ENERGY CENTER OF WISCONSIN

WOOD PELLETING IN INDIANA: FEASIBILITY ANALYSIS

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Executive summary

The underutilized wood resource in Indiana presents many opportunities to create value-added products. This paper considers the appropriateness of pelleting this wood to create a heating fuel. Indiana's primary wood processing industry generates 1.3 million tons of green residues per year, an estimated 98 percent of which is put to some profitable use. The volume of residues generated by the secondary wood processing industry is less well understood, although the percentage being used is also believed to be very high. Current applications for this wood resource include heating fuel, mulch, landscaping, animal bedding and even pulpwood.

We estimate that a pellet mill will be profitable if it can get pellet-quality wood at $30 per ton for green and up to $79 per ton kiln-dried, which is higher than any spot price observed during this study—some mills are even paying to dispose of this wood waste. It appears that a pelleting operation could compete successfully for these residues drawing these feedstocks away from other uses. Additional sources of pelletable wood include harvest residues and wood collected by construction and demolition recycling companies, although the practicality of this wood supply for pelleting is largely untested.

The primary market for wood pellets is residential heating. Pellets can be burned in most boilers with modifications, but the primary appliance is the pellet stove. There are 100,000 pellet stoves estimated to be installed in the Great Lakes region (Wisconsin to Ohio), and a surge in stove sales occurred in 2005, with its cold winter and hurricane-related infrastructure damage. Pellets are starting to make in-roads into the commercial market, but industrial and utility use will likely require a dedicated mill producing a pellet unique to that facility.

We model a pellet mill and provide a pro forma income statement for the mill under various scenarios. The model demonstrates that:

- The limiting factor for mill size is the secure supply of wood residue.
- Feedstock costs—both to make the pellets and to dry the green wood—account for 75 percent of the mill's expenses, and the mill becomes significantly more profitable as feedstock prices fall.

We place our theoretical mill in Morgan county in order to attach it to real-world inputs such as wood residue generation and the concentration of owner-occupied homes without natural gas. However, no site in Indiana seems particularly unsuited for a pellet mill. The single most important factor for site placement is the presence of residue suppliers who are committed to providing a consistent resource at a stable, workable price—a task we believe will be made considerably easier by a cooperative business structure. As such suppliers are found, this document and its associated tools will allow the Indiana Cooperative Development Center to model a facility in that area.

Introduction

Local uses of biomass provide multiplicative benefits to any economy, and, through smart design, can deliver environmental benefits as well. When used to create energy or fuel, biomass displaces fossil fuels which are often imported from out-of-state, creating a more valuable product for the state's biomass producers and preventing energy dollars from leaving the state.

Indiana has a vast forest resource. The state's wood industry harvests 480 million board feet annually, with 601 firms in the primary wood industry (logging, sawmills, etc.) adding $1.18 billion in value to the state's economy, and 509 firms in the secondary wood industry (furniture, flooring, etc.) adding $1.58 billion to the state's economy.[1] The underutilized wood residues from these industries are promising biomass resources.

One application for wood wastes is wood pellets. Wood pellets are an emerging heating fuel, with an estimated 800,000 U.S. homes currently using pellets for heat.[2] Because of the simplicity and scalability of a pelleting operation relative to other biorefining technologies, a pellet mill is a here-and-now solution that can not only generate revenue, but will also subsidize tasks such as the development of an aggregation, transportation and market infrastructure. Such work can be fruitful both now and in the future, as Indiana's innovators use new technology to find increasingly sophisticated and valuable uses for the state's biomass.

Wood pellets

Wood pelleting is a decades-old technology in which wood wastes are ground and densified into uniform, dry pellets. Wood pellets have a heating value of 16.5 MMBtu per ton, compared to 5.7 MMBtu per ton for green (wet) wood. Wood pellets compete favorably with most other forms of residential heating.

[1] 2003. "Indiana Wood Industry Facts." Purdue University Wood Research Laboratory. Available online at http://www.agriculture.purdue.edu/fnr/woodresearch/industry.html (accessed March 2007)
[2] "What is Pellet Fuel?" Pellet Heat Institute. Available online at http://pelletheat.org/3/residential/index.html (accessed March 2007)

Table 1. Breakeven price of residential heating fuels

Heating fuel	**Unit**	**Heat content per unit (Btu)**[3]	**Eff.**[4]	**10-year average price per unit (2006 dollars, national)**[5]	**Cost per MMBtu**	**Estimated 2007 prices (2007 dollars, Indiana)**[6]	**Cost per MMBtu**
Natural gas	MCF	1,031,000	0.78	$9.72	$12.09	$10.62	$13.21
Electric (baseboard)	kWh	3,412	0.99	$0.10	$29.60	$0.08	$23.68
Propane	gal	91,333	0.78	$0.64	$8.98	$1.87	$26.25
Fuel oil (no. 2)	gal	138,690	0.78	$0.63	$5.82	$2.10	$19.41
Wood	cord	20,000,000	0.6	--	--	$150	$12.50
Wood pellets	ton	16,500,000	0.8	--	--	$175	$13.26

A 2005 nationwide study by the RAND Corporation shows that while the relationship between demand and energy prices has been small and therefore relatively inelastic over the past 20 years, there are signs in recent years that things are changing. While not enough time has passed in order to statistically measure these effects, there is inconclusive evidence that rising fuel prices have negatively impacted demand growth. The study also finds that the East North Central region (which includes Indiana) has the most inelastic demand response for residential electricity, which is significant for this study given the prevalence of electrically heated homes.[7]

The primary pellet market is residential, and the primary appliance for the consumption of pellets is the pellet stove. These stoves are typically 80 percent efficient and fit comfortably into a home's existing HVAC framework. They have been designed for ease

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[3] 2007. "Heating Fuel Comparison Calculator." US DOE Energy Information Administration. Available online at www.eia.doe.gov/neic/experts/heatcalc.xls
[4] Ibid.
[5] Based on data from "State and U.S. Historical Data." US DOE Energy Information Administration. Available online at http://www.eia.doe.gov/overview_hd.html
[6] Various sources, including EIA and census data.
[7] Bernstein, Mark A. and James Griffin. "Regional differences in the price-elasticity of demand for energy." The RAND Corporation. Available online at http://www.rand.org/pubs/technical_reports/2005/RAND_TR292.pdf

of use and require little maintenance other than the removal and disposal of ash. An installed pellet stove costs a homeowner about $1,000 to $5,000, depending on the size and type of stove, installation considerations and the amount of labor hired for installation. In addition to pellet stoves, homeowners can use pellets in traditional wood stoves by using an insert. Pellets can also be used in a commercial or industrial boiler if they are retrofit with the appropriate components.

Pelleting facilities and technology

A pellet mill can use green or dry wood. If not already separated into chips and sawdust, the residues pass through a screener and the chips are ground before rejoining the sawdust. The wood is then dried to approximately 8 percent moisture, most commonly using a biomass burner that takes advantage of any wood waste.[8] In some operations, the sawdust may be screened again to separate coarse and fine sawdust prior to the coarse sawdust going into the hammer mill. In others, all sawdust is processed in a hammer mill to bring it to a uniform fine consistency. This sawdust goes into the pellet mill to create pellets, and the pellets are then cooled. Those pellets that are going to be sold in bags are then bagged, and all pellets are stored until they are transported to a distributor or retail location. The economics of these facilities will be discussed in a later section.

Pellet mills can operate at multiple sizes. Jim Wikle of Roskamp/CPM, which manufactures its California Pellet Mill products in Crawfordsville, says that 1 ton per hour is the “ragged edge” of feasibility (7,000 tons per year if run 24/7 with 15% downtime), and recommends 4 tons per hour (30,000 tons per year) if possible.[9] Luann Lafreniere of New England Wood Pellet says that, going forward, their company only wants to operate mills that produce 100,000 tons per year or greater, which, under these operating assumptions, would mean at least 13 tons per hour.[10] A 2005 study found that for biomass pellet mills, the economies of scale measured in lowered cost per ton flattens above 11 tons per hour.[11] A basic estimate for on-site labor is two people to run the mill[12] and three people to run a non-automated bagging line for a 4 ton/hr plant.[13,14]

We are only beginning to see a turnkey market emerge, where a fully engineered facility is being offered with all of the necessary components are optimized for the desired design. Industrial TurnAround Corporation of Virginia is working on its first mill, Dixie Pellets, a 500,000 ton per year mill in Selma, Ga.[15] New England Wood Pellet is currently developing its turnkey plant fabrication facility. Lafreniere of New England

[8] To create wood at 8 percent moisture, we assume that we begin with green wood that is roughly equal parts wood and water by weight. Given a ton of green wood, we estimate that you will need to drive off 913 lbs of water to get 1,087 lbs of wood at 8 percent moisture.
[9] Interviews and correspondence with Jim Wikle, March 2007.
[10] Interviews and correspondence with Luann Lafreniere, April 2007.
[11] Mani, S., et al. 2006. “Economics of producing fuel pellets from biomass.” Applied Engineering in Agriculture, vol. 22(3). American Society of Agricultural and Biological Engineers. Abstract online at http://asae.frymulti.com/abstract.asp?aid=20447&t=2
[12] Ibid.
[13] Ibid.
[14] Wikle 2007.
[15] Interviews and correspondence with Steve Gordon, ITAC Engineers & Constructors, April 2007

Wood Pellet says her company's design will accommodate all scales of production and will manufacture all its own equipment. Although New England Wood Pellet operates a 75,000 ton per year plant, neither company has an operational mill yet based on its turnkey design. Both believe the integrated engineering of their design will make efficient and cost-competitive plants.

From a regulatory perspective, a pellet mill would be comparable to any other primary or secondary wood processing facility in Indiana. The biomass burner should be comparable to any wood boiler.

Pellet standards

Today, pellets occupy a place that is relatively rare in the world of emerging value-added uses of biomass residues: an established market with clear quality standards which has facilitated the adoption of pellets. These standards have been established and promoted by the Pellet Fuels Institute (PFI), the major industry association serving pellet manufacturers. The standard covers density (>40 lbs./cu.ft.), dimensions (max 1 ½" length, $^{1}/_{4}$"-$^{5}/_{16}$" diameter), fines (from pellet breakdown, <0.5 percent by weight) and chlorides (300 ppm); they differ only in ash content. *Premium* pellets have less than 1 percent ash content, and *standard* pellets have less than 3 percent ash content. PFI recommends in-plant and independent testing for these standards. The nearest independent laboratories recommended by PFI are American Interplex Corp. Laboratories in Little Rock, Ark., Envirocompliance Laboratories in Glen Allen, Va., Interpoll Laboratories in Circle Pines, Minn. And Twin Ports Testing in Superior, Wis.[16]

Since the primary market for wood pellets is as a residential heating fuel, the premium pellet dominates US market share, because its lower ash content means less maintenance, such as ash removal and reduced need to clean soot from the viewing glass attached to the firebox.

Two other pellet quality designations have been discussed. A *super-premium* pellet would have less than ½ percent ash, and a *utility* pellet (which could be densified into a larger shape than a pellet, and for this reason is sometimes called a cube) could have as much as 6 percent ash.

The industry has yet to see significant movement on these new grades of pellet. It is uncertain whether there is any market demand for a more expensive pellet with less ash than the current premium pellet; pellet stove retailers contacted for this study were unanimous in saying that customer satisfaction with the stoves is high, and that customers have not complained about the amount of maintenance or ash disposal their stoves required.

Utility pellets are a promising opportunity because they would allow ashy but calorific forms of wood, such as bark or long-dead trees, to be made into pellets. For residential pellet stoves, these pellets would generate too much ash to be attractive, but for a

[16] "Industry specifics." Pellet Fuels Institute. Avaliable online at http://www.pelletheat.org/3/industry/index.html

commercial, industrial or utility-scale biomass boiler with automated ash handling capability, the cost savings associated with these lower quality pellets may justify the increased maintenance and disposal costs the additional ash would require. However, the above breakeven prices do not apply to the industrial market, and for the same reasons that they can accept a higher-ash pellet, it has not been demonstrated that they have an incentive to burn pellets whatsoever, relative to any other less expensive wood waste. (Because they are so dry, pellets release more useful energy than other wood fuels, but whether that benefit justifies their cost must be compared on a case-by-case basis.) Both T.J. Morice of the Pellet Fuel Institute (an industry trade group) and Jim Wikle of CPM suspect that for the near future, any industrial or utility customer interested in pellets as a heating fuel will either create their own pellets or serve as the sole customer of whichever pellet mill would supply them. "Utilities are basically one-off deals," Wikle said. "If you want to deal with this utility, they basically need to buy all of your product. Their boilers are going to be different than the utility down the road, or one in another state …. You'd have a die for each one of your customers." [17,18]

Pellet market and supply

Fewer than 100,000 pellet stoves are believed to be in the Great Lakes region (Illinois, Indiana, Michigan, Ohio and Wisconsin), with more than 15,000 stoves shipped to area retailers in 2005 and more than 14,000 shipped by the end of September 2006.[19] These installations are presumed to be primarily in rural areas. Members of the Pellet Fuel Institute, which does not include all pellet mills, shipped 1.0 million tons of pellets in 2005, which is an increase of 61 percent over 2000.[20] The confluence of a cold winter and the disruptions in fossil-fuel infrastructure during hurricane season caused a surge in wood pellet popularity in 2005, to the extent that pellets were sometimes scarce at retail outlets. The region saw a milder winter with more stable fuel prices in 2006, and most pellet mills and stove suppliers contacted during this study indicated that stove sales were not as strong, although pellet sales tended to be as good and were in some cases better than 2005 because the supply was more consistent.

Pellets can either be sold bagged or bulk. Bagged pellets can be sold wholesale to retailers or can be sold directly to consumers if the pellet mill has a retail presence. Bulk pellets typically must be picked up on-site or delivered. For instance, Marth Wood Products of Wisconsin delivers pellets to some of its commercial customers, but notes that because of the relatively short tenure of the average US homeowner in any given house, few people will invest in a mechanism that will allow for the easy transfer of pellets from the truck to a storage facility in the residence near the stove, although such practices are being adopted in Europe.[21] To our knowledge, no pellet mill is delivering bagged pellets to residences.

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[17] Interviews and correspondence with T.J. Morice, January and March 2007.
[18] Interviews and correspondence with Jim Wikle, March 2007.
[19] Interview with Leslie Wheeler, Director of Communications, Hearth, Patio and Barbecue Association. January 2007.
[20] Morice 2007.
[21] Ibid.

An Indiana-based pellet mill will have to consider many markets.

Indiana

The breakeven prices shown in Table 1 suggest that residences heated by anything but natural gas may be amenable to making the switch to wood pellet heating.[22] If we consider only owner-occupied housing (given that landlords are unlikely to install a pellet stove in a leased property), 32 percent of homes have a main heating fuel besides natural gas. That suggests that as much as a third of Indiana's owner-occupied homes could benefit from a switch to wood pellets. While this is a tall marketing task, it also represents a clear and present opportunity that justifies interest in manufacturing wood pellets.

The relevant 2000 census data about Indiana homes and primary energy sources is included in its entirety in Appendix B. The following map and table present highlights of the census data.

[22] It is worth noting that there are two factors at work here—both the general appeal of wood pellets and the natural end-of-life replacement of home heating equipment. It is quite conceivable that someone would have both a pellet stove and another space heating system in their house, with one supplementing the other or with the homeowner switching fuels depending on their relative price.

Figure 1. Owner-occupied homes in Indiana whose primary heating fuel is not natural gas (2000 Census)

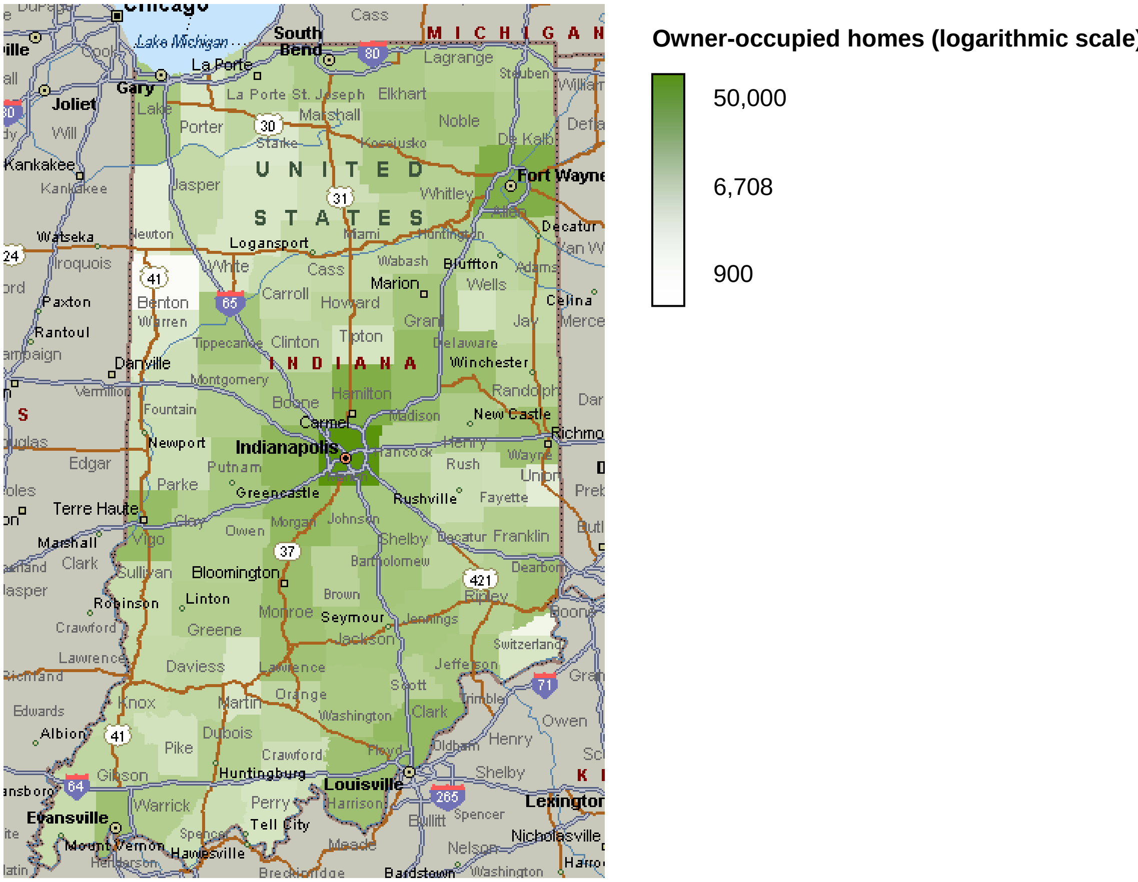


Table 2. Top 5 Indiana counties by number of owner-occupied homes by selected primary heating sources (2000 Census)

County	Occupied housing units	Owner-occupied housing units	Owner-occupied housing units without natural gas as primary heating fuel
Marion	352,164	208,932	46,001
Hamilton	65,933	53,344	17,923
Allen	128,745	91,394	16,598
Hendricks	37,275	30,919	12,865
Morgan	24,437	19,472	11,087

Domestic

The price and quantities of the U.S. domestic market for pellets are difficult to predict. Because the pelleting process almost always involves the transport of green wood, a distributed network of pellet producers that allows processing to take place as near as possible to the feedstock is desirable, and this may in turn spawn a similarly local retail market for each producer's pellets. Such a scenario would put a low value on exporting pellets from Indiana to a neighboring state. Currently, however, pellet mills primarily supply third-party retailers with product, including such chains as Home Depot, Tractor Supply Company and Menards. These retailers, who especially prize consistent product quality and consistent supply, face two opposing incentives: the simplicity of minimal supplier contracts, and the cost of shipping pellets nationwide from a single supplier. When asked about the supply of wood pellets available at Menards locations in Indiana, Dan Loeb, one of Menards' principal buyers, said, "If I could find a supplier in Indiana, it would be something I would consider. It comes down to the availability and consistency of their products. It's easier to manage one relationship than multiple, but freight is a huge cost."[23]

This provides two opportunities for a pellet mill to partner with a national retailer: serving as their primary source of wood pellets for all locations, and providing their local outlets with local product. Menards currently has one main supplier of wood pellets, but more than 10 percent of all pellets sold at Menards comes from supplemental suppliers.[24]

In terms of specific domestic markets, the West was the only region considered "open" in the 2006-2007 heating season. The slowdown in home construction reduced the demand for dimension lumber, which in turn reduced the amount of sawdust produced by sawmills. Therefore pellets were in short supply in the west in 2006-07. But the higher prices available were offset by the high cost of freight. On the other hand, most, if not all, of Indiana's neighboring states are pursuing wood pellet production with similar vigor, so a new Indiana operation is unlikely to have any first-mover advantages in the region, meaning that in those markets, Indiana pellets would need to compete on such factors as price, reliability and quality.

International

The export market for pellets remains compelling. While European entrepreneurs responded to the same market forces that caused the 2005 surge in US pelleting start-ups, brokers remain enthusiastic about sending pellets overseas. Duane Splan of Bay Lakes Companies, LLC in Oconto Falls, Wis. stated that he felt he could sell his biomass pellets to Europe for roughly $125-150 per ton F.O.B. He estimated that additional shipping costs to Europe were about $50-60 per ton.[25] One factor that helps justify this additional freight cost is the Kyoto Protocol observed by the European Union, which prizes low-carbon heating fuels such as pellets and uses them year-round in combined heating and

[23] Interview and correspondence with Dan Loeb, January 2007.
[24] Ibid.
[25] Interview and correspondence with Duane Splan, March 2007.

power facilities. Any overseas customers could presumably be served by shipping from the Port of Indiana or by shipping the pellets to another state's port.

Other markets and products

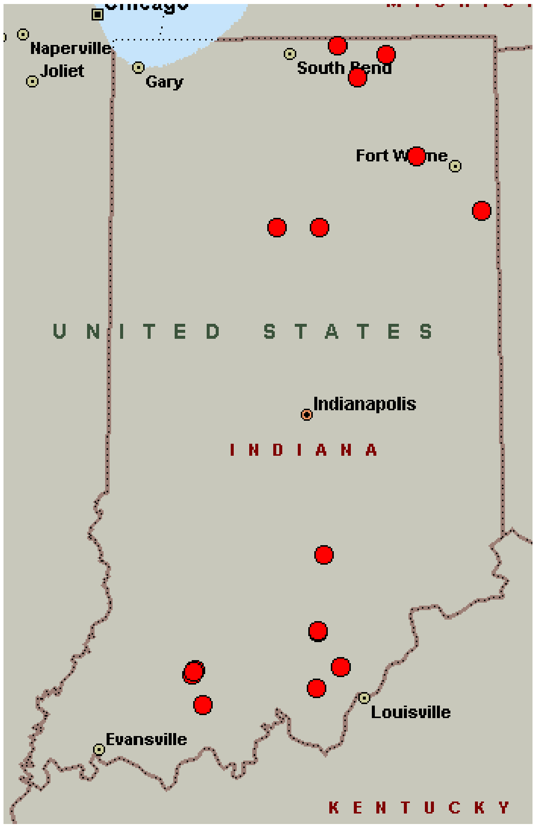
Any biomass processing facility is aided by the presence of multiple product lines, and this is especially true of pellet mills because heating fuel is a seasonal market. One currently operating Indiana pellet mill expects to fill two 25,000 sq. ft. warehouses over the summer. Many of the larger and more successful pellet producers in the region—including Fiber By-Products and Koetter & Smith, Indiana's two principal producers—added pelleting as part of a larger portfolio of managing industrial wood waste. Related services and products provided by many such companies prior to their entry into the pellet market include trucking wood residues away from other wood processors and selling wood residues as such products as chips, sawdust, mulch and wood flour, for uses ranging from landscaping to plastics manufacturing. This diverse product mix is a hedge against a drop in fossil fuel prices.

Pellets themselves need, and have, notable uses apart from residential heating. One major use is as animal bedding. Wood pellets have emerged as a premium equestrian bedding because they are easy to handle and long-lasting. Once part of the stall has been soiled, the exact area affected is readily apparent and can be extracted, whereas typical bedding such as wood shavings does not allow such discrete removal, therefore causing unused volumes to be discarded. One pellet manufacturer sells pellets marketed for bedding at the same price as heating pellets, noting that some competitors charge more for bedding pellets. This manufacturer's bedding product differs slightly from the heating pellets in that the bedding pellets are engineered to have slightly higher moisture content so that they break apart easier.[26]

Another use for pellets would be as a peaking fuel for biomass boilers, although many require some modification to be able to use them. While wood pellets are offered at a premium price relative to other biomass that can be used in these boilers, they also offer a significantly greater heating value. Figure 2 shows wood-burning boilers in Indiana.

[26] Inteview and correspondence with Jordan Thiessen, Dansons Group Inc. March 2007.

Figure 2. Wood-burning boilers permitted in Indiana[27]



Wood can also be used as a feedstock to produce chemicals, and pellets can offer a very consistent wood feedstock. While progress in this area remains speculative, one intriguing possibility is the production of methanol from wood pellets, and specifically the possibility of creating just-in-time methanol at a biodiesel facility or other methanol consumer. Methanol is very toxic, reducing the viability on-site storage of significant quantities, and so a just-in-time manufacturing process may be ideal. On a related note, some are investigating the use of glycerin—a major waste product from biodiesel production—as a lubricant for the pellet mill. The commercial use of wood pellets for chemicals is still under development, but we believe that there are concerted efforts to unlock these possibilities.

Indiana's wood residue resource

All manner of wood processing yields residues, from treetops left in the forest to kiln-dried fine sawdust. We will characterize Indiana's wood resource by looking at mill residues, harvest residues and other sources.

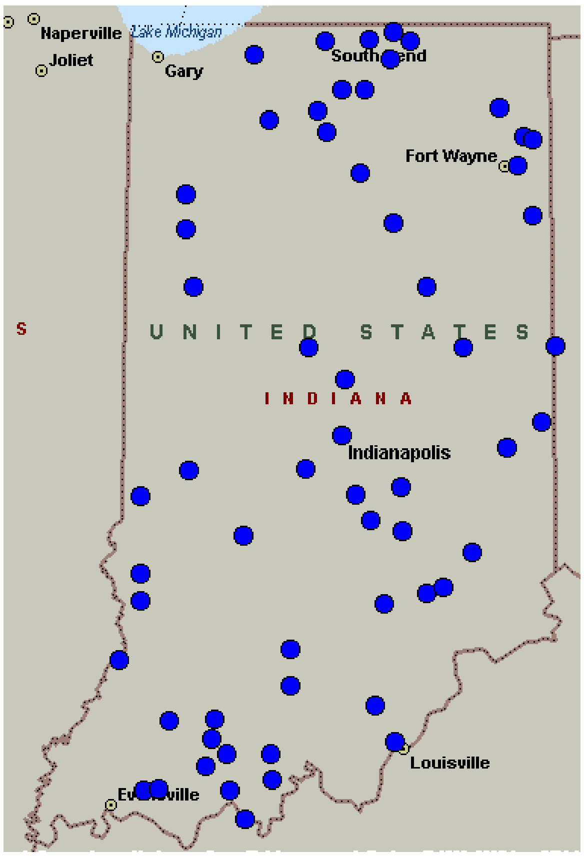
Mill residues

Any wood-using industry must be especially sensitive to wood residues—sawdust is considered a health hazard, so every wood processor has already addressed the collection

[27] Data from Jeff Settle, Indiana Forest Resources Information

and off-site transportation issues that are fundamental when trying to economically add value to biomass. It should also be noted that mill residues are not necessarily waste streams—many mills have found markets for at least some of these residues, including landscaping, durable goods and heat and power generation. Figure 3 shows all of the Indiana businesses with wastewater permits with wood industry SIC codes; this is the permit that covers the generation and disposal of sawdust.

Figure 3. Indiana facilities in SIC major group 24 with general wastewater permits[28]



The broadest estimate of green wood residue production from primary mills comes from the USDA Forest Service's 2000 assessment of the Indiana timber industry, which states that 1.3 million green tons of residues are generated annually, and that only 22,000 of these tons go unused.[29] This data is based on their Timber Product Output (TPO) survey; data from the 2000 survey is the most recent available. The Forest Service collaborates with local agencies to ensure feedback from all respondents, resulting in a response rate "pretty close to 100 percent," according to Forest Service analyst William Reading.[30] He

[28] Data from Alison Beumer, Indiana Department of Environmental Management.
[29] Piva, Ronald J. and Joey Gallion. 2003. "Indiana Timber Industry—An Assessment of Timber Product Output and Use, 2000." USDA Forest Service, St. Paul, Minn. Available online at http://ncrs.fs.fed.us/pubs/rb/rb_nc216.pdf
[30] Interview and correspondence with Bill Reading, January 2007.

acknowledges that some of the numbers in the survey are estimates made by parties other than the suppliers based on established formulas and previous years' numbers, and also notes that the TPO's emphasis on the mill residue portion of the survey has declined in recent years. Nevertheless, the survey is the most complete of its kind. In order to protect the confidentiality of the businesses surveyed, the information is only available by county or, to ensure anonymity in cases when there are too few mills in a given county, by county cluster. Responses are broken down by whether the wood is hardwood or softwood; whether the residue is fine, coarse or bark; and whether the residue is used at the mill for fuel, used for fiber products, used for residential heating, for other miscellaneous uses, or is not used. In surveys such as this, analysts must watch for "socially desirable" responses—in this case, perhaps a mill underreporting its amount of waste, or the amount of its waste that is "not used." Reading notes that there have been no studies about the TPO survey regarding any such effects.

A complete summary of Indiana's portion of the TPO survey can be found in Appendix C. The following tables and maps present highlights of the survey's findings. To protect mill anonymity, some counties are combined into clusters.

Figure 4. Green tons of Indiana primary mill residues by combined county region (Forest Service TPO)

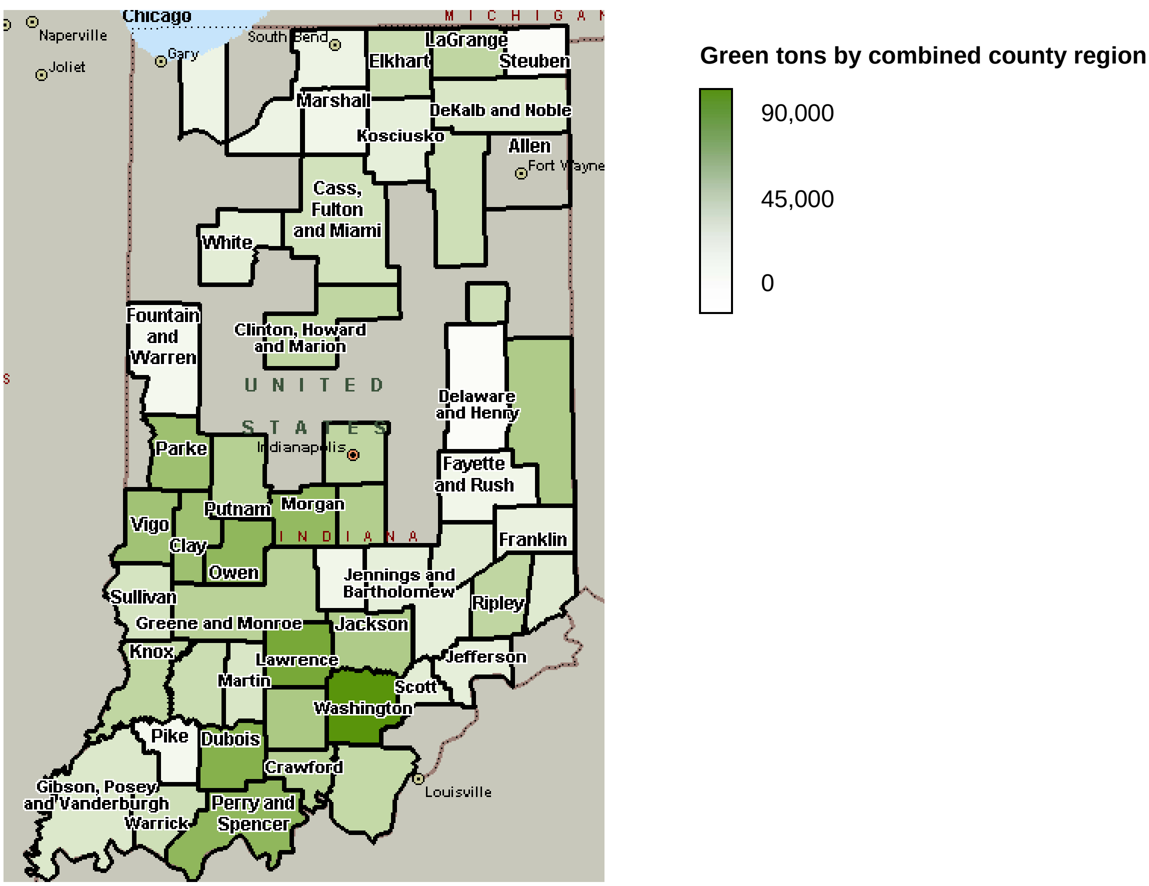


Figure 5. Green tons of Indiana primary mill residues per owner-occupied home without natural gas by combined county region (Forest Service TPO, 2000 Census)

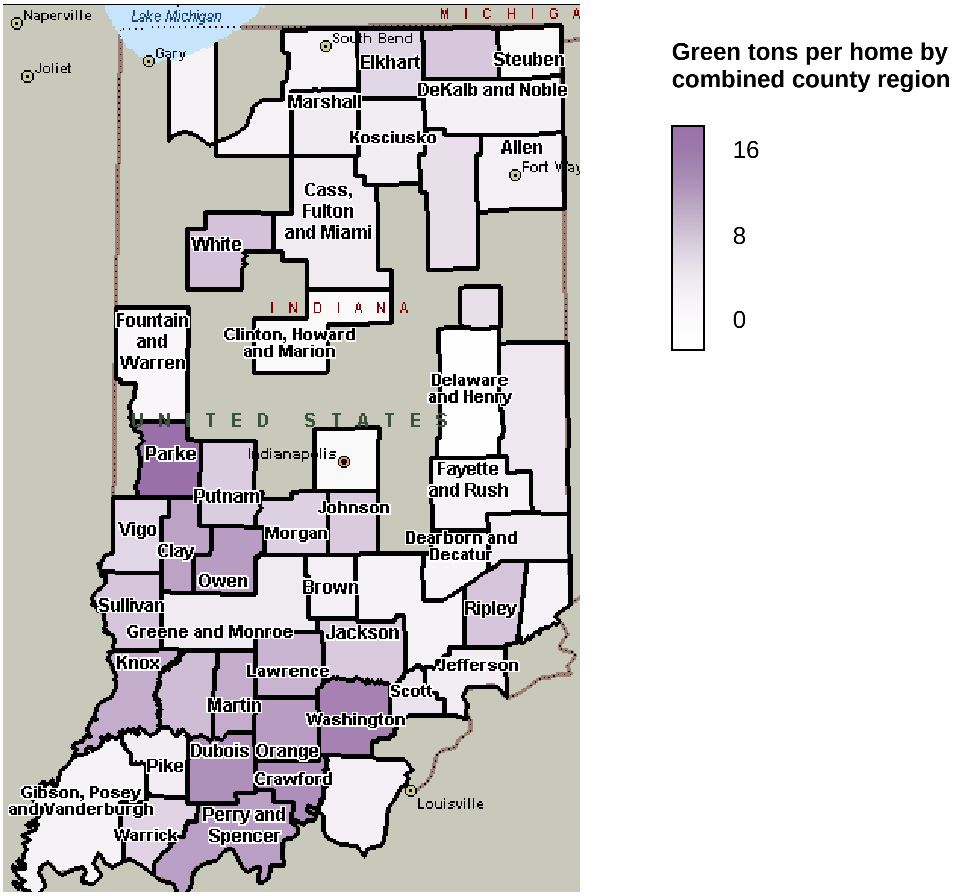


Table 3. Indiana primary mill residues by type (Forest Service TPO)

Residue type	Green tons
Bark	300,404
Coarse	731,604
Fine	352,035
Grand Total	1,384,043

Table 4. Indiana primary mill residues by end use (Forest Service TPO)

End use	Green tons
Domestic fuel	87,615
Fiber products	535,028
Industrial fuel	158,797
Miscellaneous	580,787
Not used	21,816
Grand Total	1,384,043

In 2006, the Indiana Clean Manufacturing Technology and Safe Materials Institute (CMTI) at Purdue University partnered with the Indiana Cooperative Development Center to survey Indiana's wood industry in order to estimate the resource. They received 49 responses, with the respondents claiming 216,000 tons of wood (green and otherwise) generated monthly. However, some respondents, when contacted post-survey for follow-up, offered different answers than presented in the survey. One mill recorded as 200,000 tons of wood residues a month suggests that a closer estimate would be 600 tons. [31] Another mill, which was recorded at 2,100 tons a month, suggests that 30 tons a month is more accurate.[32] With these two adjustments, the sum of residues generated by all respondents is 19,800 tons a month, or 238,000 tons a year, although it is not clear if other responses also need adjustment.[33] The largest generator of wood residues that responded to the survey, Frank Miller Lumber Co., supplies 37 percent of this volume. The next 10 largest respondents provide an additional 53 percent. While this survey is useful in identifying individual residue producers who might be interested in further value-added processing for their wood wastes, its voluntary nature suggests that it is not necessarily complete. This only means, however, that the available mill residues are higher still.

At the same time, we must remember that these residues are often put to beneficial use—sometimes as a profit center, and sometimes as a process need. At Thiesing Veneer, they estimate that they use 95 percent of the 1,300 tons they generate each month as process fuel.[34] While there may be operational benefits to selling the waste, having it converted to pellets by a separate entity and buying back a lower volume of pellets with higher heating value, this needs to be considered on a case-by-case basis. Regardless, it underscores the fact that the residues presented in the survey are not just "waste streams" with no business value.

Data regarding the residues generated by secondary mills are not regularly collected. This resource includes the vast majority of kiln-dried sawdust, which is a preferred feedstock because it requires less drying energy at the mill. Local secondary wood facilities should be approached on an individual, person-to-person basis, as this seems to be the most reliable way to generate correct estimates of production.

Harvest residues

The primary purpose of the TPO survey is to measure removals from national forests, and a second purpose is to estimate the amount of harvest residues available after removals.

[31] In a January 2007 interview with Tom Derleth of Indiana Hardwood Specialists, Derleth estimated their residue production at 40,000 lbs., or one trailer-load, a day; 20 tons every day for 30 days is 600 tons.
[32] Interview with Jeff at Shamrock Cabinets, April 2007.
[33] Some respondent data was given in cubic yards instead of tons; this was converted at a rate of 440 lbs per cubic yard, the Tellus Institute's density estimate for wood shavings, available online at http://www.recyclemaniacs.org/doc/measurement-tracking/conversions.pdf. This value is a comprise between 375 lbs per cubic yard of sawdust (also Tellus) and 500 lbs per cubic yard of shredded wood chips (EPA).
[34] Interviews and correspondence with David Mathers, March 2007.

For Indiana, these residues are estimated at 65.1 million cubic feet, or approximately 1,400,000 green tons.[35]

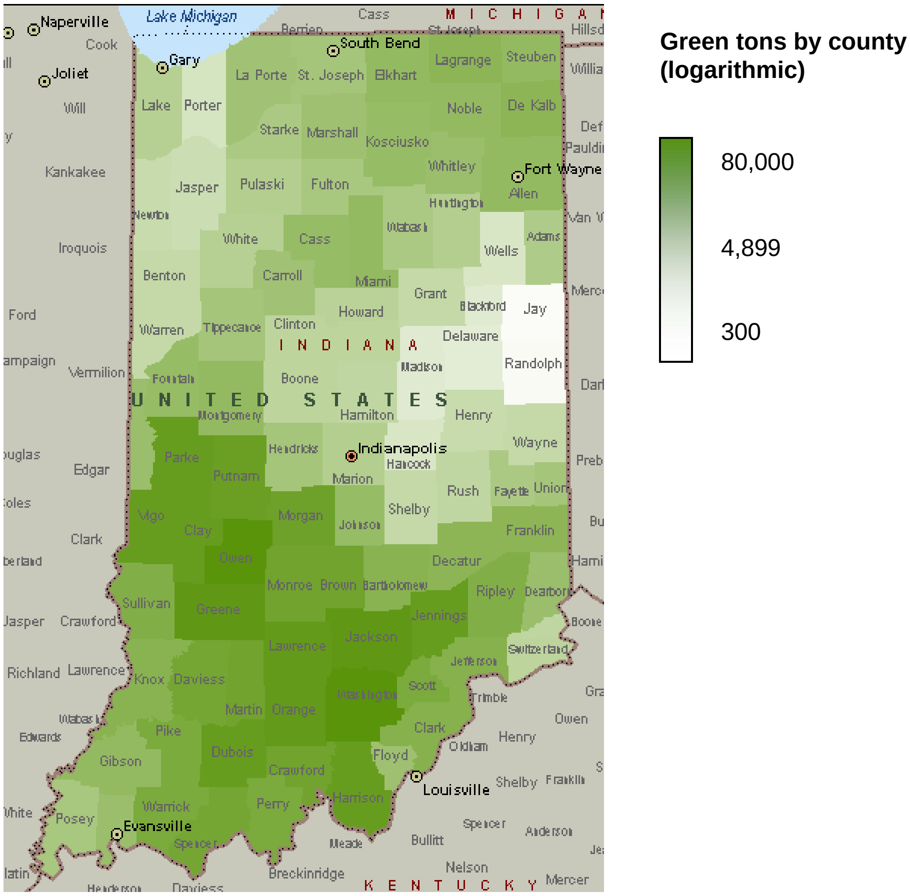
Harvest residues are a marginal option for pelleting. To the extent that these residues consist of nonmerchantable trees, then stumpage costs can make the economics prohibitive. To the extent that these residues are treetops and other branches, the question becomes whether these can be economically sorted, with branches in excess of 4" most likely to be economically debarked to make premium and standard pellets. Tops can be used without sorting when the presence of bark is not an issue; that is, for lower-quality pellets. (Pellet quality and the role of bark are addressed in the section on wood pellets.) Between these two options are some opportunity markets—for instance, tree removals due to fire hazard or recent insect kills offer a perfect pelleting feedstock, while defraying the stumpage cost that would otherwise make the tree unaffordable.

Dixie Pellets, slated to open in Selma, Ga. later this year, is one of the few that is designed to use whole trees as a feedstock. While the stumpage, debarking and chipping required has typically been regarded as too expensive for pellets, the Dixie plant will generate 500,000 tons per year, and it may harvest 5 million acres of forest for feedstock. (The plant's design will accommodate any wood resource that becomes available.) The company's website indicates that their primary market for these pellets is Europe. The viability of this plant may change expert opinion about the feasibility of harvesting trees for pellets.[36,37]

The Indiana portion of the harvest residue TPO survey is in Appendix D. The following maps presents harvest residues per county.

[35] Based on an engineering estimate of 46.5 cubic feet per ton.
[36] Gordon 2007.
[37] Available online at http://www.dixiepellets.com/.

Figure 6. Indiana harvest residues by county (green tons)



Recycled wood

An emerging source of useful wood is construction and demolition waste that would otherwise be landfilled. Generally speaking, this waste is unsuitable for pelleting—the pelleting process does not permit wood that is dirty, painted or contains materials such as nails, and wood used for combustion cannot be chemically treated (e.g. plywood). However, some Indiana entrepreneurs have recognized the potential value in what would otherwise be treated like garbage and have begun sorting operations. Two such operations are Construction Recycling Solutions in Fort Wayne and Paper Trail in Peru. Among the products recycled by these businesses are gypsum, plastic and cardboard, in addition to unpainted and untreated wood. This wood is typically kiln-dried. CRS sold 45 yards of wood, or about 7.5 tons, in its first six months, and Paper Trail sold 4,000 tons of wood between June and the close of the construction season.[38,39] Like all wood sources, location and hauling distance will be critical when considering whether to incorporate these feedstocks into a pellet mill, but the emergence and success of these businesses will

[38] Interviews and correspondence with Candace Imbody, Construction Recycling Solutions. March 2007
[39] Interviews and correspondence with Brook Edwards, Paper Trail. March 2007.

hopefully spur further construction and demolition and recycling throughout the state, increasing the availability of this resource.

Existing profitable uses of wood residues

The uses of wood residues are diverse, and prices are accordingly variable. A mill can generate trim pieces, bark, wood chips and coarse and fine sawdust in the course of its business, which can be sold as mulch, compost, heating fuel (for residences or industry), animal bedding, landscaping chips (including uses such as playground fill) and even as pulpwood, and the seasonal demand for wood for these applications varies. Some mills can generate revenue from sales of this material, some give it away as community service, and some pay to have it removed—but the bottom line is that it must be disposed of on a regular and often daily basis for the sawmill to continue to function properly. The highest price offered for Indiana mill residue found over the course of this study was $600 per trailer, or $27 a ton, for green wood chips.[40] One mill that pays for disposal is paying $400 per month to get rid of 690 tons of kiln-dried sawdust. As this demonstrates, the market for wood is highly volatile, with businesses putting a higher value on the certainty of disposal than on marginal additional revenue.

Other resources

At the present time, we do not consider other biomass feedstocks to be of significant interest for a pelleting operation focused on the achievable near-term market of residential heating. Premium pellets made from wood are present and demonstrated in the market, with uniform heating value and predictable ash content, and the wood resource is sufficiently abundant in Indiana that there is little value in combining the risk of less proven feedstocks with the risk of starting up a new facility.

Alternative feedstocks frequently considered for pellets include switchgrass and corn cobs. Switchgrass pellets cannot achieve premium-quality levels of ash, and the pellet stove installed base is not necessarily suitable to burn them.[41] T.J. Morice of the Pellet Fuels Institute has found in his work that corn cobs have too many high-value uses to justify pursuing as a pelleting feedstock.[42]

Pelleting in Indiana

The major pellet operations currently ongoing in Indiana are Fiber By-Products, which is headquartered in Goshen but runs its pellet mill in White Pigeon, Mich., and Koetter & Smith, which is located in Borden. Both companies have an extensive business based on collecting others' wood waste and processing it for uses such as mulch, compost, landscaping and animal bedding; Koetter & Smith spun off from Koetter Woodworking of Borden. Both companies entered the pellet market primarily because their existing feedstock supply permitted them to: Cory Schrock of Fiber By-Products said, "We got

[40] Interviews and correspondence with Guy Guthrie, March-April 2007.
[41] 2006. "Grassbioenergy.org: Demonstrations." Cornell University, Ithaca, NY. Available online at http://www.grassbioenergy.org/res/pellet_stove_demo.asp
[42] Morice 2007.

into it simply because we do have the raw material,"[43] and Matthew Smith of Koetter & Smith said, "We needed to do it because a lot of our competitors were."[44] Like all pellet manufacturers contacted for this study, both were apprehensive about how possible new market entrants would increase demand for wood residue. "It's going to become a commodity and it's not going to be any fun," Smith said.

The performance of pellets in 2005 greatly increased regional entrepreneurial interest in the product, and it is difficult to determine how many additional producers plan to come online, although the Pellet Fuels Institute estimates that 800,000 tons of capacity is planned regionally.[45] When considering whether it makes sense for and Indiana based cooperative or collaborative business organization to pursue its own pelleting operation, we must take a close look at the expenses and potential income of such a business, analyze regional demand for the products and investigate ways in which the ICDC can coordinate a unique project that circumvents some of the potential pitfalls.

Pro forma income statement

We have developed a pro forma income statement as a spreadsheet tool than can easily be modified to model different circumstances. This tool will be submitted with this document, and will be used in this section to outline different production scenarios of interest. For a discussion of the elements in the income statement and the assumptions that went into them, please see Appendix A. A discussion of the major components follows.

Feedstocks

We consider the price of feedstocks to be the main variable. In some ways, the spreadsheet functions as a reverse-engineering exercise to see if you can achieve a positive cash flow for feedstocks at a given price. The primary concern of any mill is to get the residue off-site in order to enable the mill's basic operations.

Because green residues are mostly generated from primary lumber operations, which generate them in great quantities, their value is usually recognized and the residues probably already are used for some purpose. As previously stated, the USDA Forest Service study on the Indiana Timber Industry suggests that only 2 percent goes unused.[46] However, the generation of residues is believed to be underreported, and "use" to be overreported, meaning actual residue volumes that could be readily available for a pelleting operation are likely to be higher. Availability of feedstocks will need to be investigated with individual producers and the pre-arrangement of secure supply agreements will be essential.

As discussed above, the price of green feedstock can range from zero (or less than zero, if that mill pays for disposal) to a maximum observed price of $27 per ton. We can only expect costs for these residues to rise over time, especially as other planned pellet mills

[43] Interviews and correspondence with Cory Schrock, January 2007.
[44] Interviews and correspondence with Matthew Smith, January 2007.
[45] Morice 2007.
[46] Piva 2007.

and other biorefining operations come online. Some feedstock suppliers operate under contracts for residue disposal, and some operate solely in the spot-price market. Often a supplier will do both at once for different lots of residues. A supplier asked to enter into a long-term contract will want to guarantee a sufficient price to prevent “seller’s remorse” if spot prices rise for a protracted period. Guy Guthrie, logistics manager for Frank Miller Lumber Company, suggests that $40 per ton would be an appropriate contractual price in this scenario.[47]

Kiln-dried residues tend to be generated from secondary mills, which are not sufficiently studied to understand the volume of waste they produce in Indiana. Furthermore, these operations are likely to create fewer residues per ton of input, and many are relatively small. A smaller mill may be less likely to consider wood residues as a marketable commodity—the business viability of wood residue processors is likely attributable to the fact that customers will often pay for removal rather than market the residue and receive revenue from it. However, this state of affairs is unlikely to last very long, given the demand for residues in the state. Many mills contacted for this study indicate that they have been contacted on multiple previous occasions about the disposition of their residues, and this demand will certainly cause prices to rise.

The ICDC has the unique perspective of approaching the pellet mill as a cooperative in which the suppliers can participate in the mill’s profits. Under such an arrangement, the per-ton price of feedstock could be reduced. We will assume our base case green feedstock cost to be $30 per ton, and model scenarios in which it is both less and more.

Design conditions

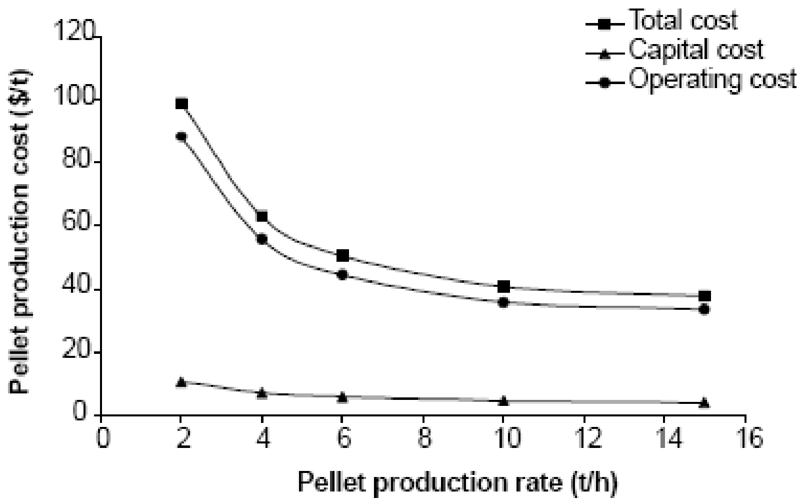
Our base-case pellet mill is modeled after the example presented in the study “Economics of producing fuel pellets from biomass” by S. Mani, et al.[48] This study is the most complete available for understanding the interplay of pellet mill costs. To model our generic pellet mill, we reproduce their assumptions about a mill’s capital and operating costs. The mill at the center of their design is a 6 metric tonne per hour mill, which would translate to a 6.6 ton per hour mill. They also estimate 49,626 tons (45,000 tonnes) per year of output. We use as the base case for our income statement a 6.0 ton per hour mill, which corresponds with the cost and scale of equipment cited in the Mani study. These costs are combined with the installation cost and expected life of that equipment to come up with annual capital costs on a per-ton basis, and the same assumptions are used to produce annual operating costs on a per-ton basis.

The reason that this is critical for this study is that the incremental cost per ton of pellets is relatively flat above 11 tons per hour (10 tonnes per hour): $37 per ton ($41 per tonne). At 6.6 tons per hour (6 tonnes per hour), the cost is $41 per ton ($45 per tonne), and at 4.4 tons per hour (4 tonnes per hour), the cost is $56 per ton ($62 per tonne). While these are appreciable differences, we judge that for the sake of this income statement the per-ton costs developed with the design equipment can be reasonably used for any facility 2

[47] Guthrie 2007.
[48] Mani 2006.

tons/hr and larger by adjusting the capital and operating expense contingency factors. These adjustments are discussed below. The following figure illustrates this relationship.

Figure 7. Pellet production rate (tonnes/hr) vs. production rate ($/tonne)[49]



To prepare an income statement for a specific pellet mill, the results of the feasibility study for that mill should replace these design assumptions. We will model one scenario using a different design.

Contingency factors

Capital contingency factor. The capital contingency factor serves two purposes. First, it recognizes that the price of equipment will rise over time. While the 2005 assumptions in the Mani study may not hold for future years, it may also not be sensible to seek out all-new data for each of these factors simply to mock up an income statement. The capital contingency factor allows you to set a percentage that represents the cost increases of capital expenses. For our base case, we assume a 20 percent capital contingency factor to reflect an increase in the cost of pelleting equipment.

This factor can also be used to increase costs based on the size of the mill, according to table 5 below, which is based on Figure 7. If you use the capital contingency factor for this purpose, the value in table 5 should be added to any contingency you want to include based on rising prices, as discussed in the previous paragraph.

[49] Ibid.

Table 5. Capital expense contingency factors for pro forma income statement[50]

Pellet production rate (ton/hr)	Proxy metric rate (tonne/hr)	Capital cost ($/t)	Capital contingency factor (%)
2-3	2	10	67
4-5	4	7	17
6-8	6	6	0
9-12	10	5	-17
Greater than 12	14	5	-17

Operating contingency factor. The operating cost contingency factor allows you to use the spreadsheet with the Mani assumptions to model facilities as small as 2 tons per hour and as large as is desired.

As shown in Figure 7, the Mani study determines the degree to which incremental cost changes with pellet production rate. In our study, we use the Mani assumptions, except that we unbundle feedstock and drying costs from their "operating cost" package. Feedstock and drying costs are linearly related to pellet production rates, so removing these elements does not change the slope of operating cost curve shown—simply its displacement from zero. (The element remaining that most affects operating cost is labor—a large pellet mill requires similar staffing as a small pellet mill.) Table 6 shows recommended operating contingency factors.

Table 6. Operating expense contingency factors for pro forma income statement[51]

Pellet production rate (ton/hr)	Proxy metric rate (tonne/hr)	Operating cost ($/tonne)	Proportion of operating cost for feedstock, drying (%)	Revised operating cost ($/ton)	Operating contingency factor (%)
2-3	2	90	61	32	100
4-5	4	56	61	20	25
6-7	6	45	61	16	0
10-12	10	38	61	14	-13
Greater than 12	14	37	61	13	-23

Please note that if you change the design assumptions, the values in this table no longer apply, although an operating contingency factor can still be used and the table can be consulted to estimate the appropriate magnitude.

Personnel and marketing

The per-ton personnel cost in the income statement, which is based on the Mani study, includes labor in production, marketing and administration. These assumptions are based

[50] Ibid.
[51] Ibid.

on two people to run the entire plant (3 shifts per day) and three people for bagging (1 shift per day), where only a third of the plant output is bagged.

T.J. Morice of the Pellet Fuels Institute suggests that successful marketing of wood pellets can cost anywhere from $0.50 to $2 per ton.[52] We assume that the marketing personnel included in the bundled personnel cost corresponds to the middle of this range ($1.25), and so to be conservative, we have included an additional marketing cost of $0.75 per ton, which is meant to correlate with a fairly aggressive marketing effort. Because marketing includes both larger tasks such as promoting pellets to regional customers, establishing retail relationships and investing in retail outlets, a per-ton assumption of marketing costs is valid. This factor can be modified in the spreadsheet.

We assume that in the beginning, the mill will sell all its pellets to a big box retailer or similar distributor (the "wholesale" market), and that over time it will convert more and more its pellets directly to customers (the "retail" market). Later in the report, we will model one possible 10-year outlook for a mills whose sales shift from wholesale to retail at a rate of 1 percent of production per year.

Selling all of the mill's year one pellets to a big box/distributor is reasonable given the demand for pellets, although a relationship with a specific buyer will have to be forged. This approach, while safe, is also the least profitable way to sell pellets. Pellets sold to these retailers are almost always bagged on-site, which will permit the mill to establish a brand name for itself.

With the "base load" income provided by 100 percent wholesale sales, the mill can then invest its marketing dollars in trying to find more lucrative retail outlets, whether that means selling the pellets as part of the same business entity (via a storefront at a mill or some other retail operations throughout the region that could conceivably carry any assortment of products) or striking a deal with smaller hardware stores, general stores, etc., that allows the mill to charge a higher price for its products than it will get from a big box. For the purposes of this study, this higher price will be considered the "retail" price even if the mill still uses some intermediary to actually operate the retail operation, and who charges the customer an amount greater than this price.

The most profitable scenario may be bulk delivery of pellets, but homeowners are considered unlikely to invest in the systems necessary to receive bulk pellets based on current fuel prices. As this changes, then it creates a different avenue for retail pellet sales.

Limitations of the income statement

The income statement is meant to show income, expenses, simple profit and profit margin. As ICDC and its associates pursue an actual mill, there will be questions of business structure, equity and debt management that are outside the scope of this study. These are significant variables: The proper business structure can strike a balance

[52] Morice 2007.

between feedstock cost and return on investment that create the most favorable scenario for wood suppliers. However, because there are so many possible approaches to these questions, the income statement does not provide information about such interrelated issues as ROI, equity, depreciation or tax burdens. The income statement does provide all of the necessary information that would be necessary to address those issues to match a given business structure, and the income statement is furthermore customizable to allow for many different inputs into such a business plan.

Production scenarios

Based on the income statement described above, we will describe a number of different production scenarios in order to demonstrate potential sites and configurations. For each scenario, we will describe why it is a useful variation on the base case to consider. These scenarios assume the same feedstock prices throughout the state.

The pelleting process is generally low scrap—only a very small fraction that for whatever reason is caught by the screeners and not milled. When taking in green wood, however, there will necessarily be some sorting to remove pieces of wood that will reduce pellet quality, such as bark. We assume a 20 percent scrap rate. Waste wood is used in the solid fuel burner to dry the green wood, but it will not be sufficient to dry all pellet feedstock, so additional dryer fuel will be needed. We will address the inclusion of kiln-dried feedstocks in scenario 1.7.

We assume pellets to be sold for $125 per ton wholesale and $175 per ton retail.

Scenario 1.1

This is the base case: a 6 ton per hour mill running two shifts a day, five days a week and creating 21,216 tons of pellets annually based on $30 feedstock. (Note that we assume a lower rate for lower quality feedstock for the additional dryer fuel.)

Table 7. Performance summary for scenario 1.1

Pellet production rate (tons/hr)	6
Total production hours	4160
Annual tons	21,216
Pellet feedstock delivered price (green, $/ton)	30
Green feedstock needed (tons/yr)	55,770
Additional dryer fuel needed (tons/yr)	18,621
Income ($)	2,652,000
Expenses ($)	2,362,128
Profit ($)	289,872
Profit margin (%)	11%

This facility requires 56,000 tons of green feedstock. According to the USDA Forest Service 2000 Indiana timber inventory, this is only 4 percent of the green residues generated in Indiana, but it is a quarter of the 230,000 tons of “waste” mill residue found by the other Forest Service study.

Scenario 1.2

The base case, except running three shifts and seven days a week.

Table 8. Performance summary for scenario 1.2

Pellet production rate (tons/hr)	6
Total production hours	8736
Annual tons	44,554
Pellet feedstock delivered price (green, $/ton)	30
Green feedstock needed (tons/yr)	117,118
Additional dryer fuel needed (tons/yr)	39,104
Income ($)	5,569,200
Expenses ($)	4,960,458
Profit ($)	608,742
Profit margin (%)	11%

Note that incomes and expenses are both primarily tied to production. With this income statement spreadsheet, more production makes profitable mills more profitable and unprofitable mills less profitable. Note also that the amount of required feedstock changes linearly with profit.

Scenario 1.3

The base case at 4 tons per hour.

Table 9. Performance summary for scenario 1.3

Pellet production rate (tons/hr)	4
Total production hours	4160
Annual tons	14,144
Pellet feedstock delivered price (green, $/ton)	30
Green feedstock needed (tons/yr)	37,180
Additional dryer fuel needed (tons/yr)	12,414
Income ($)	1,768,000
Expenses ($)	1,648,974
Profit ($)	119,026
Profit margin (%)	7%

While profit has been reduced, so has wood demand. Note that in the line item "Capital contingency factor" on the spreadsheet, the value is 37 percent—a 20 percent adjustment for rising prices, and a 17 percent adjustment for the reduction in size. Note also the use of the operating contingency factor given in table 6 (25 percent).

Scenario 1.4

The base case at 10 tons per hour.

Table 10. Performance summary for scenario 1.4

Pellet production rate (tons/hr)	10
Total production hours	4160
Annual tons	35,360
Pellet feedstock delivered price (green, $/ton)	30
Green feedstock needed (tons/yr)	92,951
Additional dryer fuel needed (tons/yr)	31,035
Income ($)	4,420,000
Expenses ($)	3,824,905
Profit ($)	595,095
Profit margin (%)	13%

Note that in the line item “Capital contingency factor” on the spreadsheet, the value is 3 percent—a 20 percent adjustment for rising prices, less a 17 percent adjustment for the increase in size. Note also the use of the operating contingency factor given in table 6 (–13 percent).

Scenario 1.5

The base case with $15 per ton green feedstock.

Table 11. Performance summary for scenario 1.5

Pellet production rate (tons/hr)	6
Total production hours	4160
Annual tons	21,216
Pellet feedstock delivered price (green, $/ton)	15
Green feedstock needed (tons/yr)	55,770
Additional dryer fuel needed (tons/yr)	18,621
Income ($)	2,652,000
Expenses ($)	1,525,572
Profit ($)	1,126,428
Profit margin (%)	42%

Scenario 1.6

The base case with $40 per ton green feedstock.

Table 12. Performance summary for scenario 1.6

Pellet production rate (tons/hr)	6
Total production hours	4160
Annual tons	21,216
Pellet feedstock delivered price (green, $/ton)	40
Green feedstock needed (tons/yr)	55,770
Additional dryer fuel needed (tons/yr)	18,621
Income ($)	2,652,000
Expenses ($)	2,919,832
Profit ($)	-267,832
Profit margin (%)	-10%

At $40 per ton, the facility is not feasible. This underscores the point that wood pelleting is, under current fossil fuel prices, only economical as an opportunity fuel—i.e., when the wood is relatively cheap.

Scenario 1.7

If the base case mill were situated in Morgan county: wood supply and local demand.

Table 13. Performance summary for scenario 1.7

Pellet production rate (tons/hr)	6
Total production hours	4160
Annual tons	21,216
Pellet feedstock delivered price (green, $/ton)	30
Green feedstock needed (tons/yr)	37,924
Pellet feedstock delivered price kiln-dried, $/ton)	79
Kiln-dried feedstock needed (tons/yr)	6,789
Additional dryer fuel needed (tons/yr)	12,662
Income ($)	2,652,000
Expenses ($)	2,363,073
Profit ($)	288,927
Profit margin (%)	11%
% of production sold locally (conservative)	7
% of production sold locally (optimistic)	28

This scenario places the base case facility in Morgan county and considers local demand. One important difference is that we assume we purchase 50 percent of the kiln-dried sawdust produced by Thiesing Veneer in Morgan county (1300 tons at 40 percent kiln-dried, or 520 tons/month) and Indiana Hardwood Specialists in Owen county (600 tons/month). (While both manufacturers were contacted for this study, neither was asked to seriously consider changing their current wood residue disposal plans—Thiesing uses the majority of theirs as process fuel, and IHS pays to have theirs removed. The selection of this county, and inclusion of these manufacturers, is meant to be illustrative rather than persuasive.) The inclusion of these residues reduces the demand for green resides at the base-case mill by 32 percent. The profit margin is unchanged *by design* because the kiln-dried residue price was arrived at by seeing which price for this residue would generate the same profits as $30 per ton green residues. The remaining 38,000 green tons for pellets and 12,700 green tons for dryer fuel is less than the total volume of primary mill residues generated annually in Morgan county, according to TPO data, and these residues are presumed to be available at the design cost.

To estimate demand, we imagine two different annual rates of penetration into owner-occupied homes without utility gas in Morgan and surrounding counties (excluding Marion, whose large urban population would skew results): 0.5 percent for the conservative estimate and 2.0 percent for the optimistic estimate. The percentages of base-case production that could be sold locally assuming those rates of conversion are 7 percent and 28 percent, respectively. Because we could assume some spillover into Marion county, and also into a larger "regional" market that is more than one county distant from Morgan, these estimates are conservative.

As an additional exercise at the bottom of the income statement, we speculate about whether we could capture Marion county, including the Indianapolis market. Historically the pellet market is overwhelmingly rural, but Marion county has a high number of owner-occupied homes without natural gas. If we could convert 0.5 percent of homeowners in Marion county, this would account for 6 percent of base-case production. If we could convert 2.0 percent of homeowners in Marion county, this would account for 25 percent of base-case production.

Again, the selection of Morgan county was based on census data about the number of owner-occupied homes without utility gas and the presence of two respondents to the Purdue survey, but is not meant to suggest that these mills are any more or less receptive to collaborating on a pelleting facility than anyone else. The spreadsheet can be used to estimate any county and surrounding region by using the data on the sheet “Indiana tenure by county.”

Scenario 1.8

A 10-year look at the base case, adjusting for increasing retail sales.

Table 14. Performance summary for scenario 1.8

	Year 1	**Year 10**
Pellet production rate (tons/hr)	6	6
Total production hours	4160	4160
Annual tons	21,216	21,216
Pellet feedstock delivered price (green, $/ton)	30	30
Green feedstock needed (tons/yr)	55,770	55,770
Additional dryer fuel needed (tons/yr)	18,621	18,621
Income ($)	2,652,000	2,747,472
Expenses ($)	2,362,128	2,362,128
Profit ($)	289,872	385,344
Profit margin (%)	11%	14%

Under this model, retail sales are increased from 0 percent in year 1 to 9 percent in year 10. Assuming $125 per ton wholesale and $175 per ton retail, a 9 percent retail market results in a 33 percent increase in profits. The retail market is difficult to enter, and only time will tell if a 1 percent annual increment in penetration is accurate. There are likely to be additional expenses unaccounted for in the spreadsheet as retail sales increase, either through increased marketing, increased trucking (to deliver pellets to residences) or the creation of storefronts from which to sell the pellets. ("Storefront" here is meant to represent any scenario that allows the mill to sell pellets without a middleman, whether that is accommodating customers at the mill or leasing small plots of land or space in existing businesses through the region to attract.)

Scenario 1.9

This scenario shows a 10-year look, adjusted for increasing heating fuel prices. This assumes a 0.85 percent annual rise in natural gas costs and a concomitant increase in both feedstock costs and pellet prices. This rate is based on current EIA predictions; while the agency predicts a decline in wellhead natural gas prices over the next few years, the price is expected to rise $0.97 from 2013 to 2030.[53]

Table 15. Performance summary for scenario 1.9

	Year 1	**Year 10**
Pellet production rate (tons/hr)	6	6
Total production hours	4160	4160
Annual tons	21,216	21,216
Pellet feedstock delivered price (green, $/ton)	30	32
Green feedstock needed (tons/yr)	55,770	55,770
Additional dryer fuel needed (tons/yr)	18,621	18,621
Income ($)	2,652,000	2,861,914
Expenses ($)	2,362,128	2,494,560
Profit ($)	289,872	367,354
Profit margin (%)	11%	13%

[53] 2007. "Natural Gas Demand: Projected Natural Gas Prices Remain Above Historic Levels." US DOE Energy Information Agency, 2007. Available online at http://www.eia.doe.gov/oiaf/aeo/pdf/trend_4.pdf

Scenario 2

A 2.5 ton per hour mill using equipment costs supplied by California Pellet Mill. This pro forma was performed primarily to demonstrate how different design assumptions can be used in the spreadsheet, and also to demonstrate the expenses of running a small mill. If this is the size of mill that the available feedstock requires, a closer look must be taken to determine the suitability of the assumptions—note the use of a 90 percent operating contingency factor. (Also, the burner and dryer may be oversized for an operation of this scale.) The failure of this model to make a profit is *not* a function of the cost of the CPM equipment; if you look at the line item “Total capital expenditures ($/ton),” you will notice that Scenario 2 has a lower value (5.3) than Scenario 1 (5.4), because Scenario 1 has a 20 percent capital contingency factor, whereas Scenario 2 has no such factor. (The purpose of the contingency factor is to model the changing cost of equipment over time, which is addressed here by substituting new equipment prices and assuming they are current.)[54]

Table 16. Performance summary for scenario 2

Pellet production rate (tons/hr)	2.5
Total production hours	4160
Annual tons	8,840
Pellet feedstock delivered price (green, $/ton)	30
Green feedstock needed (tons/yr)	23,238
Additional dryer fuel needed (tons/yr)	7,759
Income ($)	1,105,000
Expenses ($)	1,111,916
Profit ($)	-6,916
Profit margin (%)	-1%

[54] Equipment prices from Fuller, Ron. “Wood grinding & pelleting.” Undated PowerPoint presentation. California Pellet Mill.

Conclusions

We recommend that the Indiana Cooperative Development Center continue to work with businesses throughout the state to find interested partners, and use the information and tools provided to facilitate productive conversations about project feasibility. We think that a pellet mill created under a cooperative mindset (regardless of whether the business structure is a cooperative, new-generation LLC or something else entirely) can thrive by offering suppliers a fair price for their wood residues by allowing them to share in the profits (which will help lower the “seller’s remorse” price). While our prices are assumptions and not recommendations, a pellet mill in Indiana should be feasible practically anywhere in Indiana if sufficient green feedstock can be acquired for $30 per ton or less.

Likewise, the lack of external research available about secondary mill residues make the kiln-dried sawdust resource hard to quantify, but it is entirely feasible that because the removal of residue from a mill is a service first and a revenue stream second, that a lower price than $30 can be obtained. (Some mills currently pay to have their residues removed, indicating that lower prices should be possible, at least in the short term.) We have modeled a mill located in Morgan county to provide a sense of how local demand might play a role.

As important, or more important, than local demand to the success of a pellet facility is the presence of willing partners who are willing to consistently supply quality residues at a breakeven or highly competitive price and seek to make profits via sales of pellets. The location of the mill or mills should foremost depend on forging those business relationships; with a reliable supply and a quality product, the pellets become fungible, and a commitment to marketing will help grow local consumption, especially as the cost of other heating fuels rise, and if carbon credits become a reality in the U.S.

Appendix A. Income statement factors

These are the factors used in the income statement spreadsheet “ECW ICDC pelleting study income statement.xls” that was submitted with this report.

Pellet production rate

This refers to the intended rate at which pellets will be made while the mill is running, and will ideally be the same as the stated capacity of the pellet mill. This factor can be modified in the spreadsheet.

Hours per shift, production shifts, production days, production weeks

These should reflect the design operating conditions. Adjustments to these, such as equipment downtime or holidays, are accounted for with the *downtime* variable. Production shifts and production days can be modified in the spreadsheet.

Total production hours

The hours per year the mill is designed to operate. This is the product of the above four values.

Downtime

A percentage to reflect deviation from design operating conditions. Our engineering estimate for downtime is 15 percent. This factor can be modified in the spreadsheet.

Annual tons

The tons per year the mill will produce. This is the product of the pellet production rate and the total production hours, less downtime.

Wholesale sales price

The price expected from an outside retailer to whom the mill will sell its bagged pellets. Our engineering estimate for this is $125 per ton. This equates to $2.50 per 40 lb. bag. Different scenarios later in this section will look at increasing fossil fuel prices and the concomitant ability to charge more for pellets. This factor can be modified in the spreadsheet.

Retail sales price

The price expected for pellets if sold by the mill itself, or a sibling entity, either bagged or loose. The ability to sell pellets retail is a function of pellet stove penetration in the counties surrounding the mill, which is a function of marketing (as well as other things such as the weather and fossil fuel prices which the mill cannot control). Our engineering estimate for this is $175 per ton. This equates to $3.50 per 40 lb. bag. This factor can be modified in the spreadsheet.

Percent of pellets sold retail

In year 1, we assume no retail pellet sales. Scenario 1.8 at increasing retail pellet sales over time. This equates to $2.50 per 40 lb. bag. This factor can be modified in the spreadsheet.

Annual wholesale sales

The income expected from wholesale pellet sales. This is the product of the annual tons, less the percent of pellets sold retail, multiplied by the wholesale sales price.

Annual retail sales

The income expected from retail pellet sales. This is the product of the annual tons multiplied by the percent of pellets sold retail, multiplied by the wholesale sales price.

Annual sales

The sum of the above two factors.

Pellet feedstock delivered price (green)

The price per ton of green feedstock delivered to the pellet mill. We assume as our base case green feedstock cost $30 per ton, and model scenarios in which it is both less and more. This factor can be modified in the spreadsheet.

Pellet feedstock delivered price (kiln-dried)

The price per ton of kiln-dried feedstock delivered to the pellet mill. We assume as our base case kiln-dried feedstock cost $79 per ton, the price at which pellets from kiln-dried feedstock can be produced for the same cost as $30 per ton green residues. This factor can be modified in the spreadsheet.

Percent of feedstock that is green

We assume that 100 percent of feedstock is green in year 1 for the base case. This is a conservative estimate (in that we expect that it is more expensive to purchase and dry green wood than it is to purchase kiln-dried residues; this is modeled in scenario 1.7). This factor can be modified in the spreadsheet.

Required volume of green feedstock

In order to dry green wood to the 8 percent moisture required for pellets, we must drive off an estimated 913 lbs. of water. In other words, a ton of green wood yields 1,087 pounds of wood at 8 percent moisture. The required volume of green wood for the desired pellet production is calculated by dividing the annual tons by the weight of water in a ton of wood, multiplied by the percent of feedstock that is green.

Scrap rate

Not all green wood received at the facility will be able to be converted into pellets. The wood may be too dirty, may have too high an ash content for the desired quality of pellets, or may just be otherwise unpelletable. Our engineering estimate for this rate of scrap green wood is 20 percent (that is, 20 percent of all wood purchased at the delivered feedstock price will not be pelletable). This factor can be modified in the spreadsheet. We assume that all kiln-dried wood received by the facility is capable of being pelleted.

Total green feedstock needed

This is the required volume of green feedstock plus the scrap rate.

Total kiln-dried feedstock needed

This is the annual tons of pellets multiplied by 1 minus the percent of feedstock that is green.

Total tons needing drying to 8% moisture

This is the required volume of green feedstock.

Process heating rate

It requires 1,500 Btu to drive off 1 lb of water.

Water to be removed

Given a ton of green wood, you must remove 913 lbs of water to get 1,087 lbs of pelletable wood at 8 percent moisture.

Process heat required per ton

The product of the above two factors.

Total MMBtu required for drying

The product of the total tons needing drying by the process heat required per ton.

Heating value (process fuel, green)

Drying can be done by using unpelletable wood—both the scrap in the green feedstock purchased, as well as other unpelletable wood purchased specifically for this purpose (e.g. bark). Green wood has a heating value of 5.7 MMBtu per ton.

Solid fuel burner efficiency

The solid fuel burner is the part of the pellet mill used to dry green feedstock. Our engineering estimate is 60%. This factor can be modified in the spreadsheet.

Total tons of dryer fuel required

The quotient of the total MMBtu required and the heating value, divided by 1 minus the burner efficiency.

Available green scrap

The total green feedstock needed less the required volume of green feedstock.

Supplemental process fuel

The difference between the total tons of dryer fuel required and the green scrap.

Cost of supplemental dryer fuel

The price per ton of unpelletable green wood and other waste wood delivered to the mill. Our engineering estimate is $10 per ton. This factor can be modified in the spreadsheet.

Dryer feedstock cost

The product of the above two factors.

Interest rate

We assume 6 percent. This factor can be modified in the spreadsheet.

Design ton per hour/year for selected equipment

The equipment used in the base case is based on a study that proposed equipment that generated 6.6 tons per hour and 49,626 tons per year. This is discussed at length in the report under the heading “Design conditions.” These values allow us to calculate per-ton capital and operating expenses, which can be applied to a mill of any size greater than 2 tons per hour using contingency factors, discussed below.

Capital expenses

These are based on the Mani study and correspond with the base case. These factors, including cost, installation cost and equipment life, can be modified in the spreadsheet. These are annualized using the equation

$$(\text{capital cost} + \text{operating cost}) \bullet [\ i \bullet (1 + i)^N \div ((1 + i)^N - 1)\ ]$$

where i is the interest rate and N is the expected life, and then converted to annualized per-ton costs by dividing by the design ton per year.

Capital contingency factor

The capital contingency factor serves two purposes. It can increase (or decrease) capital costs based on the size of the mill, according to table 5 in the report, and it can account for a general increase in the cost of pelleting equipment. For our base case, to be conservative, we assume a capital contingency factor of 20 percent to account for increased equipment cost. Note that if you want to preserve this price cushion, any factor adjustments made based on mill size per table 5 should be added or subtracted to the price factor

Table 5. Capital expense contingency factors for pro forma income statement

Pellet production rate (ton/hr)	Proxy metric rate (tonne/hr)	Capital cost ($/t)	Capital contingency factor (%)
2-3	2	10	67
4-5	4	7	17
6-8	6	6	0
9-12	10	5	-17
Greater than 12	14	5	-17

Equipment operation and maintenance

This is based on the design equipment. Of particular note is personnel cost, which includes labor in production, marketing and administration. These assumptions are based on two people to run the entire plant (3 shifts per day) and three people for bagging (1 shift per day), where only a third of the plant output is bagged.

Additional marketing

T.J. Morice of the Pellet Fuels Institute suggests that successful marketing of wood pellets can cost anywhere from $0.50 to $2 a ton.[55] We assume the personnel cost above corresponds to the middle of this range ($1.25), and so to be conservative we have included an additional marketing cost of $0.75 per ton.

Non-feedstock operating expenses

This is an estimate of the cost per ton of creating pellets, computed as the sum of the above two factors.

Operating contingency factor

The operating cost contingency factor allows you to use the spreadsheet with the Mani assumptions to model facilities as small as 2 tons per hour and as large as is desired. The original operating costs include feedstock and dryer fuel, which we have treated separately, and revised operating cost values are in table 6. Feedstock and drying costs are linearly related to pellet production rates, so removing these elements does not change the slope of operating cost curve shown in Figure 7.

Table 6. Operating expense contingency factors for pro forma income statement

Pellet production rate (ton/hr)	Proxy metric rate (tonne/hr)	Operating cost ($/tonne)	Proportion of operating cost for feedstock, drying (%)	Revised operating cost ($/ton)	Operating contingency factor (%)
2-3	2	90	61	32	100
4-5	4	56	61	20	25
6-7	6	45	61	16	0
10-12	10	38	61	14	-13
Greater than 12	14	37	61	13	-23

Transportation to market

Guy Guthrie of Frank Miller Lumber Company suggests that the minimum payment that can reasonably be offered a trucker is $200, which would cover a 100-mile haul at $2 per mile for each additional mile. We expect a shorter hauling radius from mill to retailer or distributor, but will use the $200 charge as the base price and assume that pellets are

[55] Morice 2007.

never hauled more than 100 miles from the facility. This factor can be modified in the spreadsheet.

Trailer capacity

We estimate that a trailer can haul 23 tons. This factor can be modified in the spreadsheet.

Transportation cost

The annual tons divided by trailer capacity and multiplied by the transportation rate.

Total expenses

The sum of feedstock cost, dryer feedstock cost, annualized capital expenditures, non-feedstock operating cost and transportation cost.

Appendix B. Indiana Census data: House heating fuel by occupant

Microsoft Office
Excel Worksheet

Appendix C. US Forest Service Timber Products Output survey for Indiana, 2000: Mill residues

Microsoft Office
Excel Worksheet

Appendix D. US Forest Service Timber Products Output survey for Indiana, 2000: Harvest residues

Microsoft Office Excel Worksheet