ENGINEERING ✧ SURVEYING ✧ RESOURCE & ENVIRONMENTAL SERVICES

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December 3, 2010

Nevada Pinyon-Juniper Partnership
C/O Sarah Adler, State Director
USDA Rural Development
1390 South Curry Street
Carson City, Nevada 89703

Re: *White Paper Packet for the Pinyon-Juniper Restoration and Utilization Summit*

Dear Nevada Pinyon-Juniper Partners:

Resource Concepts, Inc. (RCI) is pleased to have been involved with the Partnership that has developed this Summit. We hope that the Summit will encourage the development and interchange of ideas for moving forward to address a major ecological need within the State of Nevada.

RCI was retained by the Pinyon-Juniper Partnership to identify two items:

1. A Pinyon-Juniper Demonstration Area where landscape level restoration of expanding and over mature woodlands is needed to establish healthy and resilient ecosystems within both the sage steppe and pinyon-juniper (PJ) woodland ecological sites
2. Potential commercial or industrial scale utilization types that may be viable using PJ biomass generated by needed restoration treatments that could help to lower the treatment costs of such restoration

To begin addressing these two items and the possible interaction between the two, RCI developed the following series of White Papers that discuss:

1. The process used by RCI to identify a Pinyon-Juniper Demonstration Area based on the restoration need at a landscape level, agency planning and readiness, and the potential to maximize partnerships and funding sources
2. The biomass that may be generated from restoration treatments that could potentially be available for utilization
3. The potential for a known biomass technology, a combined heat and power facility, to operate within the Demonstration Area based on restoration project-generated biomass
4. The Potential economic impacts of such a facility
5. Other potential and emerging forms of commercial / industrial utilization that could utilize PJ biomass

The purpose of this series of white papers is to inform and encourage discussions of implementing needed pinyon-juniper restoration, developing and building upon existing partnerships to accomplish restoration, and exploring the potential for utilizing biomass generated from such treatments to enhance and lower the cost to the landowner. These documents should not be viewed as an endpoint, but rather a starting point for encouraging development of a top-flight demonstration project and process to address a major restoration need.

Thank you again for the opportunity to contribute to such an important project.

Sincerely,

Jeremy Drew, Project Manager

JD:jm

attachments

RCI White Paper #1 –

Selection of a Pinyon-Juniper Demonstration Area

Author: Jeremy Drew, Resource Specialist, Resource Concepts, Inc.
December 3, 2010

The purpose of the Demonstration Area is to designate a location where funding, agency operations, professional expertise, and private-public partnerships can focus on restoring ecosystem health and resilience of sagebrush and pinyon-juniper (PJ) woodland ecosystems by actively treating pinyon and juniper. RCI was tasked with identifying at least one landscape-level demonstration area within the State of Nevada while highlighting other areas where treatment is also needed.

RCI developed mapping of statewide PJ distributions[1] and found that there are approximately 9.16 million acres of PJ dominated vegetation statewide. In order to determine which of those areas would be suitable for a demonstration area, RCI developed a set of priorities that included:

1. Identification of areas with an ecological need for treatment of PJ to achieve multiple resource values including: improved watershed health, increased biodiversity of both flora and fauna, enhanced wildlife habitat, reduced risk of catastrophic wildfire and improved woodland health
2. Identification of areas that were ready for action from a land-management agency standpoint based on existing planning or project documents such as Forest Plans, Resource Management Plans, and project specific planning processes
3. Identify areas that maximize the potential for multiple positive resource outcomes as a result of restoration treatment of pinyon and juniper
4. Identify areas that maximized the potential for partnership between Federal and State agencies as well as non-governmental and private organizations
5. Identify areas that may present an opportunity for utilization of PJ biomass dictated by and generated from restoration treatments

RCI solicited input from the two major federal land management agencies within the state: the Forest Service and the Bureau of Land Management (BLM). RCI requested each BLM District Office identify PJ restoration areas and identify the restoration objectives for each area. All six Nevada BLM Districts provided input. Only two of the six Nevada Districts, the Winnemucca and Southern Nevada, did not identify any potential PJ projects within their districts. The Carson City, Elko and Battle Mountain Districts each provided multiple large-scale potential project areas to achieve various resource values, primarily for fuels reduction, wildlife habitat improvement and watershed or forest health. The Ely District indicated the potential for many large-scale PJ projects to achieve a multitude of goals, objectives, and management actions included in their approved Resource Management Plan (RMP). The Ely District was the only BLM District with significant PJ distributions

that had a comprehensive district-wide RMP in place that included the need for restoration of PJ treatment for a variety of resource values. As a result, the Ely District showed the highest potential for planning PJ restoration projects across the largest area.

The State Office of the Forest Service provided a list of potential PJ projects for the entire Humboldt-Toiyabe Forest scheduled for the next five years[2]. RCI mapped the projects slated for mechanical treatments, as they tend to be the most expensive and offer to greatest opportunity for cost sharing and private-public partnerships. While the Austin-Tonopah Ranger District included several projects, the Ely Ranger District had by far the most PJ projects slated for planning and implementation over the next five years. The Ely Ranger District also indicated that it was already working with the Ely BLM District to implement joint PJ projects in the Ward Mountain Area. This provided a prime opportunity for both major federal land management agencies to implement projects across the same landscape areas.

Map 1 displays the statewide PJ distribution developed by RCI. It also shows the locations of the potential project areas that were identified by both the BLM (via return questionnaires) and the Forest Service in their 5-year Integrated Management Plan and the relative status of each project's planning phase.

> ***Note:*** *Due to the large scale of these maps, they were not legible when shrunk to include in this packet. All maps will be posted to the Partnership Website, will be shown during RCI's presentations and will be available in the display area. Please visit us at the Summit to view and discuss any questions.*

RCI collected data from the Nevada Department of Wildlife (NDOW) and the Nevada Division of Forestry (NDF) responsible for natural resources and wildlife. In 2004, The Sage-Grouse Conservation Team developed the Greater Sage-Grouse Conservation Plan for Nevada and Eastern California (Sage-grouse Plan). The Sage-grouse Plan included assessments for local planning units and population management units (PMUs). Many of the local and PMU plans identified a suite of risk factors to Sage-grouse and their habitat. One of the risk factors identified in many of the plans was encroachment of pinyon and juniper into sagebrush ecological sites. As such, RCI mapped the relative risk ranking (low, moderate or high) of PJ encroachment for each of the PMUs. Since the Sage-grouse has been found to warrant listing under the Endangered Species Act, but precluded due to higher priorities, it has become a high priority for habitat conservation and funding. By locating the Demonstration Project in an area where PJ poses a high risk to Sage-grouse habitat, it greatly increases the potential for positive resource outcomes and also improves the opportunities for developing partnerships and pooling resources to ensure that this occurs.

In 2006, the Nevada Department of Wildlife developed the Nevada Wildlife Action Plan (WAP). The purpose of the plan was to establish an action plan in an effort to effectively conserve all wildlife species and to develop strategies for conserving species of greatest conservation need and the key habitats on which they depend. The WAP identified two key habitats pertinent to this project; sagebrush and lower montane woodlands. Several of the goals, objectives, and management actions for both key habitat types included development of a planning process, large scale inventories and classification of PJ, and prioritized treatment within both habitat types. The plan went on to identify preliminary focal areas for key sagebrush and lower montane habitat.

Map 2 displays the Sage-Grouse planning management units and the relative risk factor assigned to PJ encroachment for each. The map also shows the areas identified in the WAP as "preliminary focal areas" for both sagebrush and lower montane habitat.

In 2010, the Nevada Division of Forestry (NDF) completed two plans: the State Natural Resource Assessment and the State Natural Resource Strategy. The assessment identifies "…priority forest landscapes, threats to Nevada's natural resources, and describes the analysis used to determine priority landscapes, and the current forest conditions in Nevada. The analysis was conducted and priority landscapes identified across all ownerships." A total of 17 priority landscapes were identified by the report. The priority landscapes developed and identified through the two planning efforts corresponded to many of the same areas identified by the Federal Land Management Agencies and the wildlife plans that were reviewed, particularly in western and eastern Nevada. Priority landscapes were developed as directed in the 2008 Farm Bill in order to receive funds under the authorities of the Act. Therefore, locating the Demonstration Area such that it includes one or more of these priority areas ensures a much higher potential for partnering across key state and federal agencies and provides a synergy for attracting competitive funding resources and resources included in the 2008 Farm Bill.

Map 3 shows the priority areas determined by NDF through its State Natural Resource Assessment and Strategy Reports.

In collecting the available data and inputs from key federal and state agencies, it became clear that there are many areas in need of restoration treatment of PJ. However, based on the criteria of identifying a large landscape-scale area that is ready for action from an agency-planning standpoint the Ely BLM District and Ely Ranger District proved to be the most advanced. Both agencies area already working through the NEPA process to actively plan PJ restoration projects. The area also shows a high propensity for maximizing partnerships and funding resources. Bureau of Land Management and Forest Service managed lands are interspersed, the Nevada Department of Wildlife has a vested interest in PJ restoration for the benefit of Sage-grouse as well as priorities developed by the State Wildlife Action Plan, and there are three large Priority Landscape Areas that have been

identified by the Nevada Division of Forestry. Both the Ely Ranger District and the Ely BLM District provided inputs for shaping and refining the demonstration project boundary.

Based on this analysis, RCI recommends that that Nevada PJ Demonstration Area be located within the Ely District of the Bureau of Land Management including lands managed under the authority of the Humboldt-Toiyabe National Forest's Ely Ranger District. This recommendation should not marginalize the other areas that demonstrate a high need for restoration of PJ at a landscape level. The tools and lessons learned within the Demonstration Area should serve to enhance the planning and implementation efforts of those areas that are in the process of developing landscape-level projects.

Map 4 shows the RCI proposed demonstration area.

1. Data Sources for Mapping included: Southwest Re-GAP Landcover Data, 2004 and California GAP Landcover Data, 1998
2. Humboldt-Toiyabe Forest 5-year Integrated Vegetation Management Plan

RCI White Paper #2 –

Potential for Biomass Utilization within the Demonstration Area

Author: Jeremy Drew, Resource Specialist, Resource Concepts, Inc.
December 3, 2010

Once a large landscape-level Demonstration Project was identified based on the factors listed in White Paper #1, RCI was asked to determine if the potential existed for biomass utilization within the project area.

To address that question, RCI identified two potential biomass utilization hubs, at Ely and Pioche, based on existing infrastructure and the potential for siting of a commercial or industrial facility. The two potential hubs were also identified by NDF in their statewide resource assessment and strategy reports. Once the hubs were designated, RCI conducted a mapping exercise in order to determine the potential available biomass within a reasonable haul distance, 50 radial miles.

The starting point for the exercise was the PJ distribution mapping developed by RCI[1]. That mapping showed approximately 1,421,000 acres of pinyon-juniper (PJ) within 50 miles of Ely and approximately 1,146,591 acres of PJ within 50 miles of Pioche. RCI then determined what areas would be excluded from potential mechanical harvest; those included:

- Areas where slopes exceed 30%[1]
- Wilderness or Wilderness Study Areas[2]
- Areas that have recently burned[3]

It should be noted that this very basic analysis did not identify exclusion areas that would be deemed such due to cultural concerns, ecological concerns, access concerns (i.e. lack of existing roads), etc. Such areas would have to be identified based on site specific information developed as part of the required NEPA analysis for the identified restoration projects.

Map 5 shows the two utilization hubs (Ely and Pioche) as well as the exclusion areas and acreage of PJ within 50 radial miles of each hub.

The analysis concluded that there are approximately 800,000 acres of PJ within 50 miles of Ely and approximately 720,000 acres of PJ within 50 miles of Pioche that fall outside of the identified exclusion areas.

It is difficult to estimate the total amount of potential biomass that such acreage could yield without site-specific inventory and development of restoration plans. However, based on data collected for past restoration projects, the Ely BLM District has generated up to 5 bone-dry tons per acre for treatments in Phase II Woodlands and up to 11 bone-dry tons per acre

for restoration treatments in Phase III Woodlands[4] depending on the desired outcome (mosaic harvest, thinning, etc.). These values are similar to those provided by Dr. Robin Tausch who suggested assuming a harvest regime of all trees 8" or larger in diameter within areas designated for thinning, which would generate approximately 5 bone-dry tons / acre in Phase II Woodlands and 15 bone-dry tons / acre in Phase III Woodlands[5].

To put these values in context, a 10-megawatt biomass power facility would require approximately 67,000 bone-dry tons of biomass annually. Assuming a relatively conservative average yield of 5 bone-dry tons per acre for restoration treatments, approximately 13,000 acres of restoration per year would have to be implemented to sustain the plant. Assuming that the plant were in operation for 20 years; approximately 260,000 acres of total restoration treatment would be implemented, less than half of the estimated biomass within a 50-mile radius of either Ely or Pioche.

For further context, the Ely District Final Environmental Impact Statement identified approximately 3.6 million acres of over mature PJ woodlands District wide. The Ely District Approved Resource Management Plan lists a desired range of conditions for PJ, including only about 180,000 acres of over mature woodland. At a rate of 13,000 acres per year, it would take approximately 260 years to plan and implement the 3.4 million acres identified for restoration. That does not include areas where PJ has expanded into shrubland habitat types, nor the Forest Service management units.

Based on these preliminary estimates, it is the conclusion of RCI that there exists a potential for biomass utilization to occur within the Ely District based on restoration needs and potential available biomass. However, **restoration planning and NOT commercial/industry need** should dictate where, how, and by what standards pinyon and juniper could be accessed, harvested, restored, and utilized. The planning and implementation process should be conducted in accordance with approved plans and policies and in conformance with all existing laws and regulations including the National Environmental Policy Act. It should be noted that the major barrier to achieving the needed level of restoration planning and implementation, regardless of biomass utilization, is a lack of sufficient budget and time.

1. Based on USGS National Elevation Dataset (30-meter Resolution)
2. Based on BLM and Forest Service GIS database for Wilderness and Wilderness Study Area Boundaries.
3. Based on BLM GIS database for fire areas from 1981-2007
4. Based on Personal Conversations with BLM Project Managers and Specialists
5. Based on Personal Conversations with Dr. Robin Tausch, U.S. Forest Service Rocky Mountain Research Station.

RCI White Paper #3 –

Potential for a Biomass Power Facility in Eastern Nevada

Author: Bill Carlson, Principal, Carlson Small Power Consultants
December 3, 2010

As part of a large-scale restoration of pinyon-juniper (PJ) lands in Eastern Nevada, it may be possible to develop one or more biomass power or combined heat and power (CHP) facilities to utilize PJ removed during restoration. While perhaps a suboptimal use of the material, it may be the only use which allows a developer to use commercially guaranteed technology, produce a large volume product with a guaranteed revenue stream over the life of the debt, and thus be commercially financed. The development, however, must be coupled with an equally long-term federal stewardship contract (or equivalent) of sufficient guaranteed acreage or volume to allow financing to take place.

If the plant(s) are properly sized and the stewardship contract sufficiently flexible, it should be possible to also support smaller, more valuable, uses of PJ material as those uses develop around the large volume long term material movement catalyzed by the biomass power facility. If some of the material is diverted, and the stewardship contract can accommodate both, the economics of the operation are enhanced for all parties. There are simply more dollars available to pay for the land treatments that current conditions demand be carried out.

The biomass power or CHP facility provides the "base" flow of material to allow a large scale restoration to take place. It is perhaps the only "base" technology now available to begin the restoration upon. This material use, based on economics prepared specific to White Pine and Lincoln Counties, will not pay the full cost of the PJ removal, processing, and delivery while providing a reasonable return to the developer. The amount available for fuel supply should cover the transportation and chipping of the fuel, while returning perhaps $100-500/acre towards the removal cost depending as the size of plant needed to support large scale thinning and the economic assumptions used. A larger facility would have the ability to pay more for fuel and thus return more to the land treatment.

The development of a biomass power or CHP facility depends heavily, not just on a firm fuel supply at a reasonable price, but on reasonable access to transmission and to markets that will pay a premium for renewable power. The core PJ region of Eastern Nevada is served by two publicly owned electric utilities, Mt. Wheeler Power in the North and Lincoln Power District No. 1 in the South. Both systems operate 69KV transmission and distribution systems radically from their respective delivery points on the NV Energy system, and both are very small by electric utility standards. Neither system is subject to Nevada's Renewable Portfolio Standard, which establishes large renewable energy requirements for NV Energy and some large mining interests. While neither Mt. Wheeler Power nor Lincoln Power District would be expected to purchase the output of a reasonable sized biomass power facility, either system would benefit from such a

development and both provide direct delivery to NV Energy, who would be a likely purchaser. Based on recent renewable power purchases by NV Energy, and by various recent utility purchases in Southern California, a project in either system would likely obtain an electric sale price within the range of $92-97/megawatt-hour at time of startup at the interconnection with NV Energy.

Siting a project within a 69KV transmission system and using exclusively fuel from widely dispersed PJ removal limits project size. In this case, the focus is on a 10MW electric output project sited in either the vicinity of Ely or Pioche. The project would use standard stoker grate boiler technology and a standard steam turbine-generator. Because of water limitations in Eastern Nevada, it was decided to propose dry cooling for the facility, though there are potential locations that could support standard wet cooling technology. Extraordinary air pollution control requirements are not expected due to the small project size and the fact that all of Eastern Nevada is in compliance for all criteria pollutants. A financial pro forma was prepared for a prototype project with the result that when using low cost financing, the project could afford to pay for fuel chipping/transportation and make a modest contribution towards the cost of PJ removal. Thus, it is likely possible to utilize biomass power generation as the "base" for accelerated PJ treatment.

The above economics could be enhanced if a sizeable thermal user can be identified within the two counties that would utilize a substantial amount of low-grade steam/hot water from the power generation process. A survey of the two counties identified only the Nevada State Prison at Ely as having the necessary size and characteristics to represent an economic enhancement to the project. Work is underway to further define this potential. Alternatively, the biomass power facility might also anchor a new industrial park in Eastern Nevada, offering "green" steam and hot water to potential new tenants of the park.

The core economics of a PJ restoration based biomass power project in Eastern Nevada indicates it could provide a starting point and be capable of paying the incremental processing and delivery cost for PJ fuel and provide some modest reduction in the current cost of PJ restoration for government and private landowners. Such a project is clearly infeasible without a large long-term stewardship type contract from one or more federal agencies.

RCI White Paper #4 –

Preliminary Analysis of Potential Economic Impacts of Proposed Pinyon-Juniper Electric Power Plant in Lincoln and White Pine.

Author: Thomas R. Harris, Director, University Center for Economic Development, UNR, Reno
December 3, 2010

To gain a sense of the theoretical economic effects that biomass utilization could have on the two counties located within the proposed Demonstration Project Area, RCI requested the University Center for Economic Development to develop preliminary analysis assuming the development of a 10-MW combined heat and power facility in either White Pine or Lincoln County. This request correlates to the two identified utilization hubs of Ely (White Pine County) and Pioche (Lincoln County). The analysis was conducted solely on the construction and operation of such a facility and did not include the potential economic impact of planning and implementing restoration treatments, which will likely occur regardless of whether or not a commercial or industrial utilization is developed. This white paper is intended to provide insights into the potential economic effects for developing one type of biomass utilization within one of two rural communities.

Executive Summary

The University Center for Economic Development conducted a preliminary study of the potential economic impacts of a proposed pinyon-juniper (PJ) electric power plant in either Lincoln County or White Pine County.

Socio-Economic Trends

- White Pine County's population from the 2000 Census was 9,181, which ranked White Pine County 10th among Nevada's seventeen counties. As for Lincoln County, the 2000 Census population was 4,165, which ranked Lincoln County 14th in population size among Nevada's seventeen counties.
- Using state of Nevada demographer data, White Pine County population has increased from 9,181 in 2000 to 9,570 in 2009 or a 4.2 percent increase in nine years. Lincoln County population increased from 4,165 in 2000 to 4,317 in 2009 or a 3.6 percent increase in nine years.
- The economy of White Pine County is highly concentrated in mining. The output of the Copper Mining Sector in 2007 was approximately 25 percent of total White Pine County output. With rising and high copper prices, the Copper Mining Sector is the primary export sector for growth in this county.
- As for the economy of Lincoln County, the government and Agricultural Sector are primary actors in the local economy. As for total county output, the Agricultural Sector in Lincoln County was approximately 14 percent of total county output in 2007. Mining is a lesser actor in Lincoln County as opposed to White Pine County.

- Public lands play an important part in the economics of Lincoln County and White Pine County. Of total land acreage in Lincoln County, approximately 98 percent is under federal administration while for White Pine County, 94 percent of total county acreage is under federal administration. Changes in federal public land policies can impact these counties.

Concepts of Economic Multipliers: Income and Economic Multipliers

- Export sales bring dollars to the county economy, which provide for future economic growth.
- Import sales act as leakages from the county economy.
- Changes in economic activity by the Agricultural Sector will impact the economic activity of the White Pine County economy.
- A measure of the economic effects of the changes in the White Pine County economy from changes in economic activity by the Agricultural Sector is called the multiplier effect.
- To derive these multiplier effects and county level sectoral output, employment, and labor income levels, the U.S. Forest Service input-output model IMPLAN was used.

Construction and Operation Impacts of Proposed Pinyon-Juniper Electric Power Plant

- Direct construction and operation costs were developed for the analysis. The theoretical facility would be a 10 MW power plant that could be built in either White Pine County or Lincoln County. It is estimated that local capital construction costs in Lincoln County and/or White Pine County would be $13.3 million. Of total supplies for construction, approximately $5.6 million would be spent locally in either Lincoln County or White Pine County. For construction activities, the proposed facility requires 40 employees.
    - If Lincoln County is the location of construction, only 12 construction employees would come from Lincoln County
    - If the construction occurred in White Pine County, 16 jobs would be hired from White Pine County labor force. Because of an available skilled labor force in White Pine County, more construction employment will be hired locally in White Pine County than Lincoln County.
- After construction, annual operation and maintenance costs were estimated to be $4.17 million. For operation employment, it was estimated that the facility would

hire 11 employees where all operation employment would be hired from either Lincoln County or White Pine County.

- Using the IMPLAN input-output model, total economic and employment impacts were estimated.
    - For Lincoln County, direct construction expenditures were estimated to be $15.3 million with total economic impacts of $17.0 million.
    - For White Pine County, direct construction expenditures were estimated to be $15.0 million and with economic linkages of White Pine County, total economic impacts were estimated to be $17.13 million.
- As for operation expenditures for the proposed PJ electric power plant:
    - In Lincoln County, direct expenditures were estimated to be $5.1 million. As for employment, the operation phase of the proposed power plant in Lincoln County was estimated to be 11.0 employees. With economic linkages in White Pine County, total economic impacts from operations by the proposed PJ electric power plant were estimated to be $5.3 million.
    - In White Pine County, direct expenditures for the proposed PJ power plant were estimated to be $5.14 million. Including the economic linkages of White Pine County, total economic impacts from operations in White Pine County were estimated to be $5.34 million. As for employment, direct employment for the proposed power plant was estimated to be 11.0 employees in White Pine County.

These are only initial estimates for a proposed PJ power plant in Lincoln County or White Pine County and do not include estimates for harvesting, processing, and transporting biomass.

A more detailed analysis would be required to derive exact economic linkages of the proposed power plant as well as occupational impacts. Additional analysis is required to fully develop an industry and occupational cluster analysis of the proposed PJ power plant.

However, this provides a sense of what kinds of economic impacts might be expected from one type of biomass utilization.

RCI White Paper #5 –

Alternative Technology Applications for Pinyon-Juniper Woodlands

Author: John McLain, Principal, Resource Concepts, Inc.
December 3, 2010

Agency assessments of the vast expanse of pinyon-juniper (PJ) woodlands have identified a myriad of resource concerns and challenges. Collectively, these concerns reveal a woodland type in desperate need of restoration actions so future conditions will allow ecological functions to mostly occur naturally.

With the new emphasis on renewable energy, the technology for potential utilization of identified sources of excess biomass is rapidly evolving. This paper provides a brief overview of some of the processes that have been represented as viable, or under testing at various scales. It is important to note that some of these processes are not fully operational at this point, despite a growing level of process development and implementation.

This overview does not attempt to compare or grade the individual processes, but rather to list them for information. The merits of each of these, and other processes not included, will rest on their ability to demonstrate success when applied in the field with private dollars.

It is recognized that a dependable biomass supply is a fundamental requirement for any successful commercial venture, including reasonable access to markets. A biomass supply has proven problematic in the recent past, as public land agencies are presently only able to commit to a maximum ten-year stewardship arrangement with any willing taker. Absent a long-term (i.e. 20-30 year) commitment, it is a high-risk venture for industry to commit multi-millions of dollars for infrastructure while attempting to capitalize a facility over shorter time periods, being unsure of a dependable long-term biomass supply.

Of special note is the fact that Nevada is the most arid region of the country and closely regulates and monitors water consumption activities. Any biomass utilization process that requires a significant volume of water will likely find it difficult in securing the necessary permits for operation.

Processes that show opportunity for the future include:

- *Gasification:* Gasifiers have been used to breakdown carbon based materials such as coal or wood into a mixture of combustible gases (producer gas). With today's technology biofuels demonstrate a product that shows promise.
- *Synthesis Gas (Syngas):* Syngas is the product obtained during numerous chemical processes including the gasification of coal, biomass, and waste-to-energy. The manufacturing of fuel grade alcohols and hydrocarbons have potential to have broad market applications.

- *Compost:* Woody biomass can be incorporated into the compost making process for commercial purposes.
- *Wood Composites:* Pinyon pine and Utah juniper were tested in the early 1980's by a German firm that determined the chips suitable for particle board, flake/chip board, OSB, and wood/Portland cement. Samples of these products were made available to the State at that time.
- *Direct-Combustion:* Direct combustion is a process of burning biomass in a modern boiler or furnace system. The net efficiency of modern biomass heating systems varies between 60 and 80 % depending in part upon moisture content of the wood fuel.
- *Combined Heat and Power (CHP):* CHP is an Integrated process of producing heat and power. Exhaust heat is used for processes like space conditioning (heating and cooling), which increases economies.
- *Biochar:* Biochar is charcoal created by pyrolysis of biomass, and differs in that it is not used for fuel, but for bio-sequestration of carbon in the soil.
- *Torrefaction:* Torrefaction is anaerobic thermo-chemical decomposition of carbon based materials, performed at temperatures ranging between 200-320 degrees C. During torrefaction, the properties of the organic material is altered from woodchips to charcoal to obtain a better quality fuel that can then be utilized in combustion or gasification applications.
- *Compressed Biofuels* (pellets, briquettes, bricks): These products may have market potential, but the wood products labs have not analyzed pinyon pine and juniper species for pellet suitability.
- *Charcoal:* Char can be activated carbon to clean industrial waste streams.
- *Liquification:* Biomass is reduced to a liquid biocrude by a combination of thermal application and pressure. It can then be transported to a refinery for processing. Biocrude can be refined into asphalt additives, binders (adhesives) to bind coal fines or biomass into briquettes. Development of a portable unit under testing has not yet been confirmed.
- *Cellulosic Ethanol:* The conversion technology of cellulosic sources (wood) to biofuels (ethanol) has been in production for some time, but is not yet economically viable due to the reliance on imperfect biochemical processes. Two challenges remain: separating cellulose from lignin and preventing contamination during the fermentation procedure.
- Co-firing: Co-firing is the combustion of multiple fuels in the same energy system. Coal fired plants can be retrofitted to accommodate both coal and biomass. This process can increase equipment performance and reduce pollution.

P.J. Woodlands