (OR MULTI-CYCLONE): A particulate removal device that includes a number of cyclone separators.

MUNICIPAL WOOD WASTE (MWW): Wood from sources like urban demolition and construction debris, urban tree waste, land and right-of-way clearing, and chipped pallets.

NOMINAL INFLATION RATES: Price inflation rates including the rate of general inflation in the economy.

NOx: Oxides of nitrogen. Air pollutants that can be released from various types of combustion processes, including biomass combustion.

ON/OFF FUEL FEED: A fuel feed system that delivers fuel to the grates on an intermittent basis in response to boiler water temperature and load variations. Efficient combustion is typically achieved during on cycles and during high-load conditions. In low-load conditions, and while off-cycle, combustion is less efficient.

OVER-FIRE AIR: Combustion air supplied above the grates and fuel bed. Also called secondary combustion air.

PARTICULATES: Very small solid airborne particles. A source of air pollution that can result from the combustion of biomass and other fuel types.

PERFORMANCE SPECIFICATIONS: For mechanical systems, specifications used in design/build and turnkey contracting. Set forth the owner’s minimum requirements for how a system will be configured and function.

PILE BURNER: A type of biomass combustion burner in which a pile of fuel burns on the grates. Primary combustion air comes from above the grates, not below.

PROCESS HEAT / STEAM: Steam used as a high-temperature medium for a variety of industrial purposes.

PYROLYSIS: The oxidation process by which solid wood is converted to intermediate combustible gases and combustible solids through a variety of thermo-chemical reactions.

REAL INFLATION RATES: Price inflation rates that do not include the general inflation rate in the economy.

REFRACTORY: A material resistant to high temperatures that is used to line combustion chambers in order to reflect heat back to the fire and to keep furnace temperatures steady.

RETENTION TIME: The transit time of hot gases from the point in the combustion process where the last combustion air is added to the beginning of the heat exchanger. The period during which carbon burnout takes place.

ROTARY AIRLOCK: A device used to pass solids such as incoming fuel or fly ash from a multi-cyclone without passing air. Can be used to prevent burnback or the introduction of boiler room air into the exhaust gases through a multi-cyclone.

SEASONAL EFFICIENCY: The efficiency of a heating system averaged over an entire heating season.

SENSITIVITY ANALYSIS: A part of economic analysis used to determine how sensitive the results of the analysis are to changes in the input variables.

SETTING: A base on which a boiler or combustor sits, used to elevate a boiler. Houses the grates and primary combustion zone in a direct-burn system. Can form the connecting chamber in a multi-chamber system.

SHARED SAVINGS: A form of energy project financing in which the party supplying the financing and/or installation gets a share of the dollar savings resulting from the reduction in energy consumption.

SIMPLE PAYBACK: A method of economic analysis in which cost effectiveness is based on installed cost and first-year savings. Also refers to the number of years it takes an improvement to pay back the investment, computed by dividing the installed cost by the first-year energy savings.

SIZING: The process of specifying the size (measured in MMBtu/hour or MMBH) of a heating plant.

SOx: Oxides of sulfur. Air pollutants implicated in acid rain caused by combustion of fossil fuels. Modern wood systems have 1/6 the sulfur dioxide emissions of fuel oil.

STACK: The chimney of a combustion system.

STACK EMISSIONS: The components of the hot combustion gases (including particulates) exiting from the stack.

STACK TEMPERATURE: The temperature of the combustion exhaust gases passing into the chimney. One indicator of appliance efficiency.

STEADY STATE EFFICIENCY: See appliance efficiency.

STEM: The main trunk of a tree, exclusive of branches and top.

STOKER: An auger or other device for feeding solid fuel into the combustion zone.

SUMMER BOILER: A small boiler sized to meet the summer or off-season heating load.

SUSPENSION BURNING: A type of combustion in which fuel is blown into the combustion chamber, with some or all of the solid fuel particles burning in the air (in suspension).

TA STUDY: Technical assistance study under the federal Institutional Conservation Program (ICP).

TERTIARY AIR: Combustion air in addition to under-fire and over-fire air, injected downstream in the flame path to increase turbulence and aid in carbon burnout.

TERTIARY HEAT EXCHANGER: A heat exchanger that removes latent heat from the exhaust gases by cooling them below the condensation point.

TRAMP AIR: Unintentional, uncontrolled air entering the combustion chamber.

TRAMP METAL: Metal found in biomass fuel (nails, chainsaw chain, tools, etc.).

TURN-DOWN RATIO: An index of the range over which efficient combustion can be achieved by a biomass burner. Calculated by dividing the maximum system output by the minimum output at which efficient, smoke-free combustion can be sustained (for example, with a maximum of 2.4 MMBtu and a minimum of .4 MMBtu, the turn-down ratio is 6:1).

TURNKEY: For mechanical systems, a contracting process under which the contractor has full responsibility for design and for the complete installed package of work. The owner accepts the completed system once the contractor has demonstrated that the system meets the performance specifications.

TWO-CHAMBER SYSTEM: A combustion system in which the primary combustion furnace, or combustor, is separate from the boiler, with the two connected by a constricted opening or a blast tube. The boiler combustion chamber forms the secondary chamber.

ULTIMATE ANALYSIS: Laboratory analysis that tells the percentage components of the elemental constituents of a fuel, including water and ash.

UNDER-FIRE AIR: Combustion air added under the grates. Serves the function of drying the fuel, cooling the grates, and supplying oxygen to the pyrolysis reactions.

VAN: A delivery trailer (the trailer of the term tractor trailer).

VOLATILES: Fuel constituents capable of being converted to gases at fairly low temperatures.

WALKING FLOOR TRAILER: See live-bottom trailer.

WET SCRUBBER: A flue gas particulate removal device that uses a water spray to capture and remove small, gas-entrained solid particles. Used only in very large biomass burners.

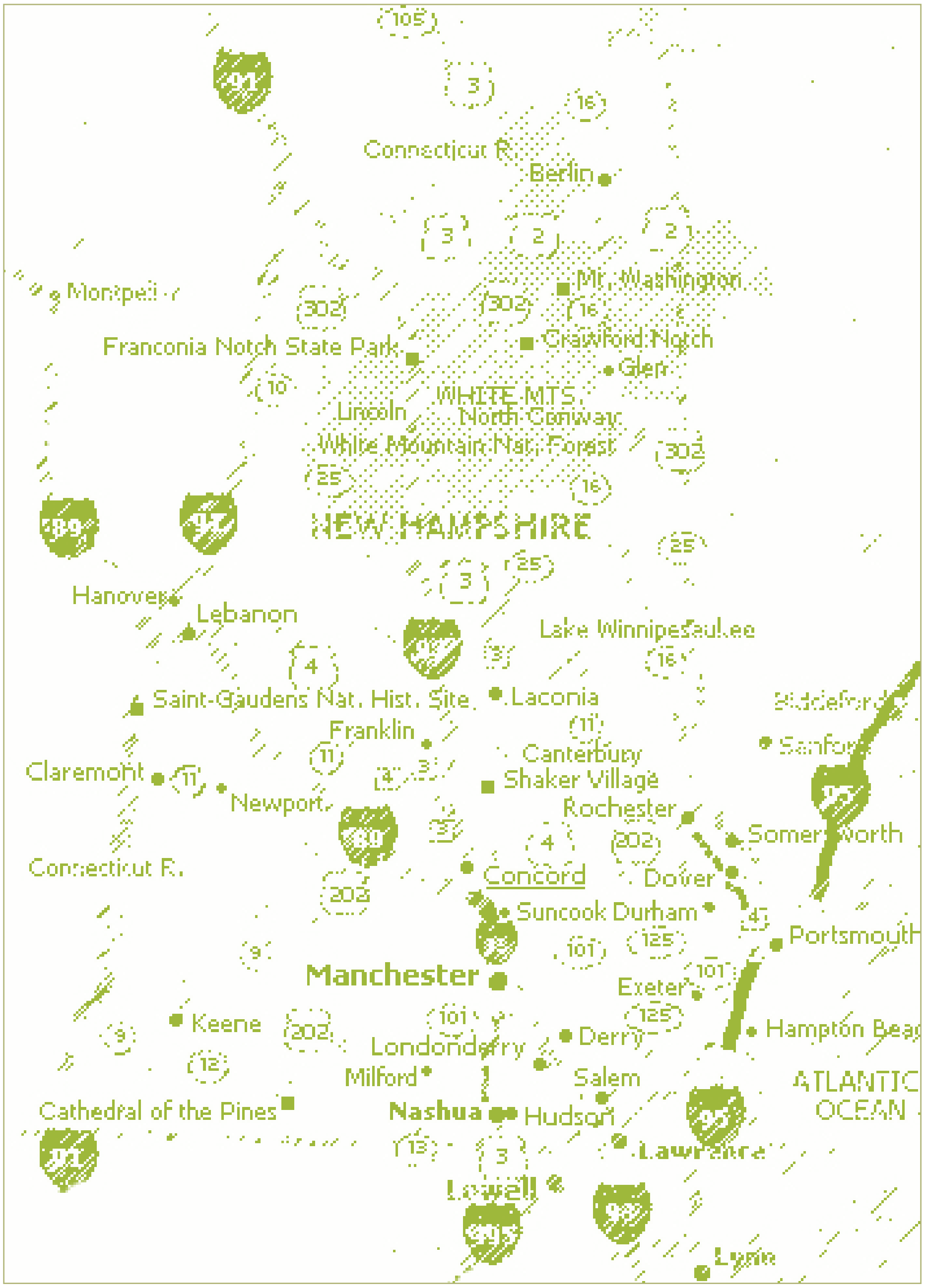
WHOLE-TREE CHIPS: Woodchips produced in the woods by feeding whole trees or tree stems into a mobile chipper, with discharge directly into a delivery truck.

WOODCHIPS: Small rectangular pieces of wood (approximately 1” x 2” x 1/2”) produced by either a mill chipper or a whole-tree chipper.

YEAR-ROUND BIOMASS HEAT LOAD: Biomass systems can be used to meet hot water needs as well as industrial cooling or chilling demands, in addition to space heating. These additional demands often need to be met throughout the year and increase the cost savings and efficiency of the biomass system.

Community Roadmap to Renewable Woody Biomass Energy:
A Step-by-Step Decision-Making Tool for New Hampshire Communities

2010



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This Roadmap was produced by Yellow Wood Associates and the Biomass Energy Resource Center for the North Country RC&D.