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Wyoming–Colorado Technical Assistance Visit Trip Report

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Abstract

Woody biomass utilization is critical to resolving forest health issues in Wyoming and Colorado. This paper discusses technical assistance site visits conducted to help address the effects of insect infestation and excessively high forest fuel loading. It provides a thought-provoking look at the issues and opportunities for utilizing small-diameter wood and woody biomass to help reduce widespread risk of insect infestation such as the mountain pine beetle (*Dendroctonus ponderosae*) and risk of catastrophic wildfire. Many questions and uncertainties have yet to be addressed as to how to achieve sustainable forest-based communities with strong economic engines and simultaneously ensure healthy, productive, and sustainable forests. Several critical factors and opportunities are considered for utilizing small-diameter material and woody biomass. The scope of this technical assistance visit to Wyoming and Colorado is applicable throughout the Western United States.

Keywords: Woody biomass, sort yards, utilization, small-diameter, feasibility, mountain pine beetle, hazardous fuels, Colorado, Wyoming, markets, forest products, biomass energy.

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Cover Art: Air current burner at Meeker Park, Colorado, biomass collection and sort yard

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Wyoming–Colorado Technical Assistance Visit Trip Report

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Introduction

Woody biomass utilization is critical to resolving forest health issues in the West—primarily, the current beetle infestation epidemic and high risk of catastrophic wildfire associated with excessive forest fuel loading. Discussion of several issues and opportunities for salvaging beetle-killed trees and utilizing small-diameter material from forest fuels reduction projects are provided in this Wyoming and Colorado Technical Assistance Visit (TAV) trip report. The primary purpose of this technical assistance visit was to provide follow-up to the initial TAV to Region 2 conducted in 1996 by the Forest Products Laboratory (FPL), Madison Wisconsin.

Technical Assistance Visit Background

Beginning in 1994, the FPL conducted a series of TAVs throughout the United States to Forest Service Regions. The goal of these TAVs was to foster closer working relationships between the FPL, the national forests, local and state government, local communities, and the private sector. The purpose of these partnerships was to sustain social and economic vitality in rural communities while conserving natural resources and maintaining and enhancing the health of our Nation's forests. The objectives of the TAVs varied from region to region but generally included the following:

- ***Merge environmental and economic concerns***
  Link production and marketing of value-added products with local and regional forest sustainability, forest health issues, and stewardship of forestlands.
- ***Prevent loss and waste of natural resources***
  Reorient existing forest products technology and identify new technological needs to take advantage of recycling, wood waste, and alternative woody biomass opportunities.
- ***Build stronger economies in forest-dependent communities***
  Identify and support development or expansion of forest products commercial opportunities to assist rural communities and private enterprises that are trying to adapt to rapid social and economic changes.
- ***Make the best use of available technical assistance***
  Promote partnerships and collaboration between the various government, private, and business interests, merging research and development capabilities with the needs of forest-dependent communities.

The FPL Director and staff participated with regional Forest Service staffs in several site visits for each of the TAVs. These site visits include touring forest products processing facilities, in-woods operations, and town hall meetings. Several issues and opportunities were uncovered and further explored. Follow-up action plans were developed and included a wide array of activities from providing technical publications and networking to onsite training and research studies.

Valuable insights gained during the initial TAVs help guide new research, technology transfer, and technical assistance. These efforts were coordinated by the Technology Marketing Unit (TMU) at the FPL. In addition to research, two other significant efforts were initiated. First, ***SmallWood***, a bi-annual national conference, was initiated to provide a forum for the exchange of ideas to address the many challenges of small-diameter trees and biomass in the context of forest health and protection and enhancing forest-dependent communities. Second, in addition to follow-up technical assistance, the Hazardous Fuels Woody Biomass Utilization Grants Program was authorized to help mitigate the excessively high cost of hazardous forest fuels reduction work on Forest Service lands.

By the year 2000, follow-up visits began to provide more focused technical assistance in high priority areas. This report discusses one of many such follow-up technical assistance visits. As with the original TAVs, similar issues and opportunities arise time and time again. Consequently, this report is published to provide shared learning and experiences of the follow-up technical assistance visits and in particular the visit to Wyoming and Colorado in August 2008.

The report reviews (1) the trip itself; that is, who was involved and the itinerary; (2) new issues that have emerged concerning utilization of small-diameter and salvageable trees; (3) utilization opportunities that make the most sense for our partners in Wyoming and Colorado; and (4) tech-

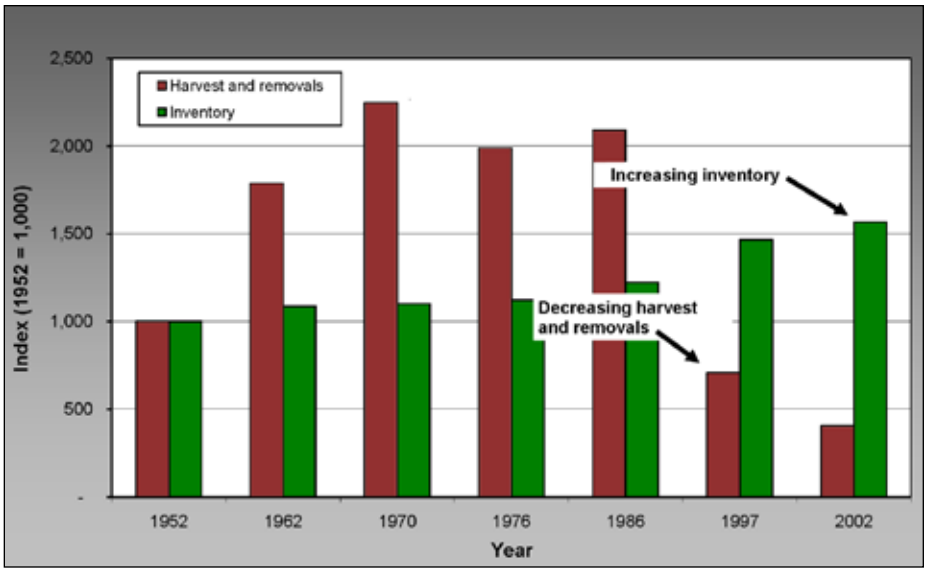

Figure 1—Indexed softwood harvest and removals and inventory for the national forest timberlands in the Rocky Mountains, 1952–2002. Data source: Haynes and others 2007.

niques that if used to evaluate those opportunities, will help to ensure that they are well-planned and should increase the chances of success. We believe the results of this TAV will facilitate improved forest management and economic development that will better suit the land, forest products enterprises, and the citizens of forest-dependent communities.

The Situation Today

The Intermountain West has a history of relatively frequent insect attack outbreaks and wildfires. Fire suppression efforts have been in place for a number of decades. With the exclusion of fire from ecosystems, forest stands have become overstocked, leading to stress, especially during periods of drought. Stressed trees are more susceptible to insect attacks and disease infestation.

Overstocking in the West has been exacerbated by the decline in national forest harvests and removals (Fig. 1). Harvest and removals from national forests doubled in the West from 1952 to 1970 and remained at about the same level through 1986, when they declined sharply. In 2002, harvests and removals from national forests were less than half their 1952 levels and less than one quarter of their levels during the 1970 to 1986 peak.

Although harvest levels were increasing from 1952, total inventory levels in the Rocky Mountains national forests were remaining constant to increasing slightly over the 1952 to 1986 period (Fig. 1). When harvest and removals began declining, total inventory began increasing more quickly (Fig. 1), so that in 2002 the national forests in the Rocky Mountains region on average were carrying more than half again as much standing softwood volume compared with 1952.

When comparing the periods 1990 to 1999 and 2000 to 2008, the average annual acres burned by wildfires in the United States has more than doubled, jumping from 3.3 million acres to 7 million acres (Fig. 2). Some of this increase can be linked to changing drought patterns (Siebold and Veblen 2006). However, drought also means that overstocked stands become stressed and weakened as the trees compete for limited water resources. Stressed trees are more susceptible to insect attacks. Overstocked stands increase the risk of catastrophic wildfires by providing ladder fuels so that fires can more easily move into the tree crowns. Dead trees provide hot-burning fuels and are long-lasting even on the ground in drought-prone areas.

We cannot have healthy forests without healthy communities and vice versa—healthy forests and healthy communities are interdependent. Interdependency is the cornerstone foundation for sustainability. The recurring question asked by forest-dependent communities is, “How can we develop viable forest products enterprises that will help diversify our economy and use local forest resources in a manner that will help restore healthy, productive, sustainable forests?”

Opportunities for improved utilization and marketing of small-diameter and beetle-killed trees will help control beetle infestations and reduce the widespread risk of catastrophic wildfire while providing economic development opportunities. The cost of salvaging “red and dead” beetle-killed trees and removing excessive forest fuels can be prohibitively expensive. An economical outlet (market) for such biomass is needed. One viable alternative is to provide economical small-diameter utilization options. Reestablishing integrated forest products utilization capacity and retooling the existing industry for processing small-diameter material and salvaging beetle-killed trees are critical needs. New industry is also needed in many locations that have lost all capacity to harvest and utilize harvested trees.

The Wyoming and Colorado TAV was conducted September 8–11, 2008, by Rusty Dramm, Ted Bilek, and John Zerbe

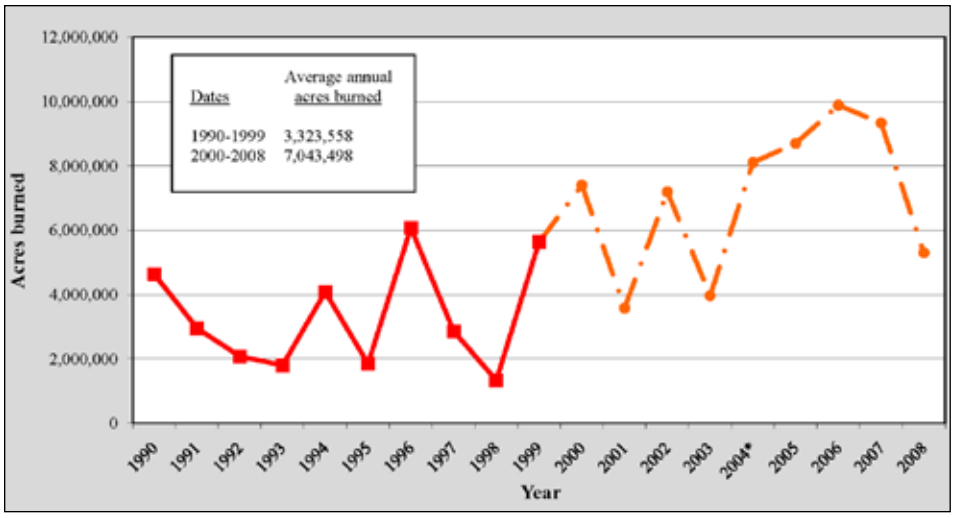

Figure 2—Annual acres burned by wildfires in the United States, 1990–2008. Data source: National Interagency Fire Center, Wildland Fire Statistics

from FPL and key regional Forest Service specialists—Susan Ford and Scott Bell, State and Private Forestry, and Dan Len, Arapaho–Roosevelt National Forest. Key TAV partners included Dan Perko, State of Wyoming Forestry Division; Craig Jones, Colorado State Forest Service; Randy Williams, Teton Conservation District; Arla Strasser, Saratoga–Encampment–Rawlings Conservation District; and Gayle Hinschberger, Dubois–Crowheart Conservation District. The team met throughout the week with key state, local, and Forest Service partners and several community and forest industry representatives.

Figure 3 shows a variety of potential opportunities for using small-diameter material, including most of the major forest products and related business sectors. These potential opportunities include a full range of low- to high-quality small-diameter and underutilized materials. Technically, there are many potentially viable options for producing products from small-diameter material. The real questions are whether a market exists and if it is economically feasible to produce and sell. Also of interest are the material properties of small-diameter material—are they suitable for intended use?

Technical Assistance Visit Summary

The week opened with a meeting with folks from the Dubois–Crowheart and Teton Conservation District in Dubois, Wyoming, and ended with a closeout meeting on Thursday in Gilpin County, Colorado. The remainder of the week was spent touring projects in Dubois and Saratoga, Wyoming, and several locations in the Front Range of Colorado to meet key partners in forest health and utilization and to discuss technology-related issues (Appendix I). The TAV Team provided overviews of FPL's capabilities at several stops throughout the week. Stops included mill visits, forest sites, and meetings with the project partners (Appendix II). The team listened to issues and concerns, made suggestions, and encouraged partnerships to address issues.

Dubois, Wyoming (Bridger-Teton National Forest)

On September 8, 2008, the team met with Dan Perko, Deputy State Forester; Randy Williams, Teton Conservation District; Gayle Hinschberger, Dubois–Crowheart Conservation District; Mark Harrison, Mayor of Dubois, Rick Metzger, District Ranger, Wind River Ranger District, Shoshone National Forest; Al Christophersen, Rocky Mountain Elk Foundation; and several other partners at the Dubois–Crowheart Conservation District. After introductions and a few presentations, the group toured two wood-using enterprises and a wildland–urban interface (WUI) biomass collection yard. Further discussions followed with a stop at the former Louisiana Pacific sawmill site east of Dubois. The Conservation District was awarded a Partnership Grant from the U.S. Forest Service in 2008.

Wyoming Logsmiths

Tim Rogers is a log home manufacturer on the west side of Dubois. He described his operation, log supply, and housing market. Tim is satisfied with the size of his operation and says that he has only experienced some downturn in the housing market. He does round log and hewn/flat sawn-log construction. Although he sells his products throughout the West, he does this through word-of-mouth promotion. Tim might be interested in some of the innovative roundwood structures coordinated at the FPL. Tim Rogers was also interested in a technical trades school to train students.

Ron Eliason of Eliason Logging runs has a small yard where he sorts loads and saws products on a LT-70 Wood-Mizer sawmill (Wood-Mizer Products, Inc., Indianapolis, IN) producing about 600 board feet per hour. He does only specialty and custom sawing. Marketing is pretty much by word of mouth. Ron produces around 60 truck loads of logs per year (1,500 green tons). Ron sorts logs with his Prentice hydraulic loader-equipped log truck (Caterpillar Forest Products, Peoria, IL). For smaller log yard operations, this type of

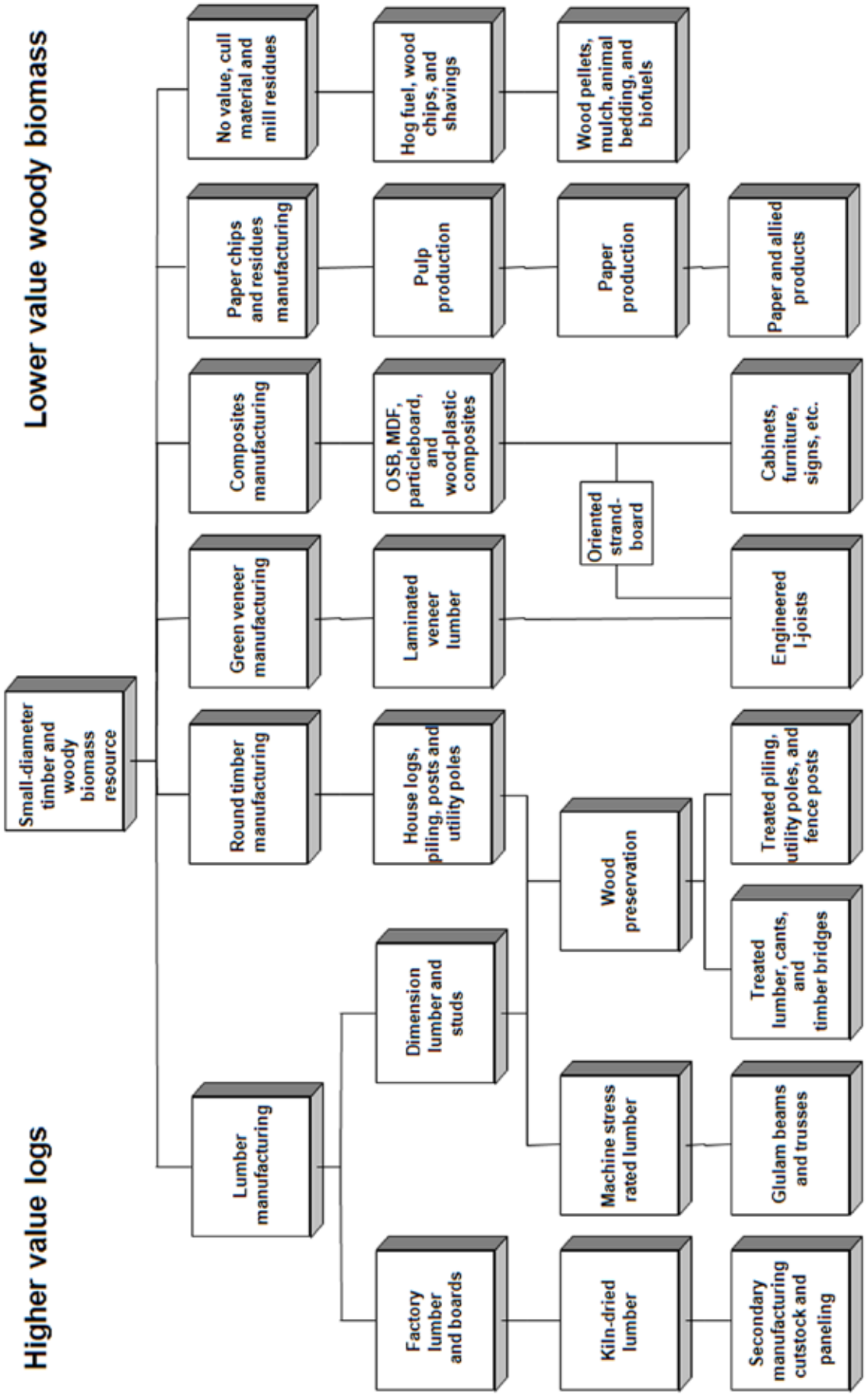

Figure 3. Potential utilization and marketing opportunities for small-diameter timber and woody biomass in the Western United States.

loader is the suggested sorting and loading system. A firewood processor is also co-located next to Ron's operation.

Union Pass WUI Biomass Collection/Disposal Yard

Rick Metzger, U.S. Forest Service, described a mastication demonstration site and a WUI fuels reduction project at Union Pass, Wyoming. Material removed from landowners' property is concentrated in a gravel pit where it is burned. This biomass appears to be a potential source of biomass energy feedstock for local use. Al Christophersen with the Rocky Mountain Elk Foundation talked about stewardship contracting partnerships for improving efficient resolution to forest fuels loading, risk of catastrophic wildfire, and control of the current insect infestations in the Intermountain West. The apparent lack of forestry contractors and woods-worker labor are barriers to accomplishing the land treatments.

Dubois Closeout Meeting

Mark Harrison, Mayor of Dubois, discussed the need for expanding the local workforce, as many jobs were lost to the gas fields, and the need for affordable housing and a stable workforce. Several issues revolve around the school system: the need to provide jobs, the need for children to fill the schools, the need for less expensive school heating, and the potential application of a wood energy system for a greenhouse to grow produce for the local market.

An overview of the ***greenhouse feasibility*** study was presented. Several community benefits are anticipated from a greenhouse operation growing produce such as tomatoes. Besides fresh produce, one or two commercial greenhouse facilities would help enrich employment for the community and increase Dubois local economy and seems a logical fit.

Copies of the *Upper Wind River Biomass Co-Generation Project Feasibility Study* by Northwest Management, Inc. were distributed to the TAV team of Dramm, Bilek, and Zerbe by the Teton Conservation District representatives. The study considers several options for application of biomass heating in the Dubois area and concludes that school district heating is probably not feasible. This conclusion is counter to a good deal of discussion on moving forward with district heating at the former Louisiana Pacific (LP) sawmill site. The point here is to take a close look at the district heating project before moving ahead and to resolve any potential issues brought up in the report. On the positive side, the study finds that the use of biomass energy for the K–8 school or proposed new high school may be feasible, especially if the high school can be co-located with the K–8. Biomass heating for greenhouse operation is perhaps a more promising opportunity.

In reviewing the feasibility study, we found a weakness in the assumptions assessing the available biomass resource. The biomass assessment in the study is based on national averages and assumptions applied to the local environ of the Dubois area. It would have been much more appropriate to consult with the Wyoming Division of Forestry on the recent state-wide biomass inventory assessment.

Note that the feasibility study cites WoodBoilerFeas.xls spreadsheet in the analysis. WoodBoilerFeas.xls was developed by Dr. Bob Govett, University of Wisconsin–Stevens Point in partnership with the FPL and UW Extension-Madison. It is a personal computer spreadsheet program for preliminary financial feasibility analysis of wood-fueled steam boiler systems. This analysis should only be used as a preliminary feasibility to see if a biomass heating system is worth exploring further, and we suggest a more detailed analysis. Be sure also to look closely at the biomass fuel specification for any proposed biomass energy project, because too often lack of attention to detail on fuel specification results in difficulties down the road. Experience has shown this to be true for industrial wood-fired heat and power applications as well as governmental and institutional biomass energy projects.

Louisiana Pacific Sawmill Site

After the closeout meeting, Dan Perko and Randy Williams brought the TAV team to the former LP sawmill site east of Dubois. The site seems to be an ideal place for co-locating several wood-using enterprises and biomass energy operations, greenhouse, and other district energy users. Currently, the site has a medical facility and a therapeutic center, with plans developing for an assisted living center nearby.

Local entrepreneurs are considering the development of a wood processing cluster at the old LP sawmill site to help revitalize the community by rebuilding wood products manufacturing infrastructure. The three businesses we toured (log home, sawmill/sort yard, and firewood processing) along with a greenhouse and biomass boiler to supply district heating might make up the core of the "Wood Cluster." In addition, biomass heat may also be able to supply the medical and senior citizen facilities as was discussed during our meeting in Dubois.

Forest residues such as at Union Pass site could supplement any mill residues used in firing the biomass boiler. Although it appears that with the Forest Service mastication and WUI work already in progress (more is NEPA ready), there might be enough biomass to make this all work, formal examination and quantification of the resource supply should be done before acting on any of these proposals.

A complete engineering and financial feasibility analysis should be done to see if this really does make sense before spending money moving forward. While the National Forest System cannot guarantee supply, biomass is available. As the lack of supply might be a limitation on securing financing from lenders for biomass utilization, this might be a good project to submit for the Woody Biomass Utilization Grants program.

Saratoga, Wyoming (Medicine Bow–Routt National Forest)

On September 9, 2008, the team met with Dan Perko, Deputy State Forester; Arla Strasser, Saratoga–Encampment–Rawlings Conservation District; local National Forest System staff, biomass energy concerns, the power company, and other interested parties from South Central Wyoming. Arla Strasser welcomed everybody and introduced the meeting agenda for the day. After introductions, FPL representatives discussed several key points for success, economic feasibility analysis, critical factors for success, and biomass energy options that may fit into South Central Wyoming.

Much of the discussion focused on potential opportunities described in the Forest Service "Partnership" grant application. In addition to Intermountain Forest Products efforts to reopen the former LP sawmill in Saratoga, opportunities being considered include the following:

- Reopening the Encampment Sawmill (R.L. Hammer Timber and Lumber Company)
- Attracting enterprise(s) that would utilize sawmill residues for wood energy or other products
- Assessing the feasibility of a 600 ton per day fast pyrolysis bio-oil facility
- Analyzing bio-mulching for land reclamation associated with oil/gas development

Matching up the existing and planned forest products operations in South Central Wyoming with the available timber and biomass supply is critical. Too many opportunities appear to be under consideration for the available log resource. The consumption capacity of the old LP mill in Saratoga was about 40 million board feet annually in 1996. Recently, the Forest Service has been able to put up 20 million board feet annually of timber sales. The group needs to focus its ideas to match appropriately scaled industrial capacity with the available resource. This will take a collaborative effort with several competing opportunities for the same log/biomass resource.

Because of high mortality from mountain pine beetle (*Dendroctonus ponderosae*), both short- and long-term supply need close evaluation to properly size a sustainable industry. The lack of a consistent long-term supply remains a deterrent to industry. Given the uncertainties of resource supply, forest products market volatility, and financial viability of forest products operations, it is essential to use an objectively planned programming approach. Planned programming leads to strategic, marketing, business, and operational plans to help guide the development and operation of the enterprise (Howe 2005).

Previous technical assistance visit to Saratoga and Encampment was conducted by Dr. Tom Hamilton, Director of FPL, and his staff in 1996. At the time, industry expressed concerns about the lack of available timber supply. Timber supply was the number one problem facing the industry in 1996. The timber resource was reportedly plentiful at that time but not available, and the mills were having a difficult time competing with Canadian lumber. Many mills had already gone out of business by the mid 1990s.

During the previous visit, the FPL Team toured Louisiana Pacific's sawmill operation in Saratoga, Wyoming; the mill was producing 2- by 4-in. studs using mainly lodgepole pine with some spruce fir. Pulp chips were shipped by rail to Longview, Washington, at the time. Unfortunately, the rail spur was subsequently removed sometime after the original FPL TAV. Opportunities to increase lumber recovery and improve mill efficiency through lumber size quality control were noted at the time. Retooling the mill with log/lumber scanning and computer optimizing technology was suggested. However, it was unlikely that Louisiana Pacific would have invested in such optimization technology because of the large capital investment required. A greater and more secure supply of timber would have been needed before such an investment in optimization technology would have taken place.

R.L. Hammer Timber and Lumber Company

The TAV toured this company in Encampment, Wyoming, in 1996. This sawmill operation produced softwood boards (1 in. thick). The operation consisted of two smaller mills. The large-log side was a conventional circular sawmill employing a sash gang resaw and was geared for lumber grade recovery. The small side was a new scragg/thin kerf resaw system capable of handling logs down to 4-in. small-end diameter. Discussion with Mike Hammer and his sons concluded that there was insufficient small timber to keep the new small log mill operational continuously. Again, lack of supply—or rather insufficient consideration of the available timber supply—resulted in poor use of small-log sawmill capacity. Sufficient volume of small-diameter material existed but were not yet available at the time.

Front Range in Colorado (Arapaho–Roosevelt National Forest)

During September 10 and 11, 2008, the team met at the Boulder County fairgrounds. After introductions, Craig Jones, Biomass Specialist, Colorado State Forest Service, provided an overview of the Partnership grant and long-term goals and objectives, implementation, and project challenges. The Front Range has a history of insect outbreaks. Entomological factors include mountain pine beetle, ips beetle (*Ips* spp.), spruce budworm (*Choristoneura occidentalis* Freeman), Douglas-fir beetle (*Dendroctonus pseudotsuqae* Hopk.), and Douglas-fir tussock moth (*Orgyia pseudotsugata* McDunnough). With the exclusion of fire, thinning, and harvesting activities, forest stands have become stressed from overstocking, leading to insect attack, often followed by catastrophic fire. Fuel build-up will be a problem for

years to come. Rusty Dramm provided an overview of the FPL and small-diameter utilization options with discussion by Ted Bilek and John Zerbe of FPL.

United Wood Products, Inc.

Raul Bustamante provided the group with an overview and tour of his operation in Longmont. Several processing operations are integrated on site including a circular sawmill, post and pole peeling, log bucking/merchandising line, and firewood processing. Raul's focus is on producing specialty products:

- Several types of fencing
- Posts, rails, barn poles
- Machine or hand peeled logs
- Unpeeled logs
- Vigas and latias
- Log rail systems
- Mantels
- Pergolas
- Play structures
- Tongue and groove aspen–pine paneling
- Timbers
- Rough sawn lumber
- Bedding/Mulch/Chips
- Firewood
- Custom sawing

United Wood Products and the other enterprises who have agreed to participate in the Front Range of Colorado log-sort yard project indicate a small, but fairly diverse forest products industry. Raul's key to success is to base his operation on specialty products, thus avoiding heavy competition found in the commodities lumber market. Specialty products are characterized by low volume but generally higher value than commodities products (2 by 4 studs, common boards). Some attention to housekeeping would help improve plant safety.

Renewable Fiber, Inc., Fort Lupton, Colorado

This is a commercial operation producing mulch and other soil amendment products from mill and forest residues. Carl Spaulding explained the products made at this facility and the technology of composting. This is certainly one of the viable utilization alternatives for dealing with the mill and forest residues.

The Forest Products Laboratory funded a shavings mill at Renewable Fiber, Inc. through the Woody Biomass Utilization Grants program in 2008. A bagger for shavings is needed for moving into new markets to overcome a recent loss of Renewable Fiber's bulk shavings market. Carl Spaulding will be working with Susan LeVan, Technology Marketing Unit, on modifications for the Woody Biomass Utilization Grant agreement for this shift in manufacturing.

We noted that some of the feedstock for Renewable Fiber comes from as far away as California. There may also be opportunities to rail products long distance by dedicated unit train (40+ cars of chips) could be loaded within 48 hours. One opportunity is to look at the export pulp chip market to Asia via the new export chip port in northern California.

Jefferson County, Colorado

The TAV Team met with Wade Yates, Special Projects Coordinator for Jefferson County, to review the long-term project of the Rooney log sort yard and wood pellets. Several issues came to light. First, the idea of a log sort yard to provide a drop off point for woody biomass from " salvage work of beetle-killed trees (red and dead) is being fairly well received by the general public. However, NIMBY (not in my back yard) appears to be a significant obstacle.

Second, the approach of using the log-sort yard concept for collecting biomass is new and innovative but an unproven concept. The yards in general are having a hard time getting the public to bring in their biomass to the yards. Up to $10 per cord is being offered for sawlog/pole lengths of 8 ft plus sawmill trim. Others operators in the area are paying $30 per cord at a landowner's or homeowner's site. The public appears to lack awareness about 1) the existence of these biomass collection/sort yards, 2) their hours of operation and 3) seasonality or temporary yard operation.

We suggest that the focus here should be on charging perhaps $30 per cord as a dumping fee for biomass rather than paying landowners $10 per cord for logs. Ten dollars per cord is not much money for all the effort that goes into making a cord of sawlogs. For the landowner, these yards really provide a service of taking the biomass off of their hands. What services are you providing your customers? Rethink the purpose of the sort yards as it applies to each of your potential customers (landowner, homeowner, tree service firms, sawmill, firewood processors, post and pole enterprise, mulch operation).

Third, a wood pellet operation adjacent the Rooney sort yard site would likely consume *all* of the available woody biomass anyway, so why bother trying to sort potential sawlogs of post and pole material from the biomass when you have a ready use for all the material? It is doubtful that enough value could be recovered to justify sorting and transporting costs of higher valued logs. The best bet is to move all of the woody material to pellet manufacture and yard debris (bark) to an operation like Renewable Fiber, Inc.

We recommend that a pellet mill feasibility study be conducted to evaluate the availability of woody biomass, plant requirements, financial analysis, and so forth. Per our conversations, we included contact information for Timber Ridge Energy Enterprises, Inc. (TREE, Crystal Falls, MI). TREE provides services for evaluating and planning cost effective processing systems (wood pellet mills) for biomass utilization.

Estes Park, Colorado

This community has a biomass collection yard that is the drop off point for woody biomass, primarily "red and dead" lodgepole pine and other victims of insect outbreak on the Front Range. Estes Park has legislated that beetle-killed trees must be removed from the land and brought to the yard for processing and disposal. The yard employs an air curtain burner. There is a potential to recover products from the biomass delivered to the Estes Park collection yard; however, long distances to potential markets (such as Renewable Fiber) may be prohibitive. We also discussed the issue of how landowners get salvaged material/biomass road side and how it is collected. One thought was to provide small-scale logging equipment (ATV with log arch) as a means of assisting landowners in removal to roadside. This might be provided by a local implement dealer or the County itself, which would then rent/lease out this equipment to landowners or tree service companies.

Salvation Army Camp's Tarm Wood Heating System

The group made an impromptu stop at the Salvation Army camp to tour the Tarm wood heating system. While some outdoor wood burners are of concern with regard to air pollution (particulate and smoldering), the Tarm system employees a heat sink (water tank). The system appears to be very efficient. There are other equivalent systems such as the Garn wood-fired systems. Tarm America has been distributing the Tarm units made in Denmark for 15 years. Before that, they were agents for other European manufacturers.

The Tarm type of combustors are clean and efficient. They burn wood, pellets, or corn in one chamber that produces a gas that is burned with a high heat in a secondary combustion chamber. The vapors that are periodically emitted from combustion are white instead of brown or black, typical of some polluting outdoor wood burners.

Tarm also makes multi-fuel boilers that have a firewood boiler on one side and a fossil fuel burner on the other side. When the unit runs out of wood, it automatically switches to burning oil or gas (natural gas or propane). More recently Tarm America has again become the agent for other European manufacturers of high quality equipment (Fröling (Fröling Heizkessel- und Behälterbau GmbH, Grieskirchen, Austria) and Scandtec (Scandtec ApS, Skjern, Denmark)). With the expansion of manufacturer representation, Tarm America changed its name to BioHeatUSA (Lyme, NH).

Tarm units supply lower energy demand needs, typically residential from 15,000 to 148,000 Btu/hr. Scandtec units are also designed from 100,000 to about 200,000 Btu/h. However, available Fröling units have wider ranges from 28 kW_T to 500 kW_T that encompass about 95,500 to 1,700,000 Btu/h. Different models burn firewood, chips, flakes, or pellets.

For a long time, Dectra Corporation of St. Anthony, Minnesota, has manufactured the Garn high-quality wood burner in the United States. It is used in higher capacity installations than the Tarm burner. The Garn combustor has capacities from 350,000 to 950,000 Btu/h.

Gordan Gulch Stewardship

Dan Len provided an overview of stewardship contracting on the Arapaho–Roosevelt National Forest. U.S. Forest Service Research has done extensive exploration of fuels reduction treatments. The wildland fire research shows that the commonly used "Thinning from Below" prescription is generally not effective (Langowski 2005). Research indicates that it is not enough to just remove ladder fuels and that a certain percentage of crown closure must also be removed to reduce the risk of crown fire. Fuel-reduction prescriptions may also substantially change the economics of fuels treatment costs. We recommended that you contact Paul Langowski, Branch Chief, Fuels and Fire Ecology, U.S. Forest Service in Golden, Colorado, for more information. Paul and Bob Rummer put on an Inter-Regional Mechanical Fuels Treatment Training for Forest Service employees and partners annually.

Meeker Park

The group toured the Meeker Park (Boulder County, Colorado) sort yard. A skid steer loader used to sort and move biomass in the yard feeds an air curtain burner (see title page photo) for slash disposal. A good discussion on sort yard economic feasibility ensued. The yard's goal is to recover the highest valued products from the biomass received. The log-sort principals assumed that the highest value would be sawlogs worth about $20 per cord. However, firewood processed to 16-in. lengths are worth about $80 per cord or $100 per cord if split. Firewood would then seem to be a much more attractive product option than sawlogs.

To know the best product mix requires a fairly simple product feasibility analysis that evaluates product margins by subtracting the cost of each product compared with revenue for each product. The products with the greatest gross margins will be the most attractive options. We also had a good discussion on training and workshops for local landowners. Group members suggested a sort yard open house with coffee and donuts, demonstrations, products, and landowner training to improve marketing of the yard. The temporary, seasonal nature of the yards makes establishing the enterprises somewhat difficult.

Gilpin County, Colorado

Scott Golden talked about the biomass collection yard and plans for expanding the yard. The issue of how to move biomass from roadside to yard is of critical importance. We discussed the possibility of a log truck equipped with a hydraulic clam loader (Prentice 150 loader or equivalent) with a pup trailer or using roll-off containers.

We then toured the Gilpin County shops. Earl Robison described Gilpin County's heating facility where Gilpin County owns a "culvert trailer" with a small hydraulic clam loader that is used for gathering and transporting woody biomass. Fuel is processed by a MorBark 30/36 chipper and stored in a covered storage bin. The heating plant is a Messersmith wood-fired boiler used for heating the county shops. Messersmith burners made in Bark River, Michigan, are high-capacity, from 1,000,000 to 20,000,000 Btu/h. They are efficient and can be highly automated, and be adapted to fire existing boilers. They fire with sawdust, wood chips, or other particle biomass materials.

Closeout Meetings and Follow-up Conference Calls

The closeout meeting was held at Gilpin County. Discussion centered on what we learned during the week and how available technology might be used to address concerns and issues. We also identified potential cooperative projects for enhanced collaboration and scheduled follow-up conference calls and net meetings.

Response to Issues, Concerns, and Opportunities

Biomass Removal

Dense, overstocked, small-diameter stands with heavy fuel loading require mechanical treatment (biomass removal). Improving overstocked stands by thinning is needed throughout the Intermountain West to reduce the urban wildfire interface risk. Private land is interspersed among Federal and state lands with many homes and structures, especially on the Front Range in Colorado, which is particularly at high risk. Slopes are moderate to steep with overstocked stands of small-diameter pine, creating a heavy fuel load. Beetle infestation is exacerbating the situation. These conditions are increasing the risk of insect outbreaks and wildfires within the wildland–urban interface. The key to managing the WUI effectively is to remove the fuel loading through thinning. Community and homeowner involvement in managing these risks is crucial.

Cost-effective small-scale harvesting and biomass removal equipment and techniques that are readily adaptable to small acreages are needed. Finding value-added uses for small-diameter material and forest residues could help reduce the cost of removal. Such removals might include full utilization of tops and limbs for ground cover.

Fuels Treatment Effectiveness and Silvicultural Considerations

The Inter-Regional Mechanical Fuels Treatment Training in Reno, Nevada (Langowski 2005) presented information on forest fuels reduction strategies. We highly encourage everyone managing fuels reduction projects to attend this Forest Service training. The following presents some highlights of the training applicable to Wyoming and Colorado.

The U.S. Forest Service fuels management strategy is not to treat all the acres—it would cost too much. Use strategically placed fuels-reduction treatments within a management unit to reduce the risk of large catastrophic fires. This is done by laying out treatments in strips or blocks based on historical fire behavior. Clearly fire, forest management, timber sale administration, research, and utilization specialists need better coordination between them.

Russell Graham, Research Silviculturist, Rocky Mountain Research Station states that foresters generally don't thin heavily enough (Langowski 2005). This limits the effectiveness of fuels reduction projects in reducing crown fire behavior. Not thinning heavily enough is less effective in changing fire behavior. It also produces lower volumes and poorer quality of forest products removed during thinning from below prescriptions. This in turn results in less than effective fuels treatment at higher net treatment cost.

Paul Langowski, Forest Service Branch Chief, Fuels and Fires Ecology, goes on to state that prescribed burning removes ground fuels (Langowski 2005). However, reducing crown fuels outweighs the importance of reducing surface fuels. The major effects (large catastrophic fires) are from crown fires. Hence, the need is to mechanically treat (thinning or tree mastication) to reduce crown fuels.

Thinning from below usually involves removing smaller diameter trees from the sub-canopy to favor growth of the dominant trees. Forest Service Wildland Fire Research (Langowski 2005), has found that thinning from below is generally not effective in reducing crown fires or reducing mortality from scorching. Researchers advocate that thinnings include bigger trees in the dominant and co-dominant crown closure. This not only reduces crown fuels but also provides more economic incentive by harvesting some larger diameter and more valuable trees. Forest Service research has developed computer modeling tools for improving fuel-reduction prescriptions.

Timber Sales

A consistent supply of timber is the overall long-term major overriding issue for establishing and maintaining a sustainable forest products industry. The U.S. Forest Service has been able to put up increasing volumes in timber sales (about 20 million board feet per year) over the last several years on the Medicine Bow–Routt National Forests. Some timber sales have sold whereas others have not. These "no bid" sales are a problem because not only has the Forest Service invested resources into preparing sales that did not happen, but also timber that the Forest Service has planned on being removed will not be cut because it has not sold. This can have adverse effects on forest health and management.

Throughout the Intermountain West, most of the former forest products manufacturing infrastructure that could have utilized small-diameter material is gone. For the most part, the current forest products manufacturing infrastructure is not set up to handle small-diameter material economically. No bid sales might be the result of (1) current poor lumber markets, (2) lack of sawmill infrastructure, (3) lack of capital to retool or re-establish sawmill capacity, (4) lack of mill residue markets, or (5) the available log supply is not being matched to the local existing forest product manufacturing infrastructure.

Unfortunately, sawmill industry representatives were not available at the Saratoga meeting to discuss timber supply issues. Specific issues and courses of corrective actions are needed. Several key questions still need to be answered, such as the following:

- Why do some of the Forest Service timber sales end up as no bid sales? Are poor lumber markets to blame? Is the inability to secure capital from your lender at fault?
- Are mixed species timber sales a problem? Generally, mills are designed for a specific log diet and cannot use everything and all species provided.
- Is available timber supply matched to the existing and planned utilization (sawmill) capacity? We must consider volume, quality, price, species, location, and logging chance.
- What kind of coordination is taking place regionally (Saratoga, Wyoming; Encampment, Wyoming; Laramie, Wyoming; Walden, Colorado) to balance supply with processing capacity? It is apparent that there is more existing/planned utilization capacity than the currently available timber and biomass supply.
- Can small-diameter materials from fuels reduction projects be processed economically by the existing and planned manufacturing capacity (sawmills)?
- Is the timber supply consistently available from year to year? This is critical for reestablishing industrial capacity.
- What assurances of continuing supply do the mills need? Uncertainty of timber supply creates difficulties in obtaining financial backing for new investments.

Industrial Issues and Opportunities

Sawmilling Infrastructure

A healthy timber industry with the ability to utilize and market a variety of species and size classes is a key component to economical forestry operations (fuels reduction, landscape restoration, red and dead timber salvage). Industrial capacity is necessary to help resolve some of the economics associated with forest health. The lack of forest products manufacturing capacity is a difficult challenge to overcome. Appropriately scaled industrial capacity can provide an outlet for small-diameter material from forest fuels reduction projects and beetle-killed salvage. Utilization capacity can also provide primary manufacturing jobs, an important economic engine.

Small-Log Sawmilling

The trend toward smaller log diameters requires existing industries to retool their operations to handle small-diameter material. Reestablishing lost industrial capacity and retooling existing industries to process small-diameter material economically are critical needs.

Sawing for higher valued products is also essential for sawmills to become competitive. It is difficult today to survive by producing commodity market lumber (studs, dimension lumber, and boards) in the Intermountain West. Given the high cost of delivered logs substantial distances away from primary markets and the lack of an adequate transportation infrastructure, cost can easily outweigh revenues. With limited capital to invest in sawmill optimization equipment, it is especially difficult for small- to medium-sized sawmills to compete.

If larger, higher quality sawlogs become available, a sawmill's product mix should include higher valued lumber such as kiln-dried boards, Clears, Shop, and Moulding lumber grades, cutstock/millwork, and other specialty sawn products (architectural timbers). Even in these trying economic times, some sawmills in the United States are already doing this successfully and surviving. Opportunities to improve log conversion efficiency through improved lumber recovery and lumber size control will also help.

Wyoming has a small industrial capacity base for processing small-diameter material (lodgepole pine). This includes the idle sawmills in Encampment and Saratoga as well as Big Horn Lumber (Laramie, Wyoming) and Rocky Mountain Pellet Company (Walden ,Colorado). The Encampment sawmill has small-log sawing technology to utilize material as small as 4-1/2 in. This mill offers small log capacity to help get forest health management accomplished.

Industry Revitalization and Rebuilding

A key point to revitalization is that regional and local collaborative efforts are often required to develop integrated, viable, and sustainable industrial capacity. The industrial capacity must be matched to the available resource. The immediate goal here should be to focus on improving the existing industrial infrastructure so that it remains viable. This helps avoid duplication of processing capacity.

We encourage all the partners to work together with forest enterprises toward a balanced and sustainable forest products industry. Engage organizations that facilitate business development, such as Small Business Development Centers and other economic development groups. This means to take a planned programming approach to business planning (Howe and Bratkovich 2005), which will greatly improve your chances of success.

Business Investment Capital

In general, heavy capital investment is needed to establish a new forest products enterprise (sawmill) in today's competitive forest products industry. In terms of economic development, it is far less expense to retain existing industrial infrastructure (sawmills) than to develop new forest products enterprises. For existing sawmills, capital investment and improved log conversion efficiency will be needed to be competitive. This is especially true if such mills are to compete in the commodities lumber market. Their competition is low-cost big mills that take advantage of economies of scale and less expensive timber supply (Canadian lumber producers).

It is unlikely that the sawmill industry will be able to make additional heavy capital investment at this time until the current housing, credit, and Wall Street worries have settled down and the National economy gets rolling again. Available capital is lacking, so this will be a severe limitation on expanding industrial capacity. Even if a guaranteed timber supply could be secured, it is doubtful that forest products enterprises will be able to borrow money from their lender (banker) given the economic issues currently facing the U.S. economy. Venture capital and the owner's personal savings, friends, and relatives are about the extent of what capital might be tapped into at this time.

Cellulosic Ethanol and Other Biofuels from Woody Biomass

Ethanol and other biofuels from wood are other potential opportunities to use small-diameter and underutilized material. Biofuel enterprises could also potentially use standing dead material for which there is no alternative use other than fuelwood.

With downed or standing dead material, moisture content is low and much of the pitch and other wood extractives are gone. This type of material could be subjected to acid or enzyme hydrolysis processes to produce sugars that could then be fermented to ethanol or subjected to thermo-chemical gasification and synthesis processes to produce ethanol, diesel, gasoline, or jet fuel. Chipped green small-diameter material and thinnings could also be processed to produce sugars for fermentation to ethanol or to produce gas for synthesis to other transportation fuels.

If production of ethanol or other biofuels from woody biomass is pursued, economics can be improved at today's prices for petroleum if at least 70 gallons or more of ethanol or other biofuels are produced from each dry ton of material. To achieve this, both five and six carbon sugars need to be efficiently and effectively fermented to ethanol and an optimal portion of the cellulose in wood needs to be converted to glucose during processing.

Areas where FPL research capabilities would be of assistance are in the development of new and improved strains of yeast that efficiently ferment mixtures of five and six carbon sugars to ethanol and developing technologies to more effectively convert cellulose to glucose as well as developing technologies for gasification and Fischer-Tropsch synthesis of lignocellulose and bark to biofuels. Work in this area would be best accomplished in partnership with the U.S. Department of Energy's National Renewable Energy Laboratory (NREL), biorefineries at pulp and paper mills, and facilities at other forest products manufacturing plants.

Sort Yards

During our visit to the Front Range in Colorado, we really did not see sawlog-quality material in the sort yards. Material in the sort yards was predominantly forest biomass of little value as sawlogs or roundwood products. Firewood, biomass chips, and feedstock for wood pellets and other wood energy uses appear to be the most logical and the predominant use for this material. To be economically feasible, a log sort yard needs a certain proportion of higher-valued log products to justify sorting. This raises the question, "Why bother sorting this material?" given what we saw—or did not see—at the sort yards. Whereas some salvaged dead material can be sold as sawlogs, most sawmills require fresh cut green sawlogs.

Critical Factors for Success

Objective business planning will be necessary to capitalize on opportunities and ameliorate some of the problems in the western forests. The importance of objective business planning cannot be overemphasized because the probability of success is low. Timmons (1990) estimated the failure rate for new ventures at 40% in the first year and 90% over 10 years. The business planning process can reduce some of the risks by pointing out weaknesses and deficiencies through market and financial feasibility analyses.

Consequently, a properly developed business plan improves the chances for success. Howe and Bratkovitch (2005) provide an excellent step-by-step guide for planning wood products enterprises. Given the current poor markets, lack of credit, and restricted timber supply, it is imperative that an objective planned approach to assessing the feasibility of re-establishing sawmill and other wood products processing capacity be taken.

Business planning accomplishes four basic things (Howe and Bratkovich 2005, Govett 2005):

1. It forces the project planning team to think strategically and take a critical objective look at starting or expanding the business.
2. A formalized operating plan provides a business owners' manual for developing and operating their business. It is a working roadmap to success.
3. A business plan enables the firm to obtain financing. It provides the lender with a basis to evaluate venture

startup or expansion plans. It communicates to others the value of the new enterprise. Two key elements of the business plan are the marketing and financial plans. These latter two elements are number 3 and number 6 in the "Seven Critical Factors for Success" and are further discussed later in this document.

4. The process of business planning improves the likelihood of success by identifying difficulties, risks, problems, and strategies to overcome barriers or to abandon enterprises where problems cannot be overcome, thereby saving time, energy, and money.

Developing a business plan is a rigorous process involving considerable work in identifying likely difficulties, hurdles to overcome, and risks. This process requires that those who proceed with the plan—bring the business to fruition and then execute it—have thoroughly and frankly considered the overall environment. Frequently, while developing the business plan, problems or hurdles that cannot be overcome are identified and the enterprise can be abandoned before financial losses have accrued. In contrast, starting a business with less research (due diligence) and being unaware of problems can lead to failure, often at great cost. The use of the business plan reduces the risk of failure where an incorrect decision to proceed is rejected in the planning process. In cases where the decision is made to proceed, the business plan can help to identify factors that will need to be closely monitored in order to ensure success. A good business plan reduces uncertainty and minimizes risk.

A well-prepared business plan addresses the "Seven Critical Factors for Success" described by Mater (1988) and Davis (1995), in the following order, beginning with the most limiting factor—raw material resource supply:

1. Raw material resource characterization and assessment: ownership and availability, price, location, quality (taper, defect, tree form), quantity, and physical characteristics (diameter distribution, length, volume)
2. Potential product options from available resource: types of products, grade mix, volume recovery, and technical feasibility
3. Market feasibility of potential product options and transportation infrastructure: competition, commodity and specialty markets, transportation, and integrated industrial infrastructure required
4. Processing technology and design requirements for handling and processing raw material into products: technical feasibility, equipment selection, and manufacturing methods
5. Management team and other business management considerations: business structure, management team, business controls, management team know-how and experience, and skilled/unskilled workforce availability
6. Financial feasibility and *pro forma* projections (projections of the balance sheet, income statement and cash flow analysis) of the proposed operation are of greatest importance, as they provide the core of the financial analysis of the business plan.
7. Safety, health, and environmental considerations, and other non-financial factors such as regulations and licensing that could limit project success

Each of these factors can have profound influence on the success of a forest products enterprise, especially in light of current timber resource availability, volatile forest product markets and weakened National economy. Weakness in or the lack of one or more of these factors could lead to project or enterprise failure. In particular, it is clearly apparent in some areas that there is not nearly enough available wood supply such as the projects planned in the Saratoga–Encampment, Wyoming, area. Follow the "Seven Critical Factors for Success" presented here, starting with the raw material resource assessment. How much do you have to play with? Match the available raw material supply to an appropriate scale of forest products processing capacity. Can you sell and make a reasonable profit?

The Marginal Log Problem

Small-diameter material is a factor in log supplies in the western United States. Small-diameter material offers moderate to low quality and lower valued products with less volume per piece than traditional large-diameter logs. Furthermore, small-diameter material is proportionately much more expensive to process than large-diameter logs. These present several challenges for the small wood operator. Economic viability depends on efficient log conversion at minimum per unit cost per thousand board feet ($/thousand board feet) while recovering a high value from the available log resource so that the difference between cost and recovery value is maximized.

The economic problem of small wood operations centers on dealing with the ***Concept of Marginal Logs***. Marginal logs are characterized by low-value (small-diameter, underutilized, moderate to low quality) material (Hallock 1964). In relation to log diameter, log cost decreases with increasing log size to a point, and then costs begin to increase, whereas value increases with log size. Product (lumber) value increases as log diameter increases (Fig. 4).

Why do costs decrease and value increase with increase in log size? An 8-in. diameter log only has about one fourth the cubic foot volume of a 16-in. log of the same length. A sawmill, for example, would have to process four or five times as many 8-in. logs to recover the same lumber volume production of 16-in. logs of similar length. For a given small wood operation, processing smaller logs can be substantially more expensive on a per unit basis ($/thousand board feet) than for larger-diameter logs (Barbour 1999).

The intersection of the cost curve with the log value curve defines the line of log marginality (Fig. 4). This is the point

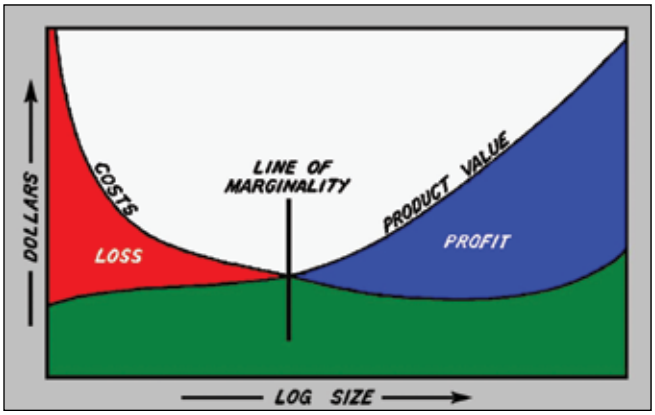

Figure 4—Concept of marginal logs. Marginal log size (small end log diameter) is at the intersection of the cost curve with the product value curve. Here, product value equals log costs. On average, logs smaller in diameter than the average diameter of the line of marginality cost more to procure and process than the value of the potential products.

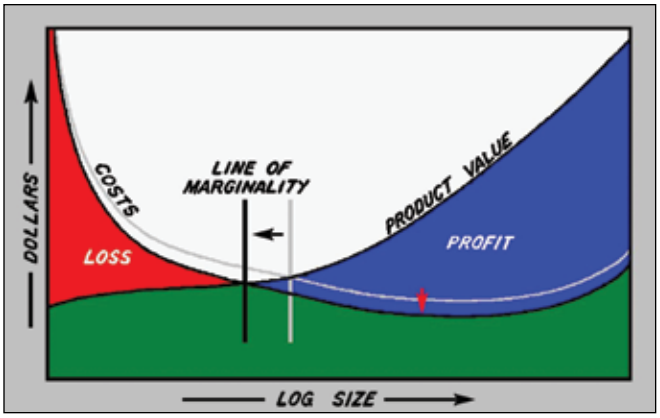

Figure 5—Lower the cost curve. Lowering the cost curve decreases the marginal log size allowing for better utilization of smaller diameter sawlogs.

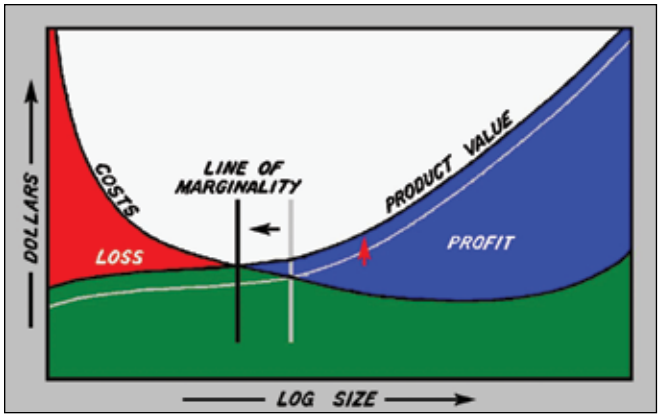

Figure 6—Raise the value curve. Raising the value curve also decreases the marginal sawlog size. A combination of lowering costs and increasing products value produce even greater benefits.

where product (lumber and mill residues) value equals the delivered log cost plus direct processing costs. One might conclude that submarginal logs should never be processed, as cost is greater than product value. In reality, all small wood processing operations to some extent process a mixture of logs from both sides of the line of marginality. What is important is that an operator processes logs better—that is larger—than the average marginal log.

The continuing overall trend toward smaller and poorer quality logs means managing marginal logs. One option is to find ways to move the line of marginality to the left to be able to use smaller log size and lower log quality/value. This is accomplished by lowering the cost curve (Fig. 5), raising the value curve (Fig. 6), or a combination of both.

Lowering the Cost Curve

This factor focuses on reducing per unit ($/thousand board feet) cost of logs delivered to the mill, sawing or processing costs, and overhead (fixed costs):

- Use "*Economies of Scale*" to spread capitalization costs over larger production volumes.
- Improve log mix—saw logs of the size and quality represented by the bottom of the cost curve.
- Incorporate linear single-pass log processing and other improvements in mill equipment.
- Concentrate on efficient plant layout and design.
- Minimize effort in processing low-value logs.
- Handle and process logs efficiently and minimize log and product (lumber) handling.
- Processing logs in like batches improves production rate and the quality of breakdown.

Raising the Value Curve

Likewise, several things can be done to raise the value curve:

- Improve marketing: Find better markets and prices for products, get the best price possible, and don't give your products away after you expended all the time, effort, and dollars to produce them.
- Improve log mix with saw logs of the size and quality represented on the value curve to the right of the line of marginality.
- Match equipment and plant design to log resource characteristics and available markets.
- Incorporate quality control to assure product conformance to specifications and improve product (more product from same volume of logs).
- Merchandise logs for highest net value (bucking long logs into various short log products such as veneer peeler blocks, sawlogs, saw bolts, and pulpwood to optimize log value).
- Marketing mill residues is a must.

Sawmill Technical Assistance

Assistance is available from the Technology Marketing Unit (TMU) of the FPL. Although assistance is generally limited to responding to technical lumber manufacturing inquiries, onsite assistance is considered at the request of your State Forestry staff. Sawmill layout, design, construction, and other in-depth studies are referred to consultants.

Today's state-of-the-art ***small-log processing*** incorporates log and lumber scanning technologies and computer sawing decisions, single-pass processing systems, curve-sawing technology, and other precision manufacturing technologies. Turnkey cost for today's small-log sawmill can be a substantial investment. Increasing production rates, maximizing lumber recovery through optimization and quality control, and minimizing production costs are keys to profitability. On a smaller scale, single-pass small-log scragg mills and resaws are available. The TMU can offer recommendations on appropriately scaled small-log softwood processing technologies and manufacturing methods.

Lumber size control is a quality control technique developed to help identify and locate problems in primary and secondary log breakdown systems in sawmill operations. This is useful in troubleshooting, setting maintenance priorities, and determining when adjustments to a breakdown system are necessary or when to leave the process alone. Benefits of size control include improved process performance and lumber quality, resulting in reduced unit costs ($/thousand board feet) and increased productivity. The TMU can provide assistance, in coordination with your State Forestry staff specialists, for studying lumber size variation and target sizing.

At the request of your State Forestry staff specialists, TMU participates in conducting ***lumber recovery and grade yield*** mill studies. These study results provide measures of log breakdown conversion efficiency and help identify opportunities for mill improvement. Manufacturing costs and market prices can be used with mill study recovery data to analyze potential sawmill improvement project feasibility. Mill study data, mill identification, and other sensitive business information are kept strictly confidential. However, general conclusions, recommendations, and insights are subject for use by the U.S. Forest Service in advancing improved log utilization and sawmill efficiency.

Lumber recovery in softwood dimension mills can be simulated using computer software. ***Computer sawing simulations*** help sawmill operators estimate potential lumber product recovery and value. Simulation results can be compared with actual results from lumber recovery studies to identify potential areas of improvement. The TMU can provide assistance with computer sawing simulations for sawmill and resource assessment studies.

Gross Margin

Early development of financial feasibility can avoid wasting time and energy. This will help you focus on the big picture, identify critical business data needs and assumptions, and narrow down potentially viable opportunities to match the available resource. Preliminary financial analysis helps depersonalize feasibility analysis so that decisions as to "Go" or "No-Go" are made on an objective rather than subjective basis. This approach helps prevent emotional attachment to bad ideas. Preliminary financial analysis also helps convert passive discussion into action as it illuminates opportunities and problems.

What forest products business planners and managers really need is an effective and simple way to simultaneously consider both manufactuing revenue and costs. Enterprise viability depends in part on the dynamics of the available timber supply (log cost delivered to the mill yard), cost of converting logs into primary and residue products (manufacturing cost), and forest products markets (revenue from the sale of products and mill residues). Evaluation of product value to delivered log cost and processing cost provides a good starting point for preliminary feasibility analysis of the proposed enterprise.

In the final calculation, ***gross margin*** will be of greatest interest and importance to the forest products enterprise planning team. Gross margin equals product revenue minus delivered log cost and variable manufacturing cost. Specifically, the gross margin is used to identify both those species, log grades, and product mix that offer the greatest potential for economic return, as well as those that pose the greatest problems, risk of losses, or unacceptably low margins.

A gross margin calculation done using "best-case" scenario assumptions can help present the financial picture early on in the planning process. It should be developed using a reasonable pair of "rose-colored" glasses. This quick and easy analysis will identify projects that are unattractive even under the best-case assumptions. When this is found and demonstrated, obviously attention should be focused elsewhere. This saves you time and energy from chasing after a poor investment scenario.

Under a best-case scenario, a positive gross margin indicates a scenario worth further investigation and a more intensive financial analysis. A negative gross margin indicates a nonviable scenario that is not worth further investigation. Pursuit of the nonviable option can be dropped before extensive time and energy have been expended. In some cases, the preliminary financial analysis may indicate that the original concept is flawed or otherwise unworkable. However, a more appropriate dimension of undertaking may be identified as a result of interactive discussion in doing the analysis and more broadly considering problems and opportunities. When options have been narrowed to perhaps three to five, a more detailed analysis of raw material supply, products and

markets, processing, and financial aspects of the project can be pursued.

Marketing

As factor three of the seven critical factors for success, market feasibility and development is the most important factor next to raw material resource assessment. Of great concern is the current pathetically poor commodity lumber markets. A key to success is ability to use and market all products including residues. Sale of mill residues often provides the difference between profitable forest products enterprises and those that struggle.

The Western Wood Products Association (WWPA) reports, "The record-setting downturn in lumber demand is expected to extend through 2009 as the U.S. financial system gets back on its feet and housing finds a bottom, according to a new supply and demand forecast…the forecast calls for housing markets and lumber demand to grow in 2010, but (WWPA) cautions that any recovery will be slow" (Random Lengths Publications 2008). Refer to Howe and Bratkovitch (2005) for information on marketing plans.

Marketing Forest and Mill Residues

Both forest and mill residues will be problematic until better residue markets can be established. There is a critical need to identify and tap into alternative markets. For example, Renewable Fiber, Inc.'s operation provides a viable alternative for mill residues to the traditional clean pulp chip. Residues can also be used as feedstocks for fiber-based products (particleboard, waferboard) or for wood energy. Although many options are available for utilizing mill residues, the problem is one of marketing and getting sufficient economic return.

Manufacturing Directories

Forest Products Industry Directories are essential marketing tools, and we recommend that every state provide up to date forest products directories of their primary and secondary wood products manufacturing firms, wholesalers, etc. The Colorado Wood Utilization and Marketing Assistance Center published the Colorado Forest Industries Directory in 2004. We are not aware of a forest industry directory for Wyoming.

Market Distribution Challenges

Marketing also involves the distribution of products to the marketplace. Transportation (high cost and lack of infrastructure) is a critical issue facing both Wyoming and Colorado. Poor transportation infrastructure limits options to move products to market. Distance to markets and lack of transportation infrastructure will continue to be barriers, especially in the Dubois, Wyoming, area. Proper industrial siting is vital to successfully establishing and maintaining a forest products industry, for which transportation infrastructure is a crucial consideration. The high cost of diesel fuel is also of great concern.

Profit-Added Opportunities

Considerable interest exists in new markets for raw materials from logs, dead timber, and other material. Remanufacturing that could help integrate operations for value-added is very important if these other markets are to develop. There is a strong need for value-added opportunities for small-diameter trees.

Note that it is not enough to simply manufacture "value-added" products. Any increase in revenues from the sale of value-added products must cover the additional costs associated in producing and marketing these products. It makes no sense to do value-added if it does improve an enterprise's bottom line. Value-added opportunities that more than cover the additional costs might be better called "profit-added" opportunities.

Marketing is the key to success with profit-added opportunities. Profit-added opportunities include specialty and niche market products such as house logs, tongue and groove (T&G) paneling, vigas and latias, architectural timbers, Douglas-fir flooring, and other high-end but limited quantity products. Profit-added includes manufacture of small-diameter material such as cabinet and furniture making as well as artisan and crafts items—and yes, even firewood if you market it right.

Financial Feasibility Analysis

In the re-invigoration of a forest products industry to support woody biomass utilization, financial feasibility analysis for each project will be critical to the success of the program. This is factor six of the seven critical steps. The steps in a full project financial feasibility analysis are shown in Figure 7.

Financial feasibility analysis is a component of project feasibility analysis. Financial feasibility analysis refers to the final four steps in a project feasibility analysis: estimating unit values and calculating the gross margin, developing the cash flow table, calculating measures of project worth, and analyzing risk and uncertainty. A description of each step in a full project feasibility analysis follows:

- ***Identify objectives*** What is the problem? What is the purpose? Why is a project being proposed? What is going to be achieved? Objectives should be quantifiable and measurable; otherwise it is impossible to evaluate how well different project alternatives might achieve the proposed objectives.
- ***Identify alternatives*** What are the different ways to achieve the objectives? This is a good place for a brainstorming phase in the project analysis. The alternatives considered will probably not be an exhaustive list. However, the alternatives should represent a realistic range of options. When considering options, "do nothing" is always an alternative with its own set of costs and benefits. When considering options, beware of a TINA ("there is no alternative") mindset. Alternatives usually do exist.

For each alternative…*define physical input-output relationships and timing; estimate unit values for inputs and outputs and calculate the gross margin; develop "cash flow" table; calculate measures of project worth; and analyze risk and uncertainty associated with alternative being analyzed*.

Define Physical Input–Output Relationships and Timing

Physical input–output relationships and timing are usually defined by the engineers and technical people involved with the project. In this step the raw materials, labor, and capital equipment as well as the likely production or other outputs are analyzed.

Unless a project is technically viable, it cannot be financially viable.

It is in this technical input–output phase that the resource supply must be considered. In projects that rely on forest resources, the resource supply portion of the physical inputs may be the same for all alternatives. This corresponds to #1 of the Seven Critical Factors for Success. What is the resource supply? What are the significant factors that describe it? These could include species, age class distributions, diameter distribution, silvicultural treatments, ownership, site conditions (slope), accessibility (existing roads), site indexes, and fire regime class.

The potential outputs correspond to both #2 (potential product options) and #4 (technical feasibility, equipment selection, manufacturing methods) of the Seven Critical Factors for Success. An important component in a full project analysis is to determine the timing of the inputs and outputs. When will the inputs be available and processed?

Note that any project analysis involves a number of forward-looking statements. These are assumptions about the future—raw materials supplies, production rates, conversion rates, costs, and revenues. It is important to state these assumptions explicitly and to provide sources for these assumptions, wherever possible. This will provide more credibility for the project analysis and will enable decision-makers to see the reasonableness of the various assumptions.

The next four steps in the project analysis comprise the financial feasibility analysis, #5 of the Seven Critical Factors for Success.

Estimate Unit Values for Inputs and Outputs and Calculate the Gross Margin

How much will the input cost and how much will the output be worth? Without #3 of the Seven Critical Factors for Success, which involves a market feasibility analysis, the outputs may be worthless. A market feasibility analysis may be necessary to estimate input and output values with a sufficient degree of confidence to undertake the project.

Before proceeding further, this is an appropriate time to double-check to see if a single-year gross margin is sufficient to make it worthwhile to continue with a more detailed analysis. The gross margin should be estimated for a year when the project is fully operational.

The gross margin is what is left over to pay for manufacturing costs, capital costs, administration and other fixed costs, financing costs, and taxes. If the gross margin does not appear to be sufficient to cover these additional costs, it is worthwhile investigating other alternatives rather than pursuing something that will probably be a "No-Go" decision.

Develop "Cash Flow" Table

If the gross margin is positive, the cash flow table shows the physical inputs and outputs and the financial inputs and outputs, as well as their timing. The cash flows in the table may be expressed in "real" terms not including inflation, or in "nominal" terms including inflation. The cash flow table should be extended over the project's life. Cash flows may be calculated simply on a before-tax-and-finance basis. Alternatively, cash flows may also be calculated after-finance but before-tax, and after-tax.

The cash flow table is important because it shows the times when the project will require financing and when it is projected to return a surplus. It is critical for project budgeting and can be used as a mark against which the project success (or failure) is measured. A cash flow table also forms the basis for the *pro forma* income statements and balance sheets that should be included in a full business plan.

Calculate Measures of Project Worth

Common measures of project worth include the following:

- Net present value (NPV), which is also sometimes called present net value, net present worth, or present net worth. All terms refer to the same formula, which discounts and sums a project's costs and benefits over its life.
- The internal rate of return (IRR), modified internal rate of return (MIRR), and the benefit/cost, or cost/benefit ratio. The closing balance or net future value is also sometimes calculated. *Pro forma* income statements and balance sheets are projected statements, given the revenues and costs in the cash flow table.

In addition to the benefits and costs that were calculated in the cash flow table, most measures of project worth also require a discount rate. The discount rate may also be known as the hurdle rate, the alternative rate of return, the cost of capital, or the weighted average cost of capital. The terms all refer to an interest rate that represents the cost of financing, which itself represents the expected return on investment if funds were not put into this project. This is an interest rate that is used to compare the net benefits and costs in different years. Like the cash flows in the cash flow table, the discount rate may be in real terms not including inflation, or in "nominal" terms including inflation. It is im-

portant not to mix real cash flows with a nominal discount rate (a common error), or nominal cash flows with a real discount rate. Both can lead to erroneous measures of project worth and mistakes in "go or no go" recommendations.

Analyze Risk and Uncertainty Associated with Alternative being Analyzed

Estimates of the input and output quantities and relationships as well as their costs and values are forecasts. In a basic project analysis, they are point estimates or "best guesses." Some of those estimates will be more critical with regard to their effect on the project's technical and financial viability. Those estimates need to be examined more closely. Some of those critical estimates will have known variable distributions (How many cords of firewood can be produced from a ton of roundwood?). These are risky estimates with distributions that can be analyzed either stochastically or with a sensitivity analysis. Some of the critical estimates may not have known distributions (What will wood pellet prices be in 10 years?). These are uncertain estimates and can only be analyzed using sensitivity analysis.

The feedback loops in the diagram (Fig. 7) show that variables both in the technical analysis and in the financial analysis are changed using both stochastic and sensitivity analysis to determine the impacts on the cash flows and measures of project worth. Once the risks and uncertainties have been analyzed, the project analysis should have sufficient information for a decision to be made regarding the project's likelihood of success or failure. In addition, and perhaps just as importantly, the risk and uncertainty analysis helps to show which of the input variables are most critical in affecting the project's overall viability.

A number of tools are available to aid in the construction of a preliminary financial feasibility analysis.

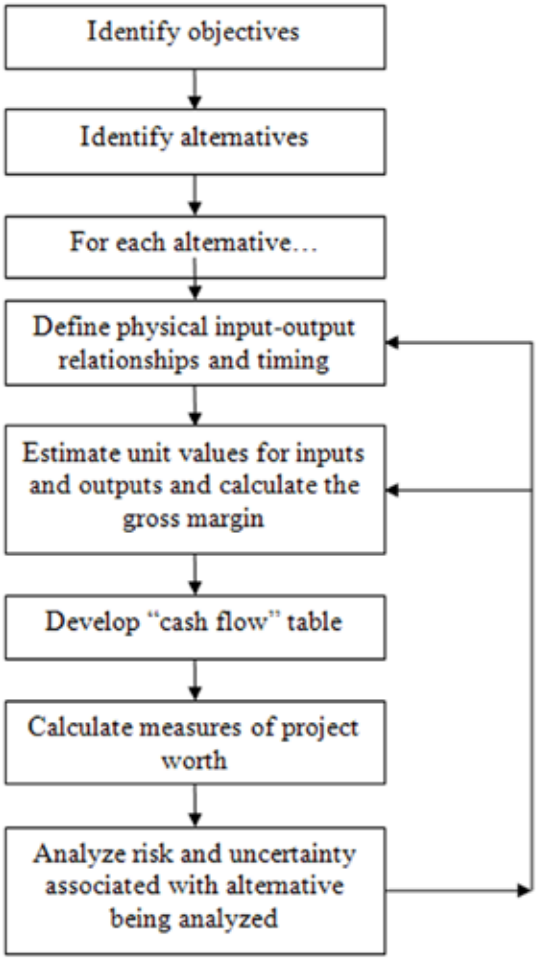

Figure 7—Steps in project feasibility analysis. Feedback loop shows uncertainty and sensitivity analysis.

Business Financial Feasibility Spreadsheet Tools

Downloadable financial feasibility and product recovery spreadsheets for sawmills and related forest products operations are available:

GRADEYIELD - Lumber Grade and Yield Studies for Analysis of Sawmill Profit-Potential

The easy to use spreadsheet program includes a step-by-step explanation of data entry to use the program itself, the manual primarily focuses on how to go about conducting lumber grade/yield recovery studies and on how to use of the GRADEYIELD spreadsheet program to perform analysis of data collected in a lumber grade/yield study and interpreting the results. Available from http://www.fwe.wisc.edu/extension/index.html

SAWFEAS - Sawmill Financial Feasibility

The SAWFEAS spreadsheet model allows the user to conduct preliminary financial feasibility analysis in the developmental planning of new sawmill operations and for preliminary financial analyses related to the acquisition of existing sawmill operations. Available from http://www.fwe.wisc.edu/extension/index.html

PROYIELD - Sawmill Yield Analysis

The PROYIELD model allows the user to project yields of lumber products and residuals generated in sawing individual logs and for user-defined log sample distributions, with user defined log, process and product assumptions. These data may be used in various types of analyses and projections including for data entry into the SAWFEAS Sawmill Financial Feasibility Analysis model. Available from http://www.fwe.wisc.edu/extension/index.html

Wood Fueled Boiler Financial Feasibility

The Wood Fueled Boiler Financial Feasibility program provides a starting point for interested parties to perform financial feasibility analysis of a steam boiler system for space heating or process heat. Available from http://forest.wisc.edu/entention/boilermanual.htm.

ChargeOut!

Cash flow analysis for logging equipment
Chargeout.xls analyzes the costs and returns for a single logging machine and may be modified to analyze any capital equipment purchase and is adaptable to other capital projects. Available from http://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr171/fpl_gtr171--chargeout.xls

LSY: Log Sort Yard Analysis

LSY (Bilek 2009) is specialized for the financial analysis of log sort yards. This template should only be used after it has been determined that there is a sufficient gross margin to make it worthwhile for a more detailed analysis of a sort yard's feasibility. A spreadsheet-based model, LSY (Logsort Yard Cash Flow Analysis), has been constructed to aid in the pre-feasibility and financial feasibility analysis of log-sort yards. It is meant to be referred to concurrently with this documentation. Both are available for downloading at no cost from the Forest Products Laboratory's website.

http://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr184/LSY3.01.xls.

http://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr184/fpl_gtr184.pdf

Another good related reference for LSY is the general technical report "Log Sort Yard Economics, Planning and Feasibility" by Dramm and others (2004) available at http://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr146.pdf

Although financial feasibility analysis is one of the Seven Critical Factors for Success, just because a project is financially feasible does not necessarily mean that it will be undertaken. There are two reasons for this. First, non-financial factors may come into the decision that cause a financially feasible project to be rejected. The second reason relates to capital budgeting, as sufficient funds may not be available to undertake all good projects.

Even if a project appears to be financially feasible, looks good in a full project analysis, and is undertaken, that does not guarantee that it will be a success. You still must achieve the rest of the Seven Critical Factors for Success (#5, a good management team and #7, safety, health, and environmental considerations). Despite the best plans, the project may not perform according to expectations or something may happen externally that will have an adverse effect on the project's cash flows. Good project planning can go far in reducing uncertainty and focusing management on the Critical Factors for Success. Armed with this kind preliminary feasibility results, project planners are in a position to begin an in-depth study of forest products enterprise feasibility, problems, and possible solutions in terms of several other critical factors.

Summary of Recommendations

The following is a brief summary of some suggested recommendations:

1. Hold state/regional workshops and provide technical information to enable entrepreneurs and small manufacturers to develop specialty products and markets.
2. Announce workshops such as the ***Southwest Sustainable Forest Partnership "Smallwood Entrepreneurial Conference,"*** that was held November 12–14, 2008, Northern Arizona University, Flagstaff, AZ.
3. Explore Stewardship contract partnerships such as with the Rocky Mountain Elk Foundation.
4. Provide technical assistance as needed:
   - Log sort yard and materials handling
   - Sawmill design and simulation, mill efficiency, sawmill technology
   - Biomass energy
   - Financial feasibility analysis
   - ChargeOut! model for equipment analysis
   - University of Wisconsin Forestry Extension business spreadsheet tools
6. Develop a regional biomass strategy and briefing paper.
7. Provide contact information for
   - Biomass Extraction studies
   - Pellet mill feasibility studies
   - Lake States Loggers for doing mechanized fuels reduction work
8. Provide contact information for Forestry Operations Research:
   - Forestry operations (fuels reduction, thinning, harvesting, roll off containers, etc.)
   - Small scale logging systems and equipment
   - Log and biomass transportation
   - Forestry/Logging Safety
9. Amend Renewable Fiber, Inc.'s original grant agreement to include a shavings bagger.
10. Focus on the "Green Tree Issue" and stay ahead of the bug infestation. How can you make the biggest impact on controlling the bugs? Leave the red and dead and treat the green stands before the bugs attack.
11. Provide landowner education, hold log sort yard open houses, and be aware of temporary yard location issues.
12. Make available a log loader and other forestry equipment to contractors.
13. Follow-up visits to Forest Products Laboratory.

For More Information

For more information, contact the Technology Marketing Unit (TMU) at the Forest Products Laboratory, Madison, Wisconsin. Send requests to TMU, Forest Products Laboratory, One Gifford Pinchot Drive, Madison, WI 53597-2398 or call (608) 231-9504. Refer to Appendix III—Technical Assistance Contacts. The TMU homepage address is www.fpl.fs.fed.us/partners/tmu/index.shtml.

The FPL also has a website with more than 5,000 publications available electronically online at http://www.fpl.fs.fed.us/. FPL publications can also be found by Internet search engines. Use keywords (log sort yard, small diameter utilization, forest fuels reduction, small logging equipment) in your search.

Literature Cited

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Appendix I—Technical Assistance Visit (TAV) Itinerary

Dubois, Wyoming

Monday, September 8, 2008

Meeting with Dubois–Crowheart/Teton project partners
- Introductions
- FPL presentation: "Log Sort Yards"

Field visits to Dubois–Crowheart/Teton project with project overview
- Wyoming Logsmiths (Tim Rogers) – log home manufacturer
- Eliason Logging (Ron Eliason) – log sort yard, Woodmiser sawmill, and firewood processor (co-located next to Ron's operation)
- Union Pass WUI biomass project and biomass collection/disposal yard (Rick Metzger, USFS) with discussion of the Rocky Mountain Elk Foundation's role in stewardship agreements (Al Christophersen)

Afternoon meeting for group discussion, Q&A, and closeout
- Small-diameter opportunities
- Forest Products Laboratory resources and sources of technical assistance
- Mark Harrison, Mayor of Dubois, discussed effect of work force needs on the community, specifically on the school system
- Upper Wind River Biomass Co-Generation Project Feasibility Study
- Greenhouse feasibility study
- Louisiana Pacific (LP) sawmill site east of town and potential for district heating, and LP sawmill site visit east of Dubois

Saratoga, Wyoming

Tuesday, September 9, 2008

Meet the Saratoga–Encampment–Rawlins Conservation District partners (Arla Strasser)

Project discussion
- Medicine Bow–Routt NF discussion of available log and biomass supply (Phil Cruz, Steve Best, and timber and inventory staffs)
- Saratoga sawmill project and startup overview (Arla Strasser and Dan Perko)
- Encampment partnership project and proposal for "FPL Partnership" grant (Arla)

FPL presentations on marginal sawlog problem, wood energy, and project feasibility
- Seven Critical Factors for Success (Rusty Dramm)
- The "Marginal Sawlog Problem" (Rusty Dramm)
- Biomass/Wood Energy (John Zerbe)
- Project feasibility analysis (Ted Bilek)

Technical assistance needs (group discussion)
Other notes and discussion by
- U.S. Senator John Barrasso's office (Sandy DaRif)
- GeoSynFuels (Tim Spilchen), Green Bay, WI
- Carbon Power (Russell Waldner)

Front Range in Colorado

Wednesday, September 10, 2008

Meeting with Front Range biomass collection yard projects at Boulder County Fairgrounds
- Introductions (Craig Jones, Colorado State Forest Service)
- Review "Partnership" grant and long-term goals/objectives, implementation, project challenges
- FPL presentations

Field visits to Front Range utilization and marketing partners
- Tour of Boulder County's district heating facility (cancelled – not enough time)
- United Wood Products mill tour and discussion
- Renewable Fiber facility – tour and discussion on Woody Biomass Utilization Grant modifications

Review long-term project of the Rooney site in Jefferson County

Front Range in Colorado

Thursday, September 11, 2008

Field visits to Estes Park, Meeker Park, and/or Gilpin County sites

- Visit Estes Park biomass collection yard and discussion
- Meeker Park site visit
- Tour Salvation Army camp's Tarm wood heating system
- Tour Gordan Gulch Stewardship Contract project – review stewardship contracting plans for Front Range (Dan Len)
- Gilpin County biomass collection yard
- Tour Gilpin County biomass heating facility at the county shops

Session wrap-up, Q&A, and closeout Len, Perko, and Ford
- Review the week's visit and first impressions
- Schedule follow-up conference calls to review progress and follow-up actions

Appendix II—Technical Assistance Visit (TAV) Participants

Forest Products Laboratory
TAV Team Members
Madison, Wisconsin

Ted Bilek, Economist
Rusty Dramm, National Sawmill Specialist
John Zerbe, Wood Energy Specialist

Dubois, Wyoming
Monday, September 8, 2008

Stephanie Bason, Partnership Coordinator
Dubois–Crowheart Conservation District

Scott W. Bell, Rural Community Assistance Coordinator,
U.S. Forest Service Region 1 and 4

Al Christophersen, Director of Habitat
Stewardship Services, Rocky Mountain Elk Foundation

John Crisp, Resource Forester
Wyoming State Forestry Division

Ron Eliason, Owner
Eliason Logging

Ruth Esperance, District Ranger
Shoshone National Forest

Mark Harrison, Mayor
Town of Dubois, Wyoming

Gayle Hinschberger, District Coordinator
Dubois–Crowheart Conservation District

Ellen Jungck
Shoshone National Forest

Roger Leseberg
TY Construction

Rick Metzger, District Ranger
Shoshone National Forest

Paul Morecency
Wyoming State Forestry Division

Dan Perko, Deputy State Forester
Wyoming State Forestry Division

Tim Rogers, Owner
Wyoming Logsmiths

Dave Riebe
Dubois, Wyoming

Randy Spiering
Shoshone National Forest

Dana Stone, District Forester
Wyoming State Forestry Division

Randy Williams, Executive Director
Teton Conservation District

Saratoga, Wyoming
Tuesday, September 9, 2008

Steve Best, District Ranger
Medicine Bow-Routt National Forests and Thunder Basin National Grassland

John Crisp, Resource Forester
Wyoming State Forestry Division

Phil Cruz, Deputy Forest Supervisor
Medicine Bow–Routt National Forests and Thunder Basin National Grassland

Sandy DaRif
U.S. Senator John Barrasso's Office

Mark Drucker
Carbon County Economic Development Council

Nancy Fishering,
Intermountain Forest Products
Intermountain Resources, LLC

Chris Meyers,
Intermountain Forest Products
Intermountain Resources, LLC

Daniel Mika, Vice Chairman
Saratoga—Encampment—Rawlings
Conservation District/City of Rawlins

Jerry Paxton, Vice Chairman
Carbon County Commissioners

Dan Perko, Deputy State Forester
Wyoming State Forestry Division

Matt Scott, Resource Specialist
Laramie River Conservation District

Tim Spilchen, Business Development Manager
GeoSynFuels

Arla Strasser, Resource Specialist
Saratoga–Encampment–Rawlings Conservation District

Russell Waldner, Director of Engineering Services, Carbon Power and Light

Randy Williams, Executive Director, Teton Conservation District

Front Range, Colorado
Wednesday/Thursday, September 10 and 11

Amanda Bucknam, Research Associate
Colorado State University
Colorado Wood Utilization and Marketing Program

Raul Bustamante, Owner
United Wood Products, Inc.

Brian Davis, Wood Utilization and Marketing Assistant, Colorado State Forest Service

Joseph A. Duda, Forest Management Division Supervisor, Colorado State Forest Service

Susan Ford, Urban and Community Forestry Specialist, Cooperative Forestry, Rocky Mountain Region

Scott Golden, Forestry and Biomass Specialist, Parks and Open Space

Craig Jones, Biomass Specialist, Colorado State Forest Service

Dan Len, Vegetation Management Program Manager, Arapaho and Roosevelt National Forests

Dave Lentz, Forester
Larimer County, Fort Collins, Colorado

Kurt Mackes, Harvesting and Wood Products Utilization Department of Forestry, Rangelands, and Watershed Stewardship, Colorado State University, Fort Collins, Colorado

Mountain Pellet Company Inc.
Walden, Colorado

Earl Robinson, Director Road and Maintenance Department, Gilpin County, Colorado

Wes Rutt, Committee Member
Colorado State Tree Farm

Matt Schulz, Forest Management and GIS Coordinator
Colorado Parks and Outdoor Recreation

Carl Spaulding, Special Projects Manager
Renewable Fiber, Inc.

Jeff Thomas, Campaign Coordinator
Colorado Forest Products

Joe Turner, Site Manager
Peak to Peak Wood

John Twitchell, District Forester
Colorado State Forest Service

Wade Yates, Special Projects Coordinator
Development and Transportation Department

Appendix III—Technical Assistance Contacts

Woody Biomass Utilization Grants Program (Forest Service grant opportunity)

Susan LeVan, Program Manager
S&PF Technology Marketing Unit
Forest Products Laboratory
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Sawmilling; Lumber Recovery; Size Control; Sort Yards; Preliminary Feasibility

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Feasibility Analysis; Business Financials; Economics

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Wood Energy

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Roundwood Structures, Wood Energy

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S&PF Technology Marketing Unit
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Forestry Operations: Harvesting, Transportation, Safety

Bob Rummer, Forestry Operation Project Leader
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Regional Forest Service Contacts

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Stewardship Contracting; National Forest System

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Forest Fuels Reduction Operations; Fire Ecology

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State Forestry Programs

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Craig Jones, Biomass Specialist
Colorado State Forest Service
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Phone: 303-443-2088
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Biomass Extraction Study; Pellet Mill Feasibility; Lake States Logging Contractors

Don Peterson, National Sawmill Specialist
Timber Ridge Energy Enterprises, Inc (TREE)
1353 W. Highway US 2, Suite 2
Crystal Falls, MI 49920
Phone: 877-284-3882
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Preliminary Business Feasibility Spreadsheet Tools

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Conversion Table

English	Conversion factor	SI unit
Btu	$1.055\,056 \times 10^3$	joule (J)
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.305	meter (m)
cubic feet (ft^3)	0.0283	cubic meter (m^3)
board feet	0.00236	m^3 (nominal)