G. RENEWABLE ENERGY PROJECTS AND POTENTIALS

1. Renewable Energy Imperative

Climate change and global warming, escalating oil and gas prices, depletion of non-renewable resources, and over-dependence on oil producing countries and corporations imparts a sense of urgency in developing clean, local, and renewable sources of energy. This presents the best opportunity in years for the San Luis Valley to develop its outstanding solar energy resources and other renewable energy potentials including wind, biomass, geothermal, and crops for biofuels in order to gain a market position.

Many challenges face the region in this pursuit, which would place us on the path of becoming a national exporter of clean energy, and a major alternative to coal-fired power plants. Some of these include the fact that our location is 200 or more miles distant from the technical expertise and university research departments needed in the planning process for renewable energy development; significant expansion and upgrading of our electrical power transmission infrastructure will be needed to meet the increased load demand; and extensive training and development of our workforce will be needed to meet the new job and skill qualifications.

Renewable energy technologies are still in their early stages, and it will probably take some time before they can compete price-wise with traditional forms of energy production. This is especially true if environmental laws remain weak and the recovery or prevention costs for environmental damage are not factored in. Some unofficial electric rates per kilowatt hour (kWH) comparing rates for coal-produced energy vs some of the renewables are being shared to give a rough idea of the challenges ahead. From these estimates, it will be hard to beat coal at 6.5 cents/kWH, compared with solar CSP at 15 cents; solar voltaic at 22 cents; and wind at 11 cents. Hydro-electric was quoted unofficially at 3-4 cents, and nuclear at 4-6.5 cents.

2. Support for Renewable Energy Development

State Government and other initiatives to assist rural regions in becoming part of the national energy solution are discussed in various sections of this document. In particular, major points in Governor Ritter's Colorado Promise and New Energy Economy are included Section IV. E; and workforce development efforts are summarized in Section IV. F.

We would also add that a Governor's Office of Energy (GOE) has been established in Colorado, and assistance is available under the Clean Energy Act. Funding for feasibility studies is also being provided by the State departments of Local Affairs and Economic Development.

Examples of Federal assistance include renewable energy development tax credits, and an increase in auto fuel efficiency standards.

In order to provide all the attention needed for this effort at the local level, however, will require substantial increases in the District staff resources which are currently very limited. Given the level of magnitude and importance of renewable energy projects, we believe that additional program funding would be timely and appropriate.

3. Xcel Energy/Sun Edison Project (Table G-1)

Table G-1 compares existing and prospective projects for generating electrical power from solar and wind sources which are known to us at this time. Investment cost ratios, jobs, and other factors may vary considerably from one project to the next, but in some cases we estimated jobs and number of homes where no information was reported.

The Xcel Energy/SunEdison project began operations in late August 2007 with partial generation capacity, and is nearing full production capacity. It will generate 8.2 megawatts to the grid for distribution to Xcel Energy customers as the demand may dictate, either here in the Valley or outside the region. This will supply an estimated 1,500 homes (although the estimate for homes changed several times and was revised downward). SunEdison, a company with main offices in Maryland, will own the facility and Xcel Energy will purchase power for distribution. While the project required 70 or more workers to construct, the automated equipment controls in place will require only 2 permanent workers to operate. A share of the supplies needed to maintain the operations can be purchased locally, but replacement equipment will be shipped in.

This operation is unique in that it will employ three different solar technologies in a side-by-side location, which will enable assessments to be made on the cost and efficiency of the various methods. These include an array of seasonally adjusted photovoltaic (PV) panels; a PV system of single-axis trackers which make daily adjustments to the position of the sun; and a system of Concentrating Solar Power (CSP) units with technology developed in Germany. The solar concentrators consist of a large number of small mirrors affixed to huge platforms which can also adjust to optimal sun position. Covering 82 acres, this is the largest solar panel operation of its kind in the nation.

An operation of this type will help Xcel meet the goals of Colorado's Amendment 37, which require power companies to generate 10% of their power from renewable sources by 2015, and 20% by 2020. By teaming up with SunEdison, Xcel will be responsible for cutting CO2 emission by 14,000 tons, or the equivalent of 2,840 cars driving 12,500 miles annually.

4. SLVDRG/NREL CSP Initiative (Table G-1)

The Development Resources Group is partnering with the National Renewable Energy Laboratories (NREL) in Golden, Colorado to assess the feasibility of developing a 100-megawatt CSP plant in the Valley. An operation of this size would require an estimated investment of $330 million; 500 or more acres; and supply enough energy to power an estimated 30,000 homes. The plant would require about three years to build; 500 construction workers; and about 40 permanent jobs when completed. NREL believes the Valley could support more than one of these operations.

To fully determine the feasibility and plans for a project of this size is requiring a $125,000 study, funded by a combination of county governments; State departments of Local Affairs and Economic Development; and the Governor's Office of Energy (GOE). The study will take several years to complete starting in 2008, and will consist of a consultant analysis of feasibility; a prospectus on legal structure; an ongoing meteorological station to determine optimal location; and a business and marketing plan for investment. A 30% would also be available to reduce the investment amount.

California has been operating CSP plants for over 15 years with a total capacity of 354 MW, but NREL believes that the resources of the San Luis Valley rival those of California and Nevada locations where CSP is in use or under construction. NREL has further shown that existing transmission lines in the Valley could carry excess energy from the proposed 100 MW solar plant to all areas of Colorado, including Denver and Front Range cities. Possibility also exists to sell power to northern New Mexico, and the Valley has the potential to support more than on 100 MW solar plant. Nevertheless, competition with Arizona and other Southwestern states does exist, and the project initiatives underway must continue to receive priority in order to accomplish the project goals.

Four main benefits of the project are cited by NREL as follows:

- Energy benefits include the vast solar resource potential of the San Luis Valley, the correlation between the solar resource and typical peak utility load profiles, and the ability of CSP plants to provide dispatchable power through hybridization with gas turbines or with thermal storage.
- Job related benefits to the State and Valley communities would include direct and indirect jobs derived from the manufacture of CSP systems, as well as jobs created during installation and sustained operation of a solar plant.
- Additional economic benefits include State and local tax revenues, revenue to local landowners, and procurement of goods and services during plant construction and operation.
- Environmental benefits include reduction in all types of air pollutants and CO2 emissions from the displacement of coal-fired power production.

An additional focus of the effort is to create a locally owned and locally controlled renewable power authority in the San Luis Valley.

5. SkyFuels Prospect (Table G-1)

If it develops, the 1,000 megawatt SkyFuels prospect backed by investors in New York and Europe would create a staggering 10-fold increase to the energy generation impact planned in our CSP initiative. The Valley probably represents one of only a few places where an operation of this magnitude could exist, due to the Valley's abundant sun, flat surface, and available land. The table shows an investment of $2 billion, requiring 5,000 acres (which we understand do not have to be contiguous), and an estimated 5,000 workers to build.

Based on the parameters of the other solar projects, this could also produce 400 permanent jobs and rivaling our largest employers. Also based on the other solar projects, this could produce enough power to meet the needs of 300,000 homes.

6. Other Solar Projects and Prospects

The San Luis Valley Regional Medical Center and Adams State College in Alamosa are in close proximity to each other, and are interested in applying CSP or other solar technology to provide for or supplement their energy needs. Other roof-top projects of this type have interest in other locations as well.

Ausra Inc. in Colorado represents another large energy export project which is interested in 180 MW solar thermal facility requiring 640 acres. The system contemplated would allow solar energy to be stored and dispatched when needed to meet peak demand. Further initiatives by Ausra will probably depend on the progress being made to increase the capacity of the Valley's transmission lines.

To apply solar and reduce electrical costs of farming operations, the Valley's Resource Conservation & Development (RC&D) agency introduced a project involving installation of solar panels at center pivot sprinkler sites. These produce 10,000 watts of electrical power and return savings to farms through a net metering system. Equipment with an initial cost of $90,000 is costing farmers $8,000-$10,000 after energy rebates and tax credits.

We would also applaud the efforts of individual homeowners and various construction firms who are utilizing active and passive solar systems in their home designs. In the 1970's the Valley was known as one of the first areas in the USA to apply solar technologies, but efforts were destroyed by the Federal Government recision of solar tax credits. Today, the credits are coming back, but are generally too limited to offset the initial investment costs or promote home installations on any seriously large scale.

7. Commercial Wind Power (Table G-1)

Table G-1 compares limited information on the Invenergy company project which is currently collecting wind data in various locations to identify the optimal site for 60 MW operation. The Pinon Hills of Conejos County met company criteria, but is located in a Bureau of Land Management (BLM) Area of Critical Environmental Concern (ACEC) and could not be developed. Some of the best potential may now exist in Saguache County.

Benefits for the Valley would include: $5,000 in taxes to counties for each of 40 turbines in the 60 MW windfarm, totaling $200,000 annually; an additional $200,000 in taxes based on the company's projected income of $35 million in energy generation; $100,000 in maintenance purchases which could be taxed; and about 5 permanent jobs at a yearly salary of about $45,000.

While the Valley has the best potential in the State for solar power generation, viable sites for commercial wind power are generally much more limited, and the Valley has to compete with favored locations in the economic cluster for wind energy which is developing on the eastern plains of Colorado. Wind gusts in the Valley can be more vigorous than the plains, but less predictable and consistent. Wind power storage technologies are improving, but this would add extra cost. Other considerations include sensitivity of siting to the Valley's numerous wildlife areas and bird migration corridors, and possible obstruction of viewsheds when placed on the summits of hills and mountains.

Small wind projects are not as common here as they are on the plains counties, but are encouraged where affordable and feasible.

8. Transmission Lines

Without increased capacity of the high-voltage transmission lines connecting the power generation source to the national distribution grid, the Valley cannot become an energy exporter. The capability of existing systems is currently estimated at 150-200 MW, far too limited to consider most of the above proposals. In May 2007, a new 230 kilovolt (kV) line was proposed to import electricity into the Valley from Walsenburg initiated by Tri-State Generation and Transmission Association which currently supplies power to Xcel Energy and San Luis Valley Rural Electric. The current connection to the Valley is from the north end at Poncha Pass. Tri-State's proposal is part of an Eastern Plains Transmission Project with more than 1,000 miles of new high-voltage lines and four new substations.

Recognizing its current line limitations in meeting projected demands, SLV Rural Electric has also proposed a San Luis Valley Electric System Improvement Project with the 4-fold purpose to: provide transmission support for

renewable energy development in the San Luis Valley; improve system reliability; prevent voltage collapse under peak loads; and upgrade existing systems.

Tri-State is also conducting a macro corridor and routing study to determine siting for the 230 kV line to include: a comparative analysis of preliminary routes; public and stakeholder meetings; selection of a preferred route: and preparation of federally-required environmental assessment and local land use permits.

9. Biofuels --- Biodiesel

Biodiesel fuel production potentials in the Valley were explored by four firms over the past several years, and further expansion is on hold. In early 2005, the SLVDRG provided $200,000 in gap loan assistance leveraged with $1.8 million in private investment to assist Alta Fuels, a successful local business, with its biodiesel wholesale and blending operations in Alamosa. Alta Fuels is using a blend of 85% to 15% canola oil for a fuel that is cleaner burning and somewhat more resistant to freezing temperatures.

Activities in the Valley and the ability to grow canola with a 42% oil content attracted the much larger and well established Blue Sun Biodiesel, which promised to develop a processing plant in the Valley, but then moved on to other locations. The company stated that it could not identify a suitable site with rail and road convergence to develop the operations.

Soon thereafter, an alliance of Alta Fuels, Canola Gold (another locally inspired venture), and the well established Bioenergy of Colorado formed to plan an expansion of the industry to include both blending and fuel processing. Capacity of the Valley to grow larger volumes of canola needed to support a large-scale crushing facility was the focus of a feasibility study, but this was determined not to have enough farmer support. Currently, Alta Fuels is continuing to operate on its own in a non-expansion mode. Under a separate set of initiatives, Costilla County is operating a successful small-scale canola oil pressing facility to supply the County's vehicle fleet.

Processing canola oil for biodiesel blending produces several byproducts, some of which include glycerol, a combination of glycerin and alcohol which can be used in skin crèmes; waste oil for home heating; and the husks of seed left over after pressing which can be used as cattle feed.

10. Biofuels --- Wood Waste Biomass

We view "wood waste biomass" as originating form sources including waste material from thining or timber harvests; beetle-, drought-, or fire-damaged trees; and sawdust, chips, and milling waste produced by sawmills. For fuel purposes, these materials can be formed into wood chips, wood pellets, or other forms as may be needed.

Since they are used for the ultimate purpose of combustion, they ultimately depend on regeneration of the forest to become truly renewable. Use of these materials is also not particularly clean-burning, but may represent other advantages. These may include a saving on fuel cost; replacement of energy sourced from coal-fired plants; reduction in solid waste; business and job opportunities in gathering, transport, and processing; and the creation of demand for material that would otherwise present a wildfire danger if left in place.

A considerable supply of wood waste exists, but may not be readily available for use or not without cost to procure. Examples of supply sources are represented as follows:

- The Baxter sawmill in Saguache produces 300 tons of sawdust and other wood waste per week.
- Studies commissioned by the SLVDRG in 2003 and 2004 reported annual "fuels treatment" programs by the Rio Grande National Forest in the 2,600-10,875/ton range, and the BLM, State, and private forest lands have similar programs.
- The RGNF County Line timber sale of beetle-damaged trees in southwest Conejos County is providing 24-29 million board feet (MBF) of timber. A logging truck fully loaded contains 5,000 board feet; 1 MBF = 200 truckloads.
- A new sale of beetle kill on the Del Norte Ranger District referred to as the Burro/Blowout sale is being reviewed for another 11-17 MBF, which will require 3-4 years to harvest.

While the supply is extensive (and may be nearly inexhaustible), the discussion on the practical use of wood waste as a biofuel has been going on for many years with very few tangible projects surfacing. Adams State College commissioned a study completed two years ago which described the equipment requirements for converting the college heating system to wood burning, but solar energy potentials now appear more attractive. Wood pellet manufacturing is frequently mentioned as a possibility, and was studied in the past, but to date no further advancements have been made.

11. Biofuels --- Cellulosic Ethanol

Several years ago, the feasibility of developing a 50,000/gallon corn-based ethanol plant was studied and found not viable due to the cost of importing corn, which can't be grown here in any quantity. Since then, the rush to produce corn for energy is crowding out corn for livestock feed, and corn has already created a dependency and overuse of corn syrup for thousands of food products where it does not belong. Corn-based ethanol has also become widely known to require more energy cost to produce than it saves.

The nation now awaits a feasible technology for producing ethanol from cellulose, such as switchgrass, and the Valley would be well-positioned to grow crops which would work. Existing and potential crops specifically mentioned for further study include barley straw; a hull-less form of barley; and sorghum-sudan, or "green

manure," which is becoming more popular with potato farmers as a rotation crop which can be plowed under as a fertilizer and nematocide.

12. SEED Park

Some level of our involvement over the next five years is anticipated with a project combining many technologies and resources to convert waste materials into clean energy, create useful activities and products, and recycle resources. Called the Sustainable Environment and Economic Development (SEED) Park, the project being introduced by a partnership of the RC&D and Global Scientific consultants is seeking a 5,000-10,000-acre site; which would also include space for a solar power plant.

The concept of the park, as explained by RC&D in the September 28, 2007 edition of the Valley Courier, is the development of environmentally compatible industries that could develop the byproducts of one industry into a marketable product for another industry. An example would be a greenhouse, which draws heat from decomposing waste to produce food or ornamental plants; and the food scraps or discarded plants could be made into a compost byproduct that would also be valuable.

The system being designed for the Valley would represent an eclectic use of many self-sustaining models and processes based on what might be most feasible with the type of resources available in the Valley. This could involve a cattle feedlot, processing plant, potato waste, municipal sewage, or other waste-generating activity or stream to provide the raw input, after which a series of gasification, anaerobic digesters, and other treatments could transform what started as waste into plants, algae, and other products. A diversity of secondary business could also be considered, including even a butterfly farm.

13. Geothermal Resources --- Geothermal Sites (Table G-2)

Table G-2 lists 35 geothermal sites and provides basic information on adjudicated water rights, natural artesian pressure flow, temperature ranges, depth, and existing use. As stated in our 1992 OEDP, this is not an exhaustive listing but does include most of the sites conducive for raising fish. The map shows the location of some of the well-known geothermal wells and springs, most of which follow the Valley fault lines.

Some sites not included have temperatures ranging up to 200 F, which has many uses but not hot enough for electrical power generation which requires at least 300 F. A dozen sites have temperatures in the 100 F range suitable for hot baths, spas, and swimming pools, and many supply the 75 F needed for warmwater fish farming.

Geothermal water sources are subject to Colorado water laws the same as other water, and have some additional restrictions. In most cases, the origin is the deep aquifer which represents a relatively unstudied water source. Water quality varies depending on individual sites, and in some places is too mineralized for crop, livestock,

fisheries, or human use. Valley fish farmers have successfully used venting systems to release toxic gases which are carried up with the deep water flows.

14. Geothermal Resources --- Current and Potential Uses

Our most innovative example of geothermal applications is the Colorado Gators alligator and exotic wildlife farm south of Hooper which began as a fish farm for tilapia and has become one of the Valley's most popular attractions. Starting with about 80 eggs from Florida, the gators are approaching 13/ft and are successfully breeding at the farm. The phenomena of alligators living at 7,500/ft and surviving below-zero nights in the Valley has attracted national news media.

Recreational and therapeutic use of the natural hot water is common in many parts of Colorado, and represented in the region by Valley View and Mineral hot springs near Villa Grove, the Hooper (Sand Dunes) swimming pool, and Splashland in Alamosa. Several Valley homes and the Villa Mall shopping center are heated by a geothermal source, and the City of Alamosa also has a geothermal well.

The South Fork area may represent a potential new geothermal location, based on the town's review of past studies indicating favorable types of underlying fault structures, and an existing hot water source at Wagon Wheel Gap and other locations. If confirmed by further study and test drilling, the Town plans to use geothermal for heating a proposed community recreational facility at an estimated cost savings of 50-60%/year.

15. Geothermal Resources --- Aquaculture and Hydroponics

Several active fish farms are successfully using geothermal including the Young farm (tilapia), the Faucette farm (hybrid striped bass), and the Kerr farm (tilapia and catfish). The Young farm also established a branch in Lamar to finish out larger fish for markets in Texas and other states, and has delivered live fish to destinations as far away as New York.

Based partly on the success of commercial farmers with geothermal, the Colorado Division of Wildlife established a $5.0 million Native Aquatic Species Recovery Facility for endangered and threatened species east of Alamosa on property once farmed by Chiles and Young. Now designated as the Playa Blanca NWR, this will provide educational and tourist opportunities.

The Valley Campus of Trinidad State established an Aquaculture Technician Program which is placing graduates in aquafarms throughout the Nation, and utilizing an on-campus wet-lab for specific and general biology instruction. It is also helping to support its classes through the sale of boneless/skinless tilapia fillets at the Kerr farm location north of Hooper, and is assisting the DOW with its Bonytail Chub recovery program.

Geothermal-fed ponds afford seasonal production, but year-round operations usually require cover in tanks to prevent heat loss. Closed system intensive culture technology with water recycling and oxygen enhancement allows large numbers of fish to be packed in tanks. A 450 gpm year-round flow and temperatures in 75-80 F range can typically support a 50,000/lbs biomass and annual production of 200,000-300,000/lbs. Warmwater species can tolerate 2 ppm dissolved oxygen while trout need at least 5 ppm.

Hydroponics (or growing plants with roots suspended in nutrient-rich water) for tomatoes and other vegetables is being used at the Sand Dunes pool location east of Hooper, but no new developments have occurred. The Young farm used enriched water from the fish tanks has been used to grow basil and other herbs, but not on a large scale.

16. Other Types of Renewable Energy

Hydrogen as a renewable energy source introduces an entirely new perspective, and will require monitoring in the forthcoming CEDS timeframe to identify any potentials for development in the region. With the advancement of research, more applications for hydrogen are surfacing. Hydrogen can be pressurized, stored in tanks, and used for internal combustion engines. The only emission from hydrogen-fueled engines is water vapor.

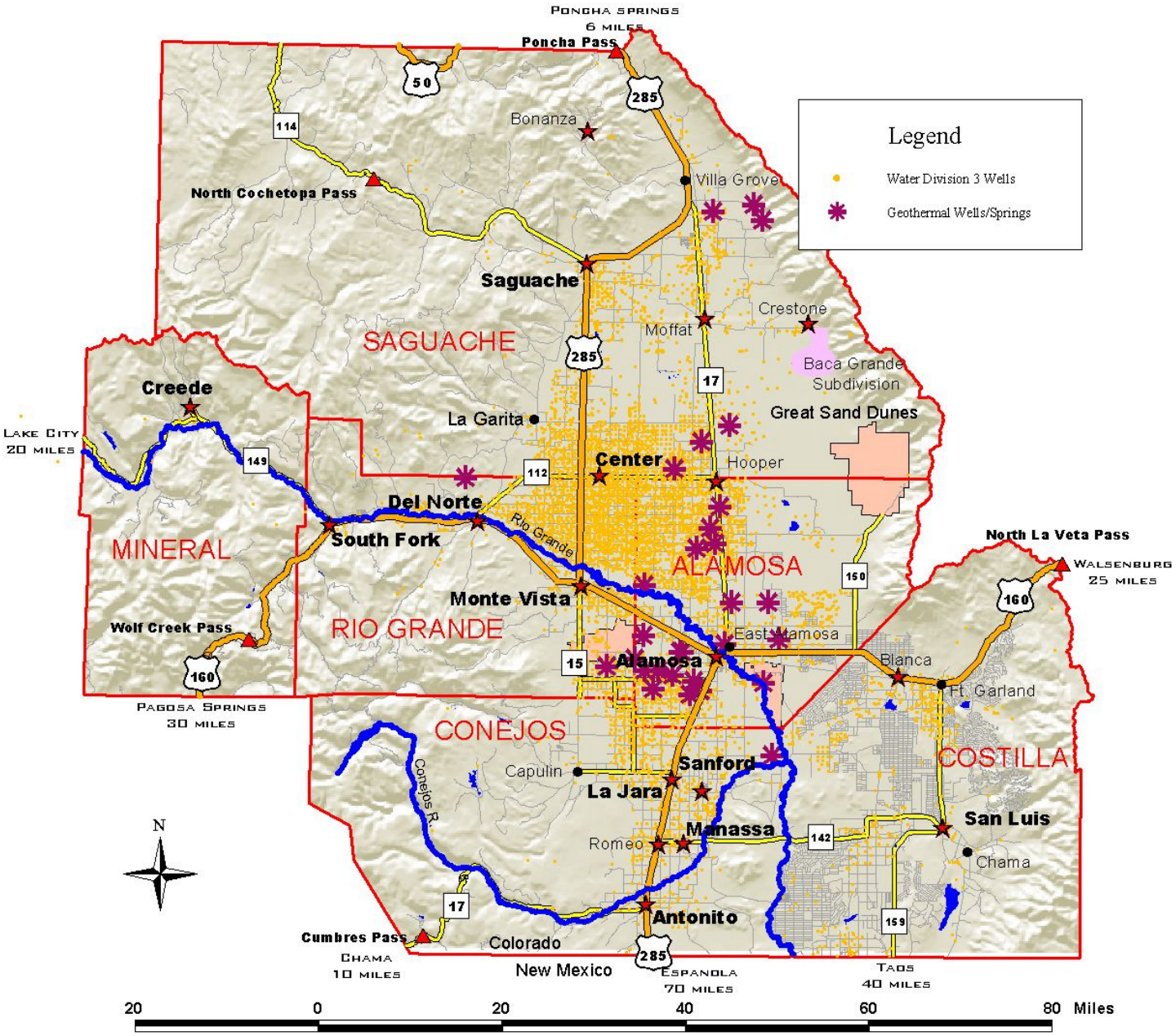
Hydro-electric is very uncommon in the region, but has been used in a Creede location fro over 50 years. Heat exchangers also are uncommon, and may not be feasible due high water tables and low temperatures.

17. Energy Definitions and Conversion Factors (Table G-3)

Energy definitions and conversion factors have remained essentially unchanged and we are retaining the table from the previous CEDS document, re-numbered as Table G-1.

Map 10

San Luis Valley Region – Wells and Selected Geothermal Sites



Source: San Luis Valley GIS/GPS Authority.

Table G-1

Existing and Proposed Solar and Wind Projects

Project/Location	Land Area (Acres)	Generation MW	Investment ($ 1,000)	Avg Cost MW	Constr. Jobs	Permanent Jobs	Supply Homes
Xcel Energy/SunEdison CO 17, 17 mu N of Alamosa	82	8.2	$60	$7.3	70	2	11,500
SLVDRG/NREL CSP initiative	500	100	$330	$3.3	500	40	30,000
SkyFuels Prospect	5,000	1,000	$2,000	$2.0	5,000*	400*	300,000
Invenergy Prospect	N/A	60	N/A		N/A	5	18,000*

Source: Compiled from Valley Courier articles and San Luis Valley Development Resource Group documents, December 2007.
*SLVDRG estimates based on 5 construction jobs per megawatt; 0.4 permanent jobs per megawatt; and 300 homes per megawatt.

Table G-2

Geothermal Sites with Aquaculture Potential

County/ Key number [1)]	Adjudicated [2)] GPM	Natural flow GPM	Temperature (Fahrenheit)	Depth (Feet.)	Uses
Alamosa					
W-149	2,480	1,200	87	1,787	Irrigation/fish
W-300	1,347	1,200	78	1,495	Irrigation
W-333	400	320	87	1,230	Irrigation
W-393	1,400	600	87	1,997	Irrigation/fish
W-393	600		70		Irrigation/fish
W-481	2,200		82	2,014	Irrigation
W-586	1,800	500	74	1,702	Irrigation
W-586	2,300	800	85	1,702	Irrigation
W-941	750	100	87	1,600	Irrigation/fish
W-941	800	150	94	1,800	Irrigation/fish
W-1094	1,300		95	1,500	Irrigation/fish
W-1263	2,140	1,200	87	2,084	Stock/irrigation
W-1456	1,800	775	105	2,526	Fish/irrigation
W-1456	1,000	560	87	1,500	Fish/irrigation
W-1456	500	200	70	900	Fish/irrigation
W-1802	5,400	1,800	85	2,018	Irrigation
W-1802	2,970	300	70	2,640	Irrigation
W-1976	2,200		110	2,193	Irrigation
W-1976	1,000	520	113	2,890	Irrigation/commercial
W-1976	100	100	116	2,484	Domestic
W-2179	2,035	1,400	87	2,063	Fish
W-2206	400	600	118	2,006	Swimming pool/stock domestic/irrigation
W-2206	475	600	124	2,600	Swimming pool/stock domestic/irrigation
W-2266	2,800		72	1,558	Irrigation
W-3526	2,400	850	97	1,648	Industrial
NR	1,500	800	80	1,510	Irrigation/fish
NR	2,000		74		Irrigation
Conejos					
W-1878	2,155		78	318	Irrigation
W-2431	1,000	800	70	1,415	Irrigation/stock
W-3898	2,780	2,780	78	835	Fish/irrigation/stock
Rio Grande					
NR		15	87		
Saguache					
W-1505	1,760	1,000	95	2,117	Fish
W-1964	1,650	900	80	1,925	Irrigation
NR	1,000	50	100+		Swimming pool
NR	350	150	147		

Source: San Luis Valley Development Resources Group, reprinted from December 1992 OEDP. Data taken from unpublished survey, 1990. Sites listed where temperature was reported at 70 F or greater. Survey is representative but not exhaustive. **1)** Water court case ref. number. **2)** Does not indicate year-round available supply. Blank space and "NR" indicates information not reported.
GPM = Gallons per minute.

Table G-3
Energy Definitions and Conversion Factors

Definitions

Energy - The ability to do work. Energy is stored in various forms including chemical energy in biomass, coal and oil, nuclear energy in uranium, gravitational energy in water used in hydroelectric plants, the wind and the sun.

British thermal unit (Btu) - The amount of energy in the form of heat which will raise the temperature of one pound of water one degree Fahrenheit. One Btu is equal to 252 calories.

Calorie - The amount of energy in the form of heat which will raise the temperature of one gram of water one degree Centigrade.

Heating degree days - Relative measurements of outdoor air temperature obtained by subtracting the mean daily temperature from an established base temperature of 65 degrees Fahrenheit.

Cooling degree days - Relative measurements of outdoor air temperature obtained by subtracting an established base temperature of 65 degrees Fahrenheit from the mean daily temperature.

Conversion Factors

Average energy content of various fuels	**Btu**
1 kilowatt-hour of electricity	3,413
1 cubic foot of natural gas	1,008 to 1,034
1 therm of natural gas	100,000
1 gallon of liquefied petroleum gas (LPG)	95,475
1 gallon of crude oil	138,095
1 barrel of crude oil	5,800,000
1 gallon of kerosene or light distillate oil	135,000
1 gallon of middle distillate or diesel fuel oil	138,690
1 gallon of residual fuel oil	149,690
1 gallon of gasoline	125,000
1 gallon of ethanol	84,400
1 gallon of methanol	62,800
1 gallon of gasohol (10% ethanol, 90% gasoline)	120,900
1 pound of coal	8,100 to 13,000
1 ton of coal	16,200,000 to 26,000,000
1 ton of coke	26,000,000
1 ton of wood	9,000,000 to 17,000,000
1 standard cord of wood	18,000,000 to 24,000,000
1 face cord of wood	6,000,000 to 8,000,000
1 pound of low pressure steam (recoverable heat)	1,000

Measurement conversions

1 short ton (ton) = 2,000 pounds = 6.65 barrels (crude oil)
1 metric ton (tonn) = 2,200 pounds
1 barrel (bbl) = 42 gallons = 5.615 cubic feet = 159.0 liters
1 Mcf = 1,000 cubic feet
1 therm = 10^5 Btu = 100,000 Btu
1 thousand Btu (MBtu) = 1,000 Btu
1 million Btu (MMBtu) = 1,000,000 Btu
1 quad = 10^{15} (quadrillion) Btu or 1,000,000,000 MMBtu
1 kilowatt-hour (kWh) = 1,000 watt-hours
1 megawatt-hour (MWh) = 1,000 kWh or 1,000,000 watt-hours
1 gigawatt-hour (GWh) = 1,000 MWh or 1,000,000,000 watt-hours
1 gallon = 4.524 pounds liquefied petroleum gas
1 standard cord of wood = 8 feet x 4 feet x 4 feet = 128 cubic feet = approx. 4,000 pounds
1 face cord of wood = 8 feet x 4 feet x 16 inches = 42.7 cubic feet = approx. 1,333 pounds

Source: *Wisconsin Energy Statistics, 2001*. Accessed from website August 2002.