# Industrial Utilization of Pinyon-Juniper Biomass Resulting From Thinning Treatments in White Pine and Lincoln Counties, Nevada: Business Considerations

**Prepared For:**
**Lincoln County Regional Development Authority**
**P.O. Box 539**
**Pioche, Nevada 89043**

**Prepared By:**
**Intertech Services Corporation**
**P.O. Box 2008**
**Carson City, Nevada 89702**

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## Introduction

Much has been written over the years concerning the management of pinyon pine and juniper woodlands (P-J) in the western states. Historically the management of these woodlands has focused on providing livestock forage through overstory removal. These programs were popular in the 1950s and 1960s, but have become somewhat controversial due to the methods used during the management process, i.e. chaining and/or controlled burns.

More recently, the threat of catastrophic wildfire has prompted the Bureau of Land Management (BLM) and the U.S. Forest Service (USFS) to give heightened attention to alternative methods of management involving selective thinning of P-J. Selective harvesting of P-J woodlands has the potential to enhance multiple-use of public land through enhanced landscape values for watershed, wildlife, and domestic livestock while simultaneously reducing the risk of devastating wildfires. Thinning of P-J stands can result in significant quantities of small diameter biomass. Alternatives for management of biomass resulting from landscape treatment of P-J woodlands include deposition of all or a part of the hogged or chipped materials on the forest floor and removal of all or a part of the biomass for disposal and/or use offsite.

The pinyon-juniper woodlands have always contributed to the local economies by providing fuelwood, fence posts, pine nuts, forage for livestock, wildlife habitat, and watershed protection. With technological changes that are taking place, there is an increasing demand for pinyon-juniper byproducts that may meet or exceed traditional product standards in many areas. A section of this report will explore many of these emerging opportunities.

## Pinyon-Juniper Biomass Availability

### Distribution & Densities

It is safe to say that there is no "one size fits all" remedy to the challenge of managing the pinyon-juniper woodlands. There have been many studies offered which estimate the available supplies of P-J biomass in the western states, Nevada, and eastern Nevada (See Table 1). These estimates vary widely as illustrated by the following data. The estimated 40-60 million acres of pinyon-juniper woodlands in the west cover a wide range of climate/geography and management practices must be adapted to the immediate areas being addressed. (Gottfried and Severson, 1993). In its plans for the Eastern Nevada Landscape Restoration Project, the BLM Ely Field Office estimates there are 10.8 million acres of PJ woodlands in Lincoln, White Pine and parts of Nye counties that are ripe for fuels reduction projects. According to another source, pinyon-juniper woodlands cover 9 million acres in Nevada and contain almost 4.4 billion cu. ft. of P-J biomass. The average acre of Nevada woodlands contains 6.5 cords (464 cu. ft) of P-J volume (Ffolliott, Gottfried, Kruse, 1999). Still another source lists the fuelwoods for Nevada at 9 million acres of woodlands (Schmidt, 1994). For the Purpose of this report, the pinyon-juniper woodlands of Lincoln and White Pine counties in eastern Nevada will be the focal point of discussion.

**Table 1**

| **Estimates of PJ Biofuel Supplies** | | |
|---|---|---|
| **Source** | **Nevada** | **Eastern Nevada (Lincoln/White Pine)** |
| | | |
| BLM Ely Field Office | | 10.8 million acres |
| Ffoilott, et. al | 9 million acres | |
| Morris | | 3.6 million acres |
| Schmidt | 9 million acres | |
| Average | 9 million acres | 7.2 million acres |

**Proposals for Woodland Treatments**

Currently the BLM Ely Field Office plans to undertake pinyon-juniper fuels reduction projects involving an estimated 4,000,000 acres in Lincoln and White Pine counties. . Between 20 and 60 million tons of pinyon-juniper biomass may result from BLM thinning initiatives in Lincoln and White Pine counties. Current studies are underway evaluating cost of potential P-J thinning and chipping initiatives. These thinning initiatives are intended to greatly reduce the threat of catastrophic wildfire and result in long-term environmental consequences to public land related environmental and economic assets. In addition, BLM planned landscape treatments will promote economic expansion through provision of increased forage for wildlife and domestic livestock and improved watersheds. Recreation and ranching components of the Lincoln and White Pine county economies will also be aided by these thinning projects. It is anticipated that such land management practices would be conducted over a 20 to 30 year timeframe.

**Resource Sustainability and Alternative Ground Cover Depth Scenarios**

Between 20 and 60 million tons of pinyon-juniper biomass may result from BLM thinning initiatives in Lincoln and White Pine counties. In the case of the Mt. Wilson fuels reduction project, BML estimated the yield to be between 5-10 tons per acre. Average tonnage from the Ward Mt. fuels reduction project was estimated at 8.5 tons per acre (RCI, 2004). If these projects are indicative of the average yield in Lincoln County, it would provide a basis of cost effectiveness for economic investment and development in the area.

Resource Concepts Incorporated (RCI) has issued a project report entitled "Pinyon-Juniper Biomass Utilization Study for Lincoln County, NV August 2004." This report is intended to help inform decisions regarding appropriate levels of in-field P-J biomass deposition and will provide support for conclusions regarding quantities of biomass potentially available for removal off-site and for eventual use by industry. The report is part of an on-going study which is to be completed in 2005. An estimate of the potential supply of biomass for industrial applications under alternative ground-cover depth scenarios will also be provided, along with alternatives of ground cover depth scenarios including deposition of chips to a depth not to exceed 2 inches (the current BLM proposal); removal of chips from the thinning area with no surface deposition and deposition of 1 inch of chips on the ground surface. In addition, an analysis will be included on the effects of differing woodchip depths on post-thinning revegetation success and soil chemistry.

Both field plot and laboratory analyses of biomass management alternatives are being undertaken. Field analysis of these alternatives include the establishment of 100 square meter pots located on public land within Lincoln County and in consultation with BLM. Study plots have been GPS surveyed and existing baseline conditions are being documented (i.e. soil characteristics, existing vegetation, litter, organic materials, wildlife, site production [trees/biomass], tree ages, site ecological health, biodiversity and stability). Post thinning site conditions are being documented and photographed to reflect level of disturbance to soils and under story vegetation; impacts to biodiversity and wildlife; soil erosion, aesthetics, soil compaction, presence of invasive plant species and success of reseeding treatments (RCI, 2004).

Laboratory analysis is being undertaken by the University of Nevada under controlled conditions. The intent of the laboratory analysis is to simulate a more rapid response to postulated environmental conditions (i.e. soil type, soil temperature, precipitation, etc). For both field and laboratory trials the supply of biomass under alternative deposition depth and environmental response scenarios will be estimated and documented. In addition, an estimate of the range of biomass tonnage which may be derived from long-term BLM thinning initiatives throughout Lincoln and White Pine counties is being derived (RCI, 2004).

With anticipated successful results, another benefit of the P-J fuels reduction process will be this "seedlink" factor which promotes germination and growth of native forbes, grasses and grains as well as retains ground moisture and curtails runoff. These vegetative species provide habitat for propagation of sage grouse, deer, elk, and other native wildlife.

## Characteristics of Pinyon-Juniper Biomass

### Biomass Components

The largest components in biomass sources such as trees and grasses are cellulose, hemicellulose, and lignin. According to a United States Department of Energy website, cellulose and hemicellulose make up the large majority of components in biomass resources. Both cellulose and hemicellulose are polymers and sugars, which can be broken down to component sugars for processing to ethanol and other vital fuels and chemicals. Cellulose is the most common form of carbon in biomass and is a biopolymer of glucose. Hemicellullose is a form of sugar found in biomass, which consists of highly branched and short chains of sugars. Finally, lignin is a biopolymer, which is abundant in phenolic components; Phenolic components provide structural integrity to plants. Often, lignin is referred to as a “clean” coal (sulfur –free) because lignin is the portion of plants, which is the ancestor of coal (par., sec).

**Energy Content**

When compared to coal or oil, biomass is a low-density feedstock with low energy content. Heat and carbon content are directly proportional to the woods density. Gambel oak is an associate of P-J woods and is known to be a heavy species; though less dense, PJ woods can still be beneficially used (Ffolliott, Gottfried, Kruse, 1999). For reference, standard energy conversions and biomass energy values are provided. Energy contents are expressed here as Lower Heating Value (LHV) unless otherwise stated (Higher Heating Value HHV).

Quantities

- 1.0 joule (J) = one Newton applied over a distance of one meter (= 1 kg m2/s2).
- 1.0 joule = 0.239 calories (cal)
- 1.0 calorie = 4.187 J
- 1.0 gigajoule (GJ) = 109 joules = 0.948 million Btu = 239 million calories = 278 kWh
- 1.0 British thermal unit (Btu) = 1055 joules (1.055 kJ)
- 1.0 Quad = One quadrillion Btu (1015 Btu) = 1.055 exajoules (EJ), or approximately 172 million barrels of oil equivalent (boe)
- 1000 Btu/lb = 2.33 gigajoules per tonne (GJ/t)
- 1000 Btu/US gallon = 0.279 megajoules per liter (MJ/l)

Power

- 1.0 watt = 1.0 joule/second = 3.413 Btu/hr
- 1.0 kilowatt (kW) = 3413 Btu/hr = 1.341 horsepower
- 1.0 kilowatt-hour (kWh) = 3.6 MJ = 3413 Btu
- 1.0 horsepower (hp) = 550 foot-pounds per second = 2545 Btu per hour = 745.7 watts = 0.746 kW

Energy Costs

- $1.00 per million Btu = $0.948/GJ
- $1.00/GJ = $1.055 per million Btu

Biomass Energy

- Cord: a stack of wood comprising 128 cubic feet (3.62 m3); standard dimensions are 4 x 4 x 8 feet, including air space and bark. One cord contains approx. 1.2 U.S. tons (oven-dry) = 2400 pounds = 1089 kg
  - 1.0 metric tonne wood = 1.4 cubic meters (solid wood, not stacked)
  - Energy content of wood fuel (HHV, bone dry) = 18-22 GJ/t (7,600-9,600 Btu/lb)

- Energy content of wood fuel (air dry, 20% moisture) = about 15 GJ/t (6,400 Btu/lb)
- Energy content of agricultural residues (range due to moisture content) = 10-17 GJ/t (4,300-7,300 Btu/lb)
- Metric tonne charcoal = 30 GJ (= 12,800 Btu/lb) (but usually derived from 6-12 t air-dry wood, i.e. 90-180 GJ original energy content)
- Metric tonne ethanol = 7.94 petroleum barrels = 1262 liters
    - ethanol energy content (LHV) = 11,500 Btu/lb = 75,700 Btu/gallon = 26.7 GJ/t = 21.1 MJ/liter. HHV for ethanol = 84,000 Btu/gallon = 89 MJ/gallon = 23.4 MJ/liter
    - ethanol density (average) = 0.79 g/ml (= metric tonnes/m3)
- Metric tonne biodiesel = 37.8 GJ (33.3 - 35.7 MJ/liter)
    - biodiesel density (average) = 0.88 g/ml (= metric tonnes/m3)

(Bioenergy Information Network, Oakridge National Laboratory)

## **Industrial Applications of Pinyon-Juniper**

Since humans have emerged in the western part of the United States, they have developed numerous ways to utilize the natural attributes of the P-J woodlands. From earliest civilizations to the Native Americans and on to the ever-increasing numbers of settlers into the 19th and 20th centuries, uses of P-J resources have centered mostly on woodfuel, pine nuts, fence posts, mine timbers, building materials, charcoal, and Christmas trees. Native Americans extended these uses to medicines, ceremonies, beads and other foodstuffs. Most uses of P-J can be placed in the category of subsistence as opposed to economic gain. The most consistent economic factor was woodfuel, either as personal heat use or marketed as firewood.

Current and future uses of P-J products can have the same base purpose; however, in an ever-changing world (economically and technologically) the old base purposes can be expanded dramatically. P-J products have demonstrated the capacity to benefit the growing renewable resource market. P-J products may be used for electric generation applications (including co-firing), space and process heating, chemical and fuel production, densification and other marketable applications.

### Electricity Generation Applications

With the energy crisis of the early 2000s, there came a new demand for sources of energy as well as a renewed interest in cost efficiency. Many new power plant proposals have been designed for southern Nevada, with most tied to natural gas as a source of initial power. As natural gas has seen a recent surge in costs, biofuel sources become much more attractive and practical to consider for a feasible heat source process. If eastern Nevada could provide a sustained supply of P-J biomass, it may be possible to provide an atmosphere of interest in a biomass power plant or several small plants scattered throughout the region to supplement lower-cost power demands. Recently enacted state legislation mandating certain percentages of power derived from renewable resources would give additional impetus to biofuel projects in Lincoln County. Additionally, federal government energy incentives for renewable sources of energy will also play a major factor in helping to promote the development of biomass power generation. In various parts of the country, it has been proven cost efficient to provide energy through biomass generation (Badger, P.C. and C.D Stephenson, 1992; Le Blanc, J.D. 1993). Moreover, Stan Raddon of Growers Energy, Inc./Carson City Energy noted other studies show the benefits of biomass co-generation facilities are just as effective as 100% biomass derived power and in some cases more practical for state-of-the-art, fixed location facilities.

Biomass can be directly burned in its solid form or converted into liquid or gaseous fuels for electricity generation. Renewable biomass fuels are created by biomass power technologies using modern boilers, gasifiers, turbines, generators, fuel cells, and other methods. (CH2MHILL, 2004) A major restraint to consider with wood for energy is that wood has a higher value for its primary end uses (e.g., paper structural components, panels, mulch, sanitary products) than for fuel. "Using more wood for fuel would place upward pressure on the cost of primary products, unless additional forest resources are available near current costs." (CH2MHILL, 2004)

In 2000, only 1% of the US power generating capacity, 40 TWh (40 billion kWh) of electric energy generation out of 3500 billion kWh annually was generated using biomass other than municipal solid waste. However, this is quite a bit larger than the capacity generated by wind and geothermal sites around the US. Biomass power is the largest block of non-hydro renewable power generation in the US. Furthermore, biomass is an economic source of power when the fuel is low cost or free (Hughes, 2000).

The California biomass fuels market is currently a fairly mature market with over fifty power-generating facilities commissioned and in operation. Somewhere in the area of 900 MW of capacity have been built and placed into service in California with facilities in all areas of the state (Morris,2000). This of course would posses a transportation challenge for the eastern Nevada biofuel market. However, if sufficient masses of P-J chips were made available for marketing, the transportation problem could be solved. Lincoln County has excellent rail service, which would provide access to the biomass generating facilities in the San Joaquin and Imperial Valleys. All facilities purchase fuel from the same competitive open market and the high Btu value and low ash content expected of P-J fuels indicate that they probably would be able to earn a premium price on the open market (Morris, 2000).

Biomass waste is utilized to produce electricity across the US using various combustion and gasification technologies and ranging from small-scale operations (<1 MW) to large-scale operations (>15MW). (Bergman, Zerbe, 2001). Major Biomass power technologies include:

- Dedicated wood-fired power plants
    - Direct combustion in a stoker or fluidized-bed boiler, driving a steam turbine generator

- Advanced direct combustion, direct firing of a combustion turbine, and exhaust duct firing in a gas-fired combustion turbine/combined cycle plant
- Advanced gasification/combined cycle, steam-injected gas turbine (STIG), intercooled STIG (ISTIG), or fuel cell power plant

- Cofiring with coal in a retrofitted utility or industrial boiler, driving a steam-turbine generator (Wiltsee, McGowin, Hughes, 1992**)**

Three 16 MW wood waste fueled power plants began operation in New England between 1987 and 1988. The plants utilized stoker technology and operated three identical boilers; 140,000 lb/hr, 900 psia/900 F units. Three primary sources of fuel supplemented the plants fuel needs including 2-3 inch wood waste chips, sawmill and wood processing plant wastes, and bark. Ash was used as an effective fertilizer and soil conditioner and was disposed of in a landfill (Leblanc).

Fluidized bed combustion technology for electric production is commercially viable for electric production and has been demonstrated at multiple sites around the US. In 1990, California developments represented the largest element of this experience within the US. California had 165 MW of Circulating Fluidized Bed (CFB) capacity based on wood and other biomass residues. Furthermore, it was noted that three CFB boilers, over 100 MW were operated by utilities around the US.

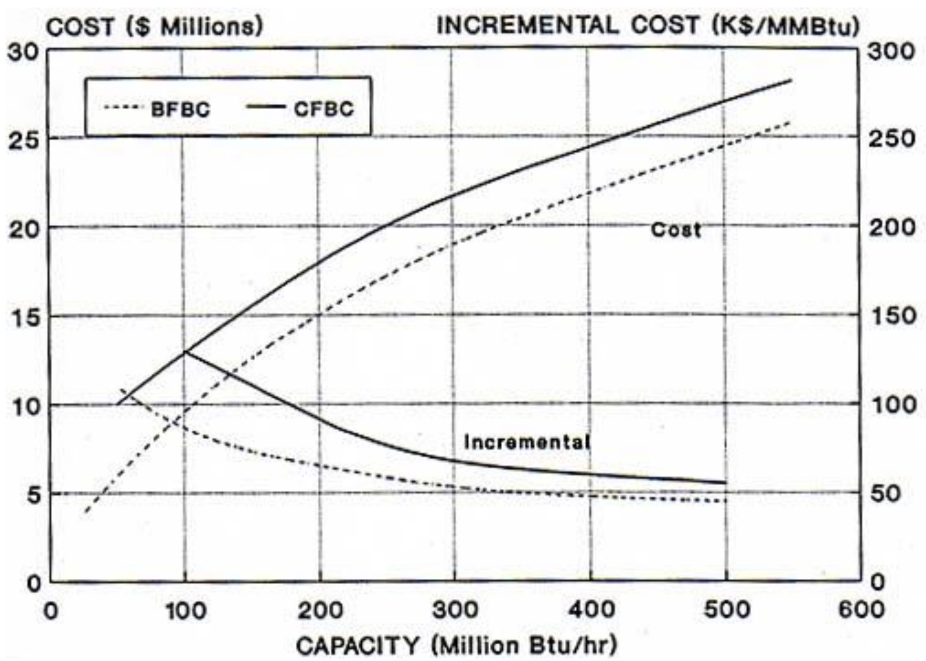
Fluidized bed combustion technology fueled with biomass has demonstrated to be applicable to rural communities. Design specifications for one such unit called for consumption of 612 lb/hr of fuel with a heating value of 5,270 Btu/lb. The net electrical output was approximately 200 kw-hr/hr. This corresponded to a heat rate of 16,130 Btu/kW-hr (Sanders, Purvis, Bray, 1994).

Prototype mobile bipower systems have been developed generally 12’ by 50’ or smaller and capable of generating 2.5 MW of power. The systems are easily moved by truck and designed to be taken into the forest to utilize downed trees, harvesting residues, and other undergrowth. Wood is burned in a fluidized bed combustion system for power generation. The systems uses a novel conversion device capable of operating off steam pressure as low as 100 psi. A transformer with the flexibility to interface with a number of high transmission voltages is included as part of the modular system and could accomplish power transmission. Thus, it is only necessary to set the system up close to a transmission line to tap into the system (Appel, 2000).

Fluidized bed gasifiers can utilize biomass to produce a low and medium Btu gas and provide an attractive alternative to fossil fuels. Syngas can be produced using a gasification system and steam reformer technology. A demand for such systems exists with forest service companies, primarily panel mills, which have a large heat requirement, and substantial quantities of sanderdust available. Steam gasification of wood residues substantially offers all the advantages of natural gas used for heat in panel mills. However, biomass gasification may offer a significantly lower long-term cost than natural gas while maintaining control over cost and supply and providing a means of wood residue disposal (Menville, 1996).

Fluidized Bed Combustion (FBC) and Fluidized Bed Gasifier (FBG) manufactures were surveyed to obtain capitol costs and installation costs for systems using biomass fuels. Costs were provided for Bubbling Fluidized Bed Combustion (BFBC) and Circulating Fluidized Bed Combustion (CFBC) steam generators and four different FBG technologies. Figure 1 shows costs of BFBC and CFBC steam generator systems between 25 and 550 million Btu/hr. Costs are for all equipment from the fuel storage tank outlet to the stack inlet, including fuel feed, fans, ducts, combustor, steam generator pressure parts, cyclones and emission control equipment (Castleman, Gottschalk, Vincent, 1994).

**Figure 1. FBC Steam Generator Capitol and Installation Cost**




A typical FBC steam generator system (100 million Btu/hr unit) burning wood chips should produce steam for approximately 2.7 cents/1000 pounds if the fuel is site generated waste which is free. (Castleman, Gottschalk, Vincent, 1994)

## Co-firing Applications

Co-firing of biomass with fossil fuels is a well-established technology and continues to develop as a positive economic method of biomass utilization. Co-firing offers potential applications ranging from small to large scale. Biomass co-generation applications include village power applications, schools that co-fire in boilers and generate hot water for space heating, processing steam for dry kilns, electricity production for industries such as a lumber manufacturing plants, and a variety of applications in power plants.

Compared to the typical practice in existing boilers that fire 100% wood-derived wastes as fuel, co-firing in existing coal-fired power plants, makes it possible to achieve better power efficiency in converting biomass into electric power (Hughes, 2000). In 1987, Power Magazine listed 182 companies who had co-fired boilers, including 31 electric utilities. Much of this was done in existing coal boilers. In addition, wood waste is also commonly co-fired with coal in the pulp and paper industry. In 1987, the U.S pulp and paper industry consumed 46.5 millions tons of wood waste and 13.4 million tons of coal (Wiltsee, McGowin, Hughes, 1992).

There is increased interest in co-firing of biomass fuel with coal in existing utility boilers for reasons including:

- Lower $SO_2$ emissions than for 100% co-firing. This is an important advantage for existing coal-fired utility boilers affected by the Clean Air-Act Amendments (CAAA) of 1990.
- Higher Thermal efficiency than for a dedicated 100% biomass-fired boiler.
- Lower capitol cost than for a dedicated 100% biomass-fired boiler. The capitol cost savings are significant for co-firing in an existing coal power plant relative to a new dedicated 100% biomass fired power plant.
- Lower cost of some biomass fuels than for coal.
- Lower impact of the varying quality and quantity of biomass fuel, due to blending with coal.
- Helps ease the growing solid-waste disposal problem.
- Potential of generating ash waste in a better form, such as slag (in a cyclone furnace) and the mixing of biomass ash with coal ash. (On the other hand, adding waste components to an existing facility's coal ash might impact the utility's ability to sell the ash.) (Wiltsee, McGowin, Hughes, 1992)

Despite the potential of co-firing, profits appear to be in the future. In many cases, the cost differential between biomass and coal is not sufficient to accomplish capitol recovery. Although profits appear to be in the future, there are potential benefits, which could manifest themselves presently. Potential profits can be found in buyers who are willing to pay extra for a megawatt hour of co-fired energy; particularly if co-firing can be considered green power. Profit and benefits may be found in selling power to a customer (community, region, state, industry) who stands to create sales and revenue based on the image co-firing creates. In addition, another path of potential revenue is selling to a governmental buyer interested in (1) research and development projects or (2) greenhouse gas emission reductions (Hughes, 2000).

## Space and Process Heating

Numerous facilities in the US use biomass wood residue for space and process heating. Operation size varies but includes micro scale operations (<1 MW) through large-scale operations (>15MW). Small-scale space and process heating is used for many schools and private institutions while large-scale space and process heating is common in many large scale-manufacturing plants (Bergman, Zerbe, 2001).

Distilleries use wood waste for space and process heat (cooking, distillation, and cleaning). One such distillery uses two boilers one rated at 55,000 lb/hr and the other at 80,00 lb/hr. The boilers burn an average of 220 TPD of hardwood sawdust (primarily oak) and whole tree chips. The distillery used 64,000 tons of wood fuel between May 1989 and May 1990. In 1991, 21% of the distilleries energy needs came from natural gas, 77-78% from wood, and 2-3% from coal (Badger, Stephenson, 1992).

Biomass waste is also beneficial for industrial drying activities. Plants which manufacture wood products (furniture, trailer decking) can use wood waste generated on site and burned in boilers to power industrial kilns, provide space heat, and meet other electric needs.

Wood waste is used in furniture manufacturing plants with natural gas to kiln dry green boards and provide other power needs in plants. Normal electric bills with cogeneration could run $65,000-6,500 per month with in-house generation saving $6,500-$9,200 per month based on $.07 kwh retail electric cost* (Badger, Stephenson, 1992).

### Chemical and Fuel Applications

The push to improve quality of life while simultaneously practicing sustainable environmental practices has resulted in an intensification of research and development aimed at developing an array of chemicals and fuels from biomass. As a result, the market for chemicals and fuels derived from biomass is gaining momentum as an alternative to non-renewable sources. Currently, projects are underway for biomass fuels and chemicals in both research and production capacities.

Possible uses of P-J include products made by altering wood fiber and products derived from the chemical constituents or extractives of wood. This may be obtained from chipped or shredded P-J. Chemical constituents including turpentine, resin, and a variety of oils can be obtained through distillation of wood and foliage and solvent extraction processes. Among the chemical products possible are extractives that are rich in cedrol and associated essential oils (Ffolliott, Gottfried, Kruse, Date.). The wood of Virginia Juniper has been exploited commercially for cedarwood oil used in pharmaceuticals, perfumes, polishes, and insecticides. It is reasonable to assume that other western junipers would produce oils of similar composition.

Other general chemical applications from biomass feedstock include; plastics, solvents, pharmaceuticals, phenolics, adhesives, furfural, fatty acids, acetic acid, carbon black, paints, dyes, pigments, ink, and detergents.

Levulinic acid, furfural and formic acid can all be produced using cellulosic biomass waste. Levulinic acid, a versatile chemical, converts to a range of commodity chemicals including:

- Methyl Tetrahydrofuran (MTHF), which has been shown to be an excellent substitute for gasoline for automotive use, can be blended with gasoline at up to 70% by volume without adverse effects on engine performance and pure MTHF has an octane value of 87; equivalent to that of base gasoline.

* Cost has been adjusted using the Consumer price index (2003)

- Diphenolic Acid is used as a component for protective and decorative finishes and can be used as a substitute for bisphenol A; the primary raw material for epoxy resin.
- Delta Amino Levulinic Acid (DALA) is a naturally occurring non-protein amino acid, which is being developed as a highly potent pesticide against a wide range of weeds and-light sensitive insect pests.

Other applications of levulinic acid include tetrahydrofuran (major solvent chemical), 1 and 4 butanediol (important polymer chemical intermediate), succinic acid (specialty chemical), and other solvents, plasticizers, disinfectants and pharmaceuticals.

Levulinic acid, with a 1993 market of 2 million lbs/year and a market value of $7.64/lb is projected to have a process cost of $.31/lb in a small scale plant*.

The commodity chemical furfural, had an estimated 1993 market of 500 million lbs/year and would presently sell for $.95/lb*. Formic acid has a market value of $.64/lb* **(**Fitzpatrick**,** 1993**).**

Tars, which may be substituted for a large portion of the phenol-formaldehyde used in adhesive resin production, can be produced using biomass. North America uses approximately 320,000 tonnes of phenol and formaldehyde to make adhesive resins used in the production of exterior grade structural panels. Approximately half the phenol and formaldehyde by weight can be replaced by biomass produced tar. A plant producing 13,865,000 kg (30,566,000lb) annually from 308 tonnes (340 tons per day of green wood chips would cost $10,140,000. Operating costs with wood at $20 per wet tonne ($18/ton) would be approximately $.34/kg ($.23/lb)* (Himmelblau, 1995).

Ethanol as a motor fuel is the most commonly produced fuel from biomass. Ethanol is commonly made using agriculture residue however, wood residue could also be used as an economically and environmentally sound feedstock in ethanol production. The cellulose and hemicellulose fraction of P-J can be broken into simple sugars, which can be fermented into ethanol. Availability of raw materials, efficient manufacturing, well managed product marketing, and federal state subsidies are important factors for ethanol to be economically viable.

In recent years, ethanol has become a major additive to the gasoline fuel market and in many states is mandated by law to make up a certain percentage of the fuel market. Serious legislation before Congress may impose mandatory requirements for ethanol to be incorporated in the national fuel market. Ethanol can be used as a fuel additive to oxygenate gasoline during summer months. Although it is probably more feasible to make ethanol from corn or other grain commodities, one cannot rule out other possible

* Cost has been adjusted using the Consumer price index (2003)

sources with the continued crises in the national and international fuel market (Bergman, Zerbe, 2001).

Novel improvements made to the dilute acid cellulose hydrolysis process may improve process efficiency and cost effectiveness in ethanol production. One process claims to produce ethanol from cellulose for about $0.65 per gallon. Other benefits include capitol cost reductions and production and operating cost reductions. Hardwood and sawmill wood wastes have both tested successfully for production.

Residue wood can also be used to produce methanol. Methanol, known as wood alcohol, is made from wood or coal through gasification. The gasification process forms syngas, which can then be converted to methanol. Methanol has a lower energy density than ethanol and is a toxic substance. However, methanol can be made at higher yields than ethanol (Bergman, Zerbe, 2001).

Facilities are capable of converting 350 tons-1,000 tons a day of municipal solid waste (MSW) and refuse derived cellulose (RDC) into 5-7 million gallons of ethanol per year. In addition, modular plants can consume 30-100 tons of cellulosic feedstock per day and yield 500,000-100,000 gallons of ethanol per year. Producers may offer packages including:

- Feasibility studies
- Site analysis
- Development and construction
- Private and public financing
- Neighborhood revenue and sharing
- Royalty sharing programs

(Bioenergy Update, 2003)

Another exciting innovation in the fuel industry is the development of biodiesel fuel as a supplement to diesel or a complete replacement. According to the Alternative Fuels Data Center the use of biodiesel has grown dramatically during the last few years. The Energy Policy Act was amended by the Energy Conservation Reauthorization Act of 1998 to include biodiesel fuel use as a way for federal, state, and public utility fleets to meet requirements for using alternative fuels. That amendment started the sharp increase in the number of biodiesel users, which now include the U.S. Postal Service, and the U.S. Departments of Defense, Energy and Agriculture. Countless school districts, transit authorities, national parks, public utility companies, and garbage and recycling companies also use the fuel.

A Number two-diesel fuel can be produced using a wide array of biomass feedstocks and a liquefaction process. The first step of liquefaction is a gasification/pyrolysis step, which produces a synthesis gas. The second step, a catalytic liquefaction step, uses the synthesis gas to produce diesel fuel. The two process steps utilize fluidized bed and slurry phase reactor technology. The process lends itself to small and medium-sized packaged plants starting at 200 tons per day and with expansion possibilities of up to 800 tons per day.

According to the American Biofuels Association, with government incentives, comparable to those that have been provided for ethanol, biodiesel sales could reach about 2 billion gallons per year, or replace about 8% of conventional highway diesel fuel consumption.

Liquefaction offers advantages such as feedstock flexibility, a transportation grade high quality product, large volume reduction, low processing times, and process simplicity. Possible system problems include solids feeding, hot solids transfer, tar condensation, and catalyst activity. Particulates from feedstock, air emissions, liquid effluents and noise control should be considered in regards to environmental compliance. The current price and availability of petroleum and natural gas should be considered a constraint when producing commercial fuel from liquefaction. Capitol costs for biomass chemical and fuel production may be defrayed by federal and state assistance to encourage a process, which helps solve a waste issue and creates relief from the nation's dependence on imported oil for gasoline production (Joyner, Vaughan, White, Wolf).

Overall, the process advantages of biomass chemical and fuel production include the ability to readily accommodate a wet feedstock, versatility of feedstock, high simultaneous yields of products, high reactor throughput rates, energy self-sufficiency, and plant modularity. Major market opportunities include food processing, petroleum, shale tar sands, plastics, tires, rubber, adhesive resin tars, products derived from levulinic acid and other liquid fuels.

**Densification**

When wood is refined into other forms its value as a fuel increases. Densification of wood wastes may prove to be an efficient and beneficial use of residue biomass. Densification is a possible solution to problems associated with production and storing of residue biomass. Densified wood fuel pellets offer advantages including uniformity, low and constant moisture content, a heat content near 8,500 BTU per pound, a sulphur content of essentially zero, and an ash content less than 1%.

P-J has been used in eastern Nevada for charcoal densification going back to the Native Americans and early mining camps. All of the P-J species are suitable raw materials for charcoal. Changes in technology have not eliminated the demand for charcoal, but perhaps have increased it with the commercialization of cooking and use of briquettes. Once again the increased home ownership and population growth in Nevada and the rest of the country have given rise to a greater demand for recreation, outdoor activity, and family picnics and cookouts.

Drying wood and compressing sawdust feedstock produces densified wood fuel. The result is a product with a density of more than 70 pounds per cubic foot. With a properly designed appliance or furnace, this product is a satisfactory clean burning fuel. The majority of densified wood fuel is manufactured as pellets. Manufacturing capacity in the U.S. is 600,000 tons per year and the market for the product is 90% residential. Consumer costs are $3.00/40 lbs a day or $8.82/MBTU **(**Pickering).

Briquetting, a densification process, involves removing odd materials, size reduction, and natural or forced drying. Briquettes are commonly used in households in furnaces, fireplaces, and barbeques. In addition, small industries like ceramics use densified fuel boilers.

Types of briquetting machines include:

- Impact press- 200 to 1,5000 kg/hr (440-3,3000 lb/hr)
- Extrusion press- 500-2,500 kg/hr (1,100-5,500 lb/hr)
- Hydraulic and pneumatic briquetting press-50-5,000 kg/hr (110-11,000 lb/hr)
- Double Roll press-Data not available
- Briquetting machine-50-800 kg/hr (110-1,1760 lb/hr
- Pellet machine- 25,000 kg/hr (55,000 lb/hr)

Industrial briquetting manufacturing costs with primary or secondary wood residues are 0.038-0.056 $/kg (0.018-0.026 $lb/hr) for factories producing over 1,000 kg.hr and working 16 hour days* (Ortiz, Miguez, Granada, 1996).

Charcoal produced from biomass can be used for large-scale industrial production as demonstrated by industrial activity in Brazil. In 1991, from a total of 8 million tonnes of charcoal, 2 million tonnes were used in the production of 3.8 million tonnes of steel, 3.7 million tonnes were used in the production of 4.5 million tonnes of pig iron, and 734 thousand tonnes were used in the production of 915 thousand tonnes of ferroalloys.

**Further Biomass Applications**

Wood waste derived from P-J stands can be used as firewood and fence posts, for the production of particle and cement board, for landscaping purposes, and a host of other uses.

P-J species have been used longer and more extensively for firewood than any other product. In the interior west, this wood remains the main fuel in some rural localities, while the popularity of wood-burning fireplaces contributes to its urban demand. Harvesting for commercial firewood is often done in urban centers such as Las Vegas, Salt Lake City, and Phoenix. Public land records indicate that 12,096 cords of P-J firewood were sold in 1989, while 4,628 cords of P-J were sold in Utah for firewood in 1992. The average wholesale price for firewood delivered to brokers within the Four Cornered States, Southern California, and Nevada ranged from $60 to $120 for pinyon and $54 to $133 for juniper; the highest prices paid where in Southern California* (Ffolliot, Gottfried, Kruse, 1999).

Juniper species in the interior west share many physical similarities with eastern red cedar and, therefore, can be considered for similar uses for veneer and particleboard.

* Cost has been adjusted using Consumer Price Index (2003)

Veneers from western juniper species could be satisfactorily utilized in furniture and paneling products however, questions of marketing veneer from juniper remain.

The wood of almost any species can be used to manufacture particleboard. Pinyon can be used to make a satisfactory interior grade particleboard while Juniper offers superior opportunities for particleboard production because its texture, color, and fragrance. With the recent building boom in Nevada and the rest of the country, along with the drastically inflating costs of construction and the shortage of wood products, the market for all building products and particleboard in general is at an all time high. Studies indicate that P-J could be a successful contributor to the equation with the proper marketing and manufacturing techniques (Ffolliott, Gottfried, Kruse, 1999).

Tests also indicate pinyon and juniper woods have potential for use as cement board. Cement board is composed of cement, wood fiber, and water. The product is fire resistant, relatively unaffected by water, and can be worked like particleboard. Cement board has many uses including exterior siding, air conditioning and utility ducts, and all-weather foundations for basements. Again, with the boom in construction in the southern Nevada area expected to continue into the distant future, such modern construction techniques will drastically increase in demand (Froiliott, Gottfried, Kruse, 1999).

Juniper wood residues have been pulped with mixed results. The wood produced low yields, which needed nearly twice the quantity of bleach chemical than is commonly required for bleachable pulps. The pulp was too difficult to bleach for white paper stock, to weak for un-bleached high-grade bag and wrapping paper and too soft for corrugating board medium. The pulp was demonstrated to be best suited for blends with other softwood pulps (Froiliott, Gottfried, Kruse, 1999).

Pinyon has been experimentally pulped with satisfactory results. Brightness and bleaching characteristics are similar to those of ponderosa pine. However, because of shorter fiber lengths, pulp strength is below average for softwood pulps. One test found that pinyon and juniper species could be used to make quality Kraft-paper (Froiliott, Gottfried, Kruse, 1999).

A new absorbent has been developed for oil spills, which attracts oil and chemicals and floats on water indefinitely. It is referred to as mpm-leaching and can save land and beaches from environmental disasters and then can be disposed in an environmentally acceptable manner or recycled. This product is made from “pin chips”, a waste wood product designed for marine oil spills. It is also effective for oil and chemical spills on land (Reed, Mobeck).

Waste woods and recycled plastics are also used for home enhancement products. Decking and railing made from waste wood and recycled plastics are becoming more common and offer a potentially viable market.

According to Horsedata.co.uk, an online equine source, wood residues can be processed as a useful surface for indoor and outdoor equestrian centers. As a riding surface, wood chips produce a firm surface, maintain a cushioned quality, and offer a slight bounce making it a popular choice within the equestrian industry. Furthermore, being a natural product, there are no smells or fumes from the surface in very hot weather (par., sec).

## Economic Considerations

The costs of such fuels reduction initiatives may be offset by cooperative ventures with other local government entities as well as private ventures. There are various scenarios that would be economically beneficial to all parties concerned. This report will focus on several possibilities that may provide a positive solution to the many problems posed by the serious conditions that exist within the P-J woodlands of eastern Nevada.

### Wood Land Treatment Costs

There are a wide variety of methods used to selectively harvest pinyon-juniper for biomass production. New technologies allow for both selective and full land clearing. Cutting is usually accomplished using shears mounted near ground level on a tractor. An alternative is to use a feller-buncher which both cuts the trees and grabs them to haul to a landing. Some operations cut the trees and leave them to be picked up by other equipment. Once the trees are cut, they can be chipped on site or hauled to a fixed processing facility for chipping. Obviously, the type of cutting/clearing and terrain of the fuels reduction project will determine the costs involved. For the areas of Lincoln and White Pine counties, onsite chipping would probably be the most cost effective means of the thinning/harvesting process due to the expense of hauling downed trees and shrubs to a central facility. It is more practical to condense any transport load into chips than to transport the mass of material to be chipped.

Much study has been given over the past years to the cost feasibility of harvesting P-J on the open market. The most recent comprehensive study involving actual costs in the local area has been conducted by Resource Concepts, Inc. in its draft document, Pinyon-Juniper Biomass Utilization Study, Cost Documentation Report, May 2004. This document presents the fuels reduction cost factors involved in several Lincoln and White Pine County projects, as well as from other areas of the state, California and Utah. As indicated in the above reference, costs may not be entirely complete but serve as the most recent and "ball-park" figures available.

Mt. Wilson Project, Lincoln County

The Mt. Wilson Fuels Reduction project was implemented during the fiscal year 2004. Seven hundred and forty acres were included in the BLM fuels reduction contract. The treatment involved thinning dense stands of P-J trees, and leaving a density of approximately 25 of the larger trees per acre. Equipment used included; rubber-tired grapple skidder, front-end loader with forks and grapple, a whole-tree chip-harvester, and trucks to haul chips to a stock-pile area for future use (RCI, 2004). The approximate cost per acre is shown in Table 2. The hauling costs for this project are relatively low because of the short distance the chips were hauled to the stock-pile area.

**Table 2**

| Summary of Contract Items for the Mt. Wilson Fuel Reduction Project | |
|---|---|
| **Contract Item** | **Total per Acre Costs** |
| Cutting | $ 260.00 |
| Skidding | $ 145.00 |
| Chipping | $ 285.00 |
| Hauling (with chip van) | $ 115.00 |
| Total per Acre Cost | $ 805.00 |

Source: RCI, Draft Pinyon-Juniper Biomass Utilization Study, Cost Documentation Report, May, 2004

Ward Mountain Project – White Pine County

In the Ward Mountain project, BLM contracted for the fuels reduction for three hundred and forty-five acres to be lopped and scattered, slashed, and chipped. Another two hundred and sixty-three acres were included in the cutting operation. This treatment also called for thinning dense stands of P-J trees, and leaving a density of approximately 25 of the larger trees per acre. Equipment used on this project included rubber-tired bunchers, front-end loader with forks and grapple, waste recycler (for chipping) and belly dumps for hauling the chips to an off site location (RCI, 2004). The approximate costs for the Ward Mountain project are shown in Table 3.

**Table 3**

| Contract Items for the Ward Mountain Fuel Reduction Project | |
|---|---|
| **Contract Item** | **Total per Acre Costs** |
| Cutting and Pilling | $ 800.87* |
| Lop and scatter | $ 12.87* |
| Slashing | $ 12.87* |
| Chipping | $ 249.29* |
| Hauling (hauling with belly dumps) | $ 179.71* |
| Total Cost per Acre | $1,255.61 |

* Adjusted for operational purposes, but total cost is accurate

Source: RCI, Draft Pinyon-Juniper Biomass Utilization Study, Cost Documentation Report, May, 2004

Hand Crew Projects

Hand crews are usually used on projects that are not suitable for large heavy equipment. These sites generally are in steep terrain or where access is limited. According to the Nevada Fire Safe Council, the cost per acre for hand crews performing fuel reduction services including, cutting, removal, grinding, and trucking operations range between $2,000 and $3,500 per acre (RCI, 2004).

Mastication

Mastication is becoming more common as a means of fuel reduction and will be touched on here simply as a comparison of fuel reduction costs. In the area of providing biomass products, mastication is not practical as the end result is not convenient for recycling the wood chips that are produce. In the mastication process, a mechanical masticator grinds trees from top to bottom leaving piles of small sized aggregated biomass material on the ground around the original tree trunk. Ground fuels following treatment are generally one to four inches deep and leave areas of bare mineral soil between masticated areas (RCI, 2004). For comparative cost purposes, recent mastication projects around the state are included in Table 4.

**Table 4**

| **Mastication Project Costs Per Acre** | | |
|---|---|---|
| **Project** | **Total Acres** | **Cost per Acre** |
| Holbrook Junction (HJ), Nevada | 110 | $740 |
| Hungry Valley (HV), Nevada | N/A | $150 |
| Cedar City, Utah | N/A | $133* |
| Alpine County (AC), California | 25 | $1,000 |

*Contractor took the contract at a loss

Source: RCI, Draft Pinyon-Juniper Biomass Utilization Study, Cost Documentation Report, May, 2004

Comparative Chipping Costs

The Lake Tahoe Basin Management Unit (LTBMU) has been conducting fuels reduction projects within the Lake Tahoe Basin and has incorporated chipping as a means to dispose of non-merchantable trees. Even though the types of trees are different from the PJ stands in Lincoln County, the costs of chipping should be comparable. Fuel loads ranged between 10 and 50 tons per acre with the average cost of $650 per acre.

Overall Cost Comparisons

As indicated earlier, there is no “one shoe fits all” cost factor which adequately predicts or accurately indicates the costs involved in fuels reduction projects. With the many variables such as density, size of trees, slope, accessibility, distance from markets, etc.; the costs will vary from site to site and project to project. The major factor in any cost analysis is the contract specifications as to what type of work needs to be done. Each phase of any project will have its own cost determinants. Cutting (hand or mechanical), types of machinery used, chipping and hauling being determined by logistics, etc. will be the major determinants in the cost factor. The most practical approach is to use comparable projects and recent actual market conditions within a framework of projections to come to a realistic expectation. Table 5 offers a comparison of biomass treatment costs for various projects. Table 6 provides a comparison of costs associated with recent field trials in Lincoln County with costs of other biomass treatment projects.

**Table 5**

| Comparison of Biomass Treatment Costs (Cost per Acre) | | | | | | |
|---|---|---|---|---|---|---|
| **Operations** | **Ward Mt.** | **Mt. Wilson** | **LTBMU** | **HV** | **HJ** | **AC** |
| Cutting and Skidding/piling | $800.08 | | | | | |
| Chipping | $249.29 | | | | | |
| Chipping, skidding And applying chips | | | $650 | | | |
| Masticating | | | | $150 | $740 | $1000 |
| Cutting, skidding Chipping, and applying chips | | $1455.84 | | | | |
| (Equivalent to hand crews) Great Basin Institute had costs of $2,000 and $3,500 | | | | | | |

Source: RCI, Draft Pinyon-Juniper Biomass Utilization Study, Cost Documentation Report, May, 2004

**Table 6**

| Summary of Project Cost Comparisons (Cost per Acre) | | |
|---|---|---|
| **Operations** | **Study Plot Cost/acre** | **Comparative Projects Cost/acre** |
| Cutting and skidding/piling | $405.00 | $800.08 (Ward Mountain) |
| Chipping | $285.00 | $249.29 (Ward Mountain) |
| Chipping, skidding, and applying chips – equivalent to mobile chippers | $2,186.27 | $650.00 (LTBMU) |
| Cutting, skidding, and chipping, - roughly equivalent to masticating* | $690.00 | $150.00 (Hungry Valley)<br>$ 740.00 (Holbrook Junction)<br>$1,000.00 (Alpine County) |
| Cutting, skidding, and applying chips – equivalent to Hand Crews | $2,446.27 | $1,455.84 (Mt. Wilson)<br>$2,000.00 (GBI)<br>$3,500.00 (GBI) |

Source: RCI, Draft Pinyon-Juniper Biomass Utilization Study, Cost Documentation Report, August, 2004

Marketing of P-J Biomass

The biggest challenge in making use of materials produced through any types of fuels reduction projects in Lincoln County is the marketing of the biofuel masses. With the volatile fuel market providing an unknown factor in any mode of transportation involved with shipping of chips, or any manufactured product, it is difficult to project economic success for any type of commercial venture.

Todd Brinkmeyer, Owner, Plummer Forest Products noted in areas such as Idaho, it doesn't seem to make a difference in cost if green fuel is cut in the forest and chipped on site or cut in the forest and shipped to a mill and processed. The price per ton is about the same, $40.00. However, they are dealing with a different type of product, in that many of the logs are mill able and they have other uses for the byproducts. In the above case excess biomass is used as a source of fuel for a biofuel generator as well as marketable landscape ground cover (Doug Fir and Larch Bark). P-J biomass would not fit into the category of hauling to a mill due to the nature of the trees and time and labor involved in trimming, sorting, stacking and hauling.

It is safe to assume that any commercial venture stemming from fuels reduction projects would have to be structured similar to the harvesting techniques used on the Mt. Wilson and Ward Mountain projects. That is, the cutting, skidding, and chipping would have to be done on site with the chips hauled to a central area for processing. With the wholesale value of chips currently at a relatively low level (approximately $25 per green ton), it appears that the most economically feasible approach to commercialize P-J biomass is to consider a chip processing plant located in or around Caliente which could combine several production processes together. One example would be to produce wood pellets or briquettes and use the byproducts for other applications (steam generation, biofuel for power, etc.) so that the maximum economic benefit can be derived at the lowest cost.

BLM had estimated the cost of fuels reduction projects in Lincoln and White Pine Counties to run between $659 and $1200 per acre. As was indicated earlier, actual cost of the Mt. Wilson Project was approximately $805 and Ward Mountain was approximately $1,255. A public/private partnership could lower this expense drastically and at the same create jobs, stimulate the economic atmosphere in eastern Nevada, and restore the forestlands to an environmentally sound condition.

**Transportation**

Lincoln County's accessibility too much of the western market affords the possibility for rapid and excellent transportation systems. Lincoln County is advantageously located at the hub of many major western markets and most of the 11 state western region can be reached via two-day truck service.

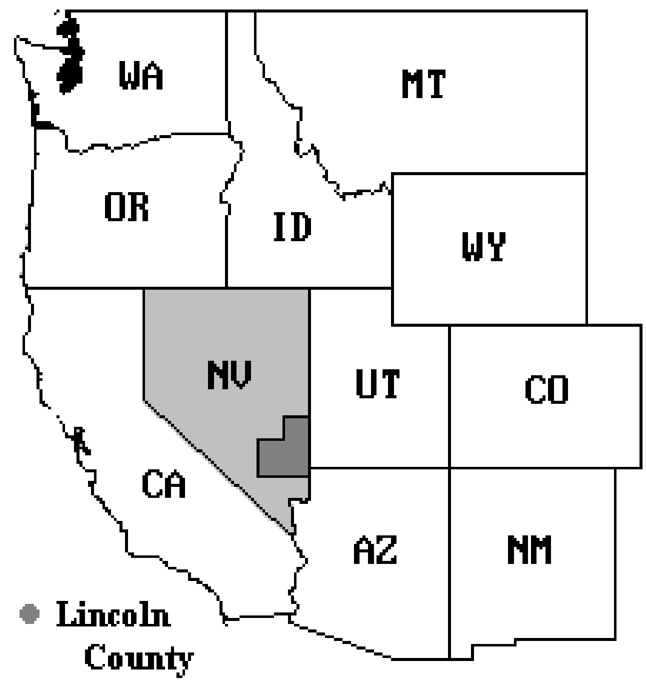
Trucking- U.S. Highway 93 runs north to interstate 80 or south to interstate 15.

Rail Service- Union Pacific Railroad provides freight service East, West and South. Amtrak provides passenger service to Salt Lake City, Cheyenne, Las Vegas, Los Angeles and all points north or south.

Airport- Lincoln County Airport is located 2 miles west of Panaca, NV. The airport has fuel available and a 4,600 ft. lighted and paved runway. The Las Vegas McCarran International Airport is 159 miles from Caliente, NV.

Even though there are markets for P-J wood chips in the biofuel electric generating arena in the San Joaquin and Imperial Valleys of California (Morris), the transportation costs whether by rail or truck would be prohibitive at this time of escalating fuel expenses. Current transportation expenses include rail costs between $1,466 (111.1 cu. yds.) - $1,700 (189.8 cu. yds.) per car (plus an additional fuel surcharge) and truck costs (10,000 lbs.) between $1,000 - $1,200 (plus and additional fuel surcharge).

| **Miles to/from Caliente, NV** | |
|---|---|
| Las Vegas, NV | 150 miles |
| Salt Lake City, UT | 345 miles |
| Los Angeles, CA | 420 miles |
| Reno, NV | 430 miles |
| San Diego, CA | 480 miles |
| San Francisco, CA | 555 miles |
| Sacramento, CA | 560 miles |
| Denver, CO | 675 miles |
| Portland, OR | 940 miles |
| Seattle, WA | 1,015 miles |




**Industrial Sites**

Meadow Valley Industrial Park
The City of Caliente has recently completed Phase I improvements to the Meadow Valley Industrial Park. The Park includes approximately 62 useable acres with direct access to U.S. Highway 93. The City will work with industrial clients to identify individual acreage needs. Future improvements will provide access to the adjacent Union Pacific Mainline Railroad. Meadow Valley Industrial Park is served by City water and sewer. In addition, the City of Caliente provides electrical service to the Park and 220 three-phase power is possible. Lease rates/terms are very favorable (significantly reduced from those in the Las Vegas metropolitan area) for industries creating employment and income opportunities for residents of the Caliente area.

Alamo Industrial Park
The Alamo industrial park is currently in the development stage. The industrial park has US 93 access and well services.

**Utilities**

| City & Towns | Electric, KWH | Water | Sewer |
|---|---|---|---|
| Caliente | $0.068 | $20.00 fr | $23.00 |
| Alamo | $0.065 | $18.00/ 10000<br>$0.50 Per 1000/ 50,000<br>$0.60 per 1000/ 100,000<br>$0.70 per 1000/ Over | $18.50 |
| Panaca | $0.0411 | $25.50/ 15000gals<br>$0.85 per 1000 | $15.50 |
| Pioche | $0.057 | $21.00/ 15000gals<br>$1.25 per 1000 | $7.00 |

*From the Local Utilities of Lincoln County*
*Source:* Caliente City Hall, Alamo Power, Alamo Sewer & Water, Lincoln County Power, Panaca Farmstead, Pioche Utilities

Telephone
Lincoln County Telephone
PO Box 150
Pioche, NV 89043
(775) 962-5131

**Labor**

**Civilian Labor Force and Unemployment Rate**

| Area | Year | Time Period | Labor Force | No. of Employed | No. of Unemployed | Unemployment Rate |
|---|---|---|---|---|---|---|
| Lincoln County | 2005 | January | 1,474 | 1,385 | 89 | 6.0 |

**Lincoln County Wages, September 2004**

| | |
|---|---|
| Estimated Employment | 1,060 |
| Mean Wage | $ 19.34 |
| Median Wage | $ 16.21 |

**Number of Businesses by Company Size, Lincoln County, 1st Quarter 2004**

| | |
|---|---|
| 100 to 249 employees | 4 |
| 50 to 99 employees | 1 |
| 20 to 49 employees | 3 |
| 10 to 19 employees | 13 |
| 5 to 19 employees | 24 |

Source:1980/1990/2000,Census, Nevada State Demographer, www.nsbdc.org/demographer

**Biomass Incentives**

The abundance of Federal and State incentives for renewable resource development and business development make Lincoln County an ideal locale for biomass development initiatives. Federal and State incentives provide tax incentives, procurement opportunities, and training programs. Included is a brief overview of Federal and State Programs and references for further research.

Renewable Energy Credits:

The State's two investor-owned utilities are required by the Nevada's Renewable Energy Portfolio Standard to derive a minimum percentage of the electricity the sell from renewable energy resources. Included in the standard is a Renewable Energy Credit (REC). As of January 1, 2003, Nevada's renewable energy producers can earn RECs and sell them to utilities that are required to meet Nevada's portfolio standard.
Authority: NAC 704.8901-NAC 704.8937
For More Information: http://www.puc.state.nv.us/renewable_energy.htm

Property Tax Exemption:

Certain new or expanded businesses are allowed a 50% property tax exemption for real and personal property used to generate electricity from renewable energy. Renewable energy includes biomass, solar, and wind.
Authority: NRS § 361.0687
For More Information: http://energy.state.nv.us/renewable/incentives.htm

SBA Designated HUBZone:

Lincoln County is a certified HUBZone (Historically Underutilized Business Zone) offering local businesses exciting development opportunities. The HUBZone program works to stimulate economic development and create jobs in urban and rural communities by providing Federal-contracting preferences to small businesses. These preferences go to small businesses that obtain HUBZone certification.
For More Information: http://www.sba.gov/

Other State Development Incentives:

- Sales and Use Tax Deferral Program
- Sales and Use Tax Abatement
- Business Tax Abatement
- Property Tax Abatement
- Train Employees Now (TEN)
- Property Tax Abatement for Recycling/Retail Wheeling
- Renewable Energy Abatements

For More Information: http://www.expand2nevada.com/

Excise Tax Exemption for Ethanol Blended Gasoline:

Includes a "small ethanol producer credit." This allows a 10¢-per-gallon tax credit for production of up to 15 million gallons of ethanol per year for facilities with less than 30-million-gallons-per-year capacity.
For More Information: http://www.eere.energy.gov/biomass/

Commodity Credit Corporation Bioenergy Program:

A new biofuel production capacity is encouraged by A U.S. Department of Agriculture Farms Service Agency program. Cash payments are made to bioethanol and biodiesel producers to compensate for a portion of increased commodity purchases commensurate with their increased production.
For More Information: http://www.eere.energy.gov/biomass/

Federal Biobased Products Preferred Procurement Program:

This program, authorized by section 9002 of the 2002 Farm Bill, requires all federal agencies to preferentially purchase biobased products that have been designated by USDA as eligible under this program.
For More Information: http://www.eere.energy.gov/biomass/

Pending Policy/Legislation:

Legislation is currently pending in the U.S. Senate to establish a national Renewable Fuel Standard and a national Renewable Portfolio Standard. The Renewable Fuel Standard would require that 5 billion gallons of renewable fuel be used in the nations fuel supply by 2012 and the Renewable Portfolio Standard would require sales of electricity from renewable sources to increase to 10% by 2020.
For More Information: http://www.eere.energy.gov/biomass/ constituent

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