

## Companion Notes

### **UPDATE ON PROPOSED GEOTHERMAL PROJECT IN THE GUNNISON RIVER VALLEY**

For the State of Colorado Water Resources Review Committee

July 18, 2013





## Colorado's Moment – The 2013 Pagosa Verde Symposium

Thursday, July 25th, Pagosa Springs, 8:30 am to 4:30 pm. Register at [Pagosaverde.com](http://Pagosaverde.com)

*Lunch provided, networking reception after. Held at the Pagosa Springs Center for the Arts.*

Pagosa Verde Symposium 2012 discussed strategies for rural and mountain resort communities to unlock Colorado's geothermal power and agricultural potential. This year's symposium illustrates collaborations providing financial, scientific and policy momentum. We will examine current examples at the 2013 Pagosa Verde symposium.

Over one hundred successful geothermal operations are producing power in the western US, yet none in Colorado. That is changing. The economic stimulus of geothermal in both power and agricultural applications is a reality. Support from federal, state and local institutions and policy is growing. Our goal is to explore financial and development structures that serve Colorado's unique landscape through innovative financial and technical models.

**Magnus Gehringer, World Bank's Energy Sector Management Program:** Sharing a global perspective on mitigating geothermal exploration risk.

**Nadiège Ayitoe-Meyo, Consultant at International Finance Corporation (World Bank Group):** Community and financial impact of oil and gas exploration and development in rural communities.

**Dr. Roy Mink, formerly with the DOE, Professor Emeritus at the University of Idaho, board member of US Geothermal,** a key player in worldwide geothermal projects and a life-long Idaho rancher: Opportunities for the rural west from geothermal energy and direct-use applications of geothermal resource in agricultural enterprise.

**Bernie Karl, visionary owner of the resort and power center in Chena, Alaska:** Experiences in providing electricity, food and heat for over 60 buildings from a local geothermal resource while operating a hot springs resort with three-hundred visitors daily year-round.

**Miriam Horn, coauthor of Earth-the Sequel and Director of the smart grid initiative at Environmental Defense Fund:** Community organization enabling new enterprise and revenue through renewable energy.

**Greg Munro, CEO of Colorado Rural Cooperative, LPEA and Jennifer Drake, Manager of Utilization Resource Strategy for Tri-State:** Sharing perspective on renewable power development and the ramifications of recent state policy changes.

**Eric Hass, Manager of Colorado's DOE Geothermal Technologies Office:** DOE's strategy and resources as applied to geothermal development in Colorado.

**Dr. Mike Batzle, Colorado School of Mines:** Geophysics and geothermal resource assessment. Recent studies of the Pagosa Springs area by CSM illustrate the promise of state-of-the-art geophysics focused on aquifer potential and reductions in drilling program risk.

**J.R. Ford of Healthy Forests, LLC:** An overview of a biomass project providing forest fire mitigation, water conservation and 5MW of clean power in a community scale business model. JR's project is scheduled to go on-line in 2014. The union of utility, state and federal forest and land agencies with private investment is ground-breaking and earned J.R. the award as Colorado's Deep Thinker for 2013.

**Michael Hillesheim, Senior Geothermal Systems Engineer at the National Renewable Energy Laboratory:** An overview of NREL and its geothermal program, a utility-to-distributed scale perspective.

*We will post a complete list of presenters' bios and symposium agenda on [Pagosaverde.com](http://Pagosaverde.com)*

*Please register at [Pagosaverde.com](http://Pagosaverde.com).*

*Attendance is free, but we need to insure seating space and lunches.*

• *Following the symposium, July 26th and 27th, is the COLORADO ENVIRONMENTAL FILM FESTIVAL CARAVAN in Pagosa Springs •  
For Film Festival info go to: [pagosagreen.org](http://pagosagreen.org)*



## **Pagosa Verde Model Geothermal Power Development**

The Pagosa Verde Model geothermal development in Gunnison County accommodates Gunnison's economic, environmental and natural resource priorities. Its financial model is innovative and promotes local or regional control of revenue, jobs and growth through public/private partnerships. The model provides clean power with no green house gas emissions, no carbon footprint and a negligible physical footprint. Financial risk during exploration is mitigated by a suite of innovations, but most importantly, by validating other commercially viable enterprise even if the resource does not prove capable of power production. The model enhances tourism and outdoor industries and does not impact wildlife habitat or wilderness esthetic. Gunnison benefits from four years of development of this model in Archuleta County.

The landowners in Waunita have agreed to pursue development within this model in a collaborative way. Gunnison County has provided leadership in arranging regulatory compliance at the sites. Gunnison County added a geothermal development district component to their strategic growth plan. This progress is significant and has required hard work and dedication from all parties and promises significant benefits to the residents of Gunnison County. The regional Forest Service and BLM representatives have contributed to the work and the planning encompasses protection of all natural resources, the Gunnison Sage Grouse and, especially, the water resource.

Key priorities within the model are:

1. Community education and support.
2. Creation of and retention of high paying jobs and revenue streams in the community
3. Scalable base-load technology. This allows plants to be designed for strategic incremental growth. It enables strategic financial and growth planning tuned to the state's Renewable Energy Standard and in harmony with the portfolio and transmission strategies of our utility partners.
4. The model uses a combination of innovative testing processes and low-temperature technology. This combination reduces high-risk exploration investment and puts the projects within reach of public/private partnerships on a local or regional level.
5. The wells, plant and infrastructure do not produce GHG emissions, have an almost zero carbon footprint and require minimal esthetic and physical footprints.
6. The community scale and distributed energy nature of the model provides energy security for its community, de-couples electric rates from commodity market volatility and lends itself to eventual smart-grid technology.
7. The model's binary, air-cooled system is non-consumptive of geo fluid and requires less water during its working life than other renewable sources of power.
8. It produces base-load power 24/7/365 at an industry low levelized cost.

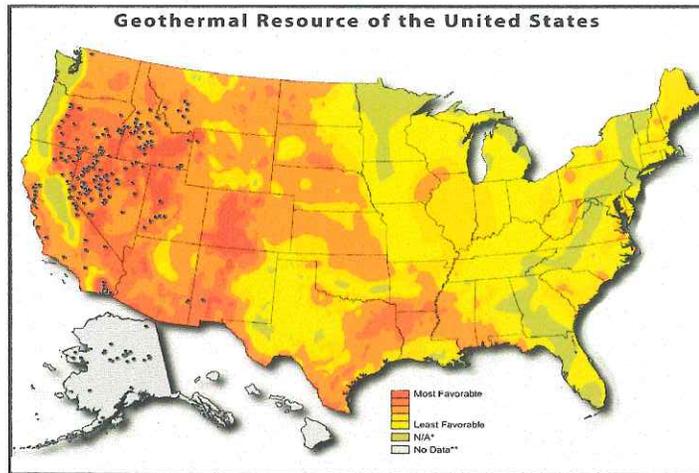


### **A Key Clarification**

Many Coloradans confuse all geothermal development with the EGS (Enhanced Geothermal System) geothermal process. In 2009 the state and DOE used recovery act funding to support EGS development in Colorado. At that time it was the proven technology. However, the EGS technology does not easily conform to the Colorado cultural or renewable energy landscape.

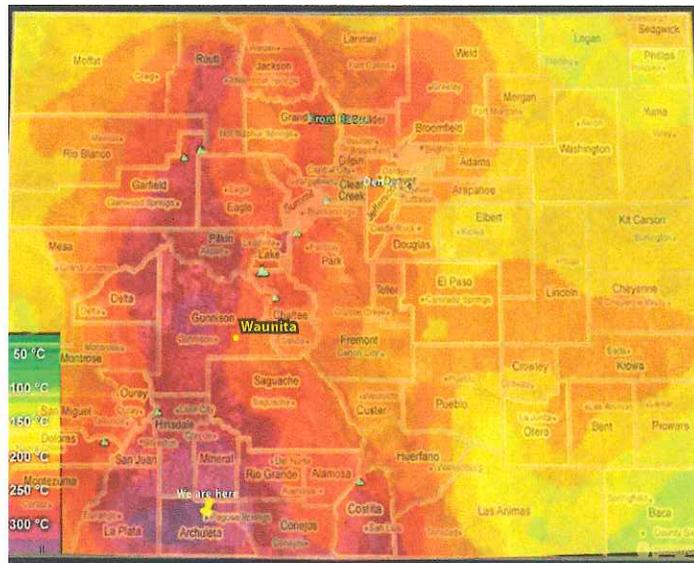
EGS or Enhanced Geothermal Systems use lots of water, deeper wells and inject water under pressure to stimulate steam production. These systems are consumptive of both geothermal fluids and surface water. The process requires major exploration and development investment and accordingly the financial model prefers large tracts of land and focuses on large production capacities with resultant large infrastructure impacts. In many ways the EGS technical and financial scenarios resemble gas exploration and production.

The current binary technology was first proven in late 2007 and gained wide acceptance in the last few years. Binary systems use little or no surface water. They are not consumptive of geo fluid, and because they function adequately at significantly lower fluid temperature, they typically require less well depth and a smaller tract for development. Low temperature binary systems such as those supported by the Pagosa Verde Model represent a new paradigm in geothermal resource development. It is now the favored technology world-wide. Both scientific and financial innovation are underway in service to the possibilities of this maturing technology.



**Over 100 Geothermal Plants in the Western US. None in Colorado.**

Most plants under construction or recently commissioned are binary, air-cooled plants using technology similar to the Pagosa Verde Model.

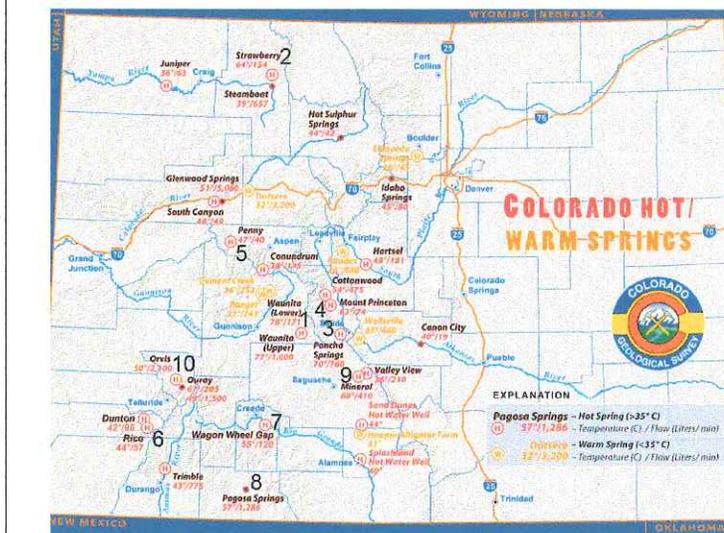


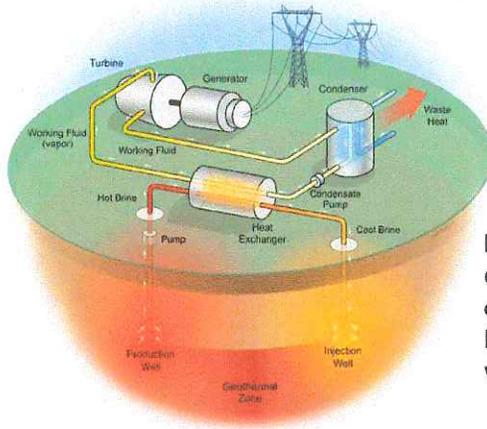
**Heat flow at depth in Colorado.** Waunita is the first or second most desirable site in Colorado. Average climate and temperature, surface expressions and historic geologic and geophysics analysis is promising. However, as in much of Colorado, land use, environmental impact, water quality and use, tourism, outdoor industry economies and wildlife habitat are issues to be considered in a successful development model.

**The most promising areas for geothermal development in Colorado are also the most sensitive to environmental, cultural and esthetic impacts.**

Additionally, mountainous or remote locales often suffer from marginal grid infrastructure and difficult local economic conditions.

On the other hand, these are the areas that benefit most from distributed, community scale projects bringing jobs, energy security and broad-based economic stimulus.



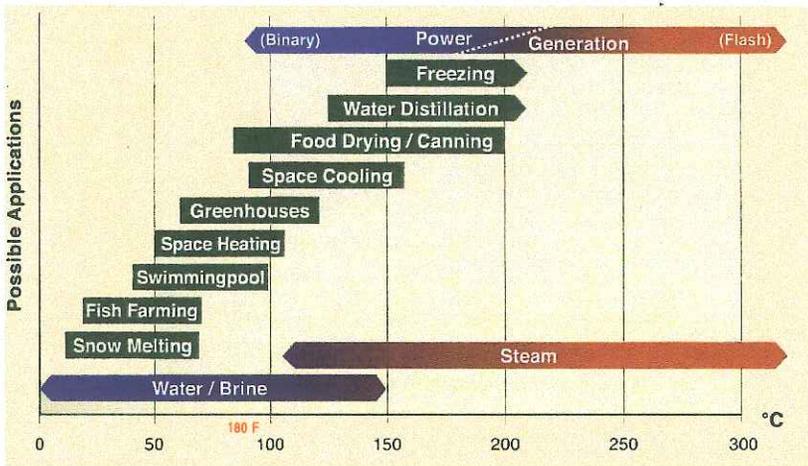
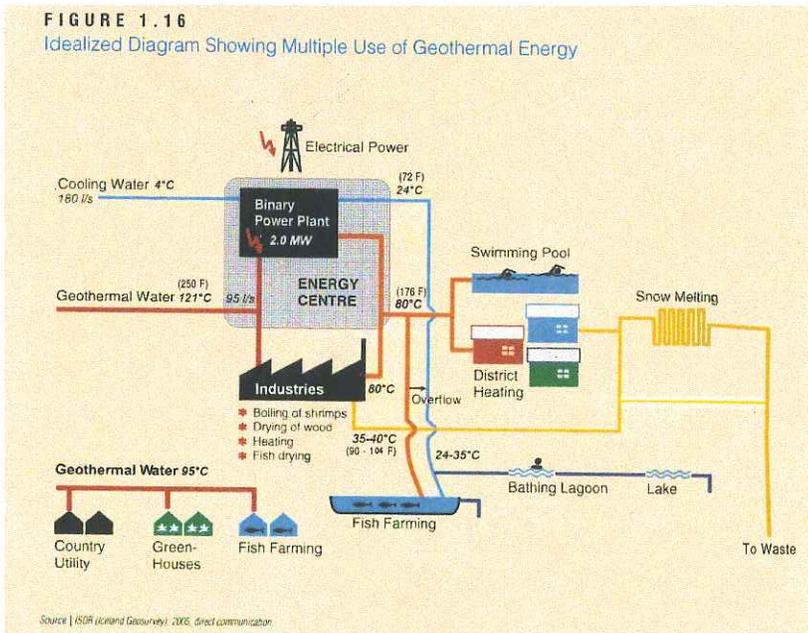


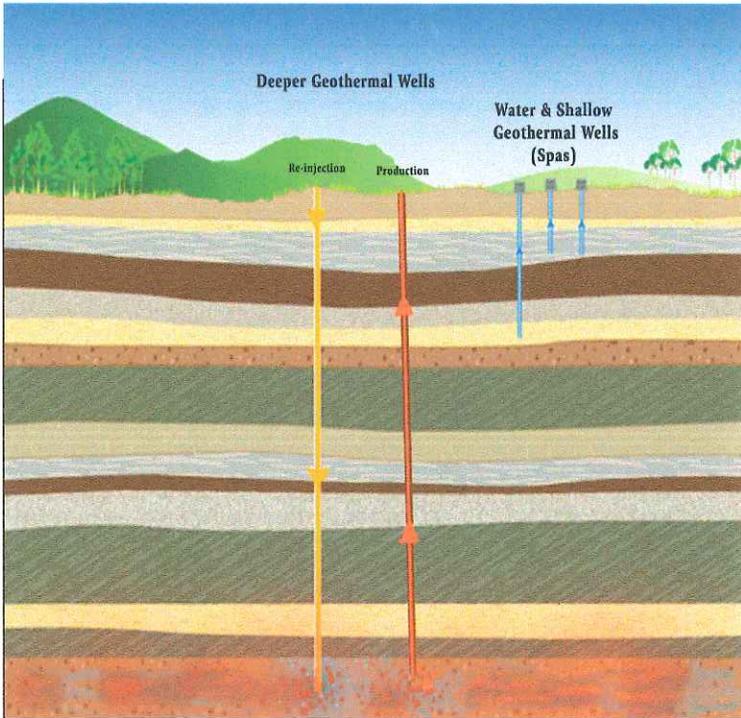
**Binary System Graphic**

Geo-fluid leaving the heat exchanger should then be run through subsidiary heat exchangers for support of ancillary enterprise as modeled below.

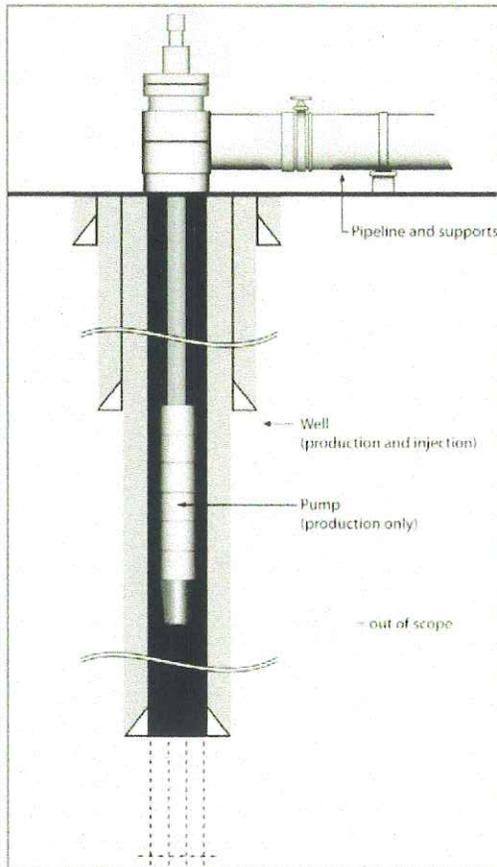
**Both Waunita landowners are pursuing direct use geothermal agriculture** using their existing surface resource (180° with high volume). Historically the brine has discharged into the stream with no negative effect other than warmth.

**FIGURE 1.16**  
Idealized Diagram Showing Multiple Use of Geothermal Energy





Geothermal wells access a deeper aquifer than water wells.



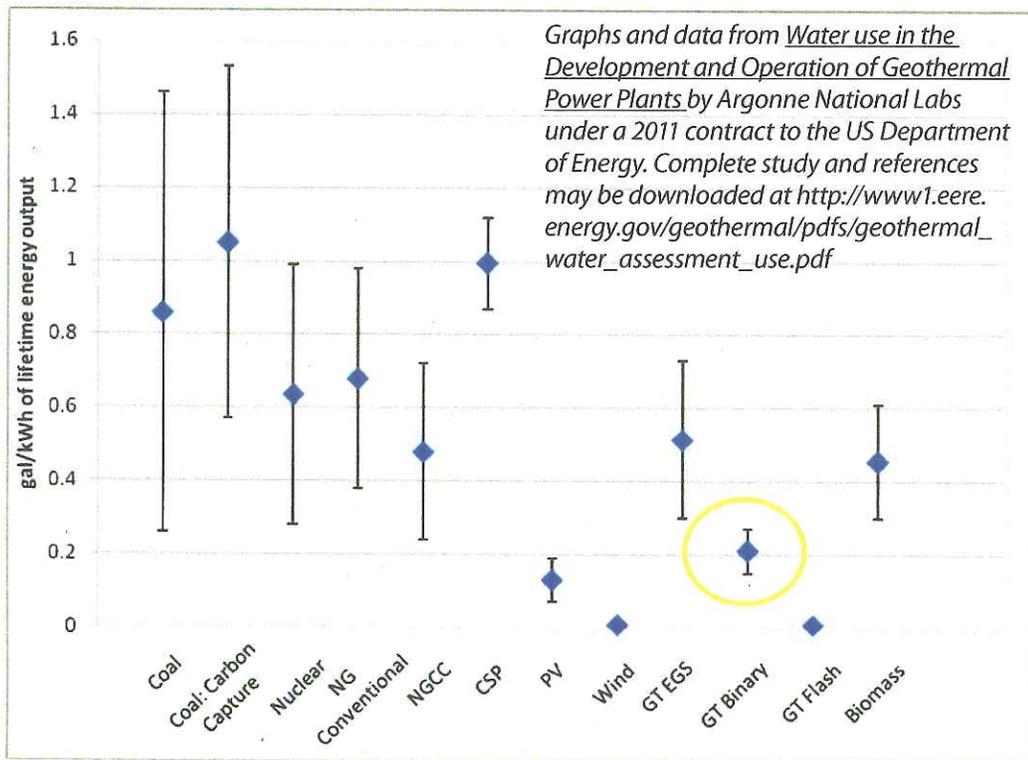
Type B Well permitting provides for regulatory supervision of well construction as well as NEPA permitting of site and infrastructure impacts.

Well casing is cemented in place and impervious to cross contamination with fresh water sources. Not only is this an environmental and NEPA requirement, but it is economically vital to protection of the fluid heat. Well cements and casing materials have to accommodate chemical, heat and pressure effects of brine transmission to the surface or during re-injection.

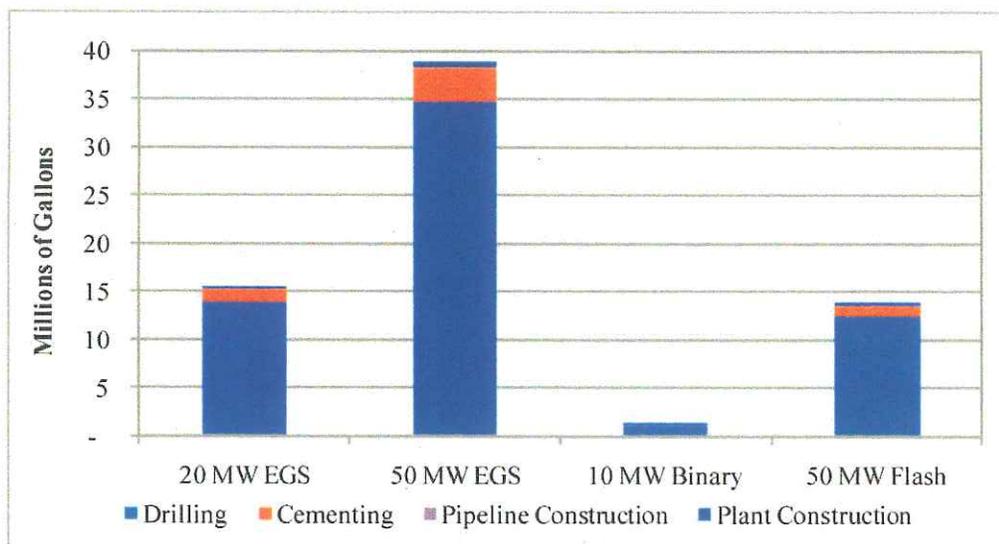
Wells are capped with a blowout preventer. Geothermal pipeline is typically above surface on concrete stanchions and insulated as shown, although it may be buried.

Well heads can be as far as one mile from plant without significant loss of fluid heat.

Water is used to mix drilling muds, cements and well cleaning during the drilling process. These fluids are typically captured and reused or disposed of according to NEPA requirements.



Water consumption for Electric Power Generation (Hydropower is not included because it is difficult to allocate evaporative losses from reservoir surfaces to electricity generation.) GT Binary and GT Flash estimates assume water consumed is makeup for operational loss and is a small percentage of total operational geo fluid loss.



**FIGURE 4-1 Volume of Water Consumed for Construction of Geothermal Power Plants according to Scenarios and Assuming Average Depth for Wells**

## Thoughts on state legislative support for geothermal development in rural Colorado.

1. The legislature showed great wisdom and boldness in authorizing statute 30-20-1203. This statute was clearly focused on fostering local participation in renewable energy development and plant ownership. I don't believe it has yet been used, however, it will be. The existing cap on the bond guarantee is unspecified. In order to stimulate municipal or county application of the statute for power plants, the cap should be high enough to encourage its use in the most financially prudent way. High risk investment capitol demands a punishing rate of return over the life of a project. The bond program should allow towns or counties to buy out high risk exploration investors once plant production and a PPA are operative. I've attached the statute for your convenience.

2. Large firms investing in geothermal are distracted by the new geothermal fields being developed with sovereign debt in Kenya, Indonesia and so-forth. For this reason there is little motivation for their investment in the Colorado market. However, the reality of many potential projects in Colorado argue in favor of supporting this Colorado market that promises so much.

I believe our elected bodies should consider a *Renewable Energy Development Trust*. This would allow the state and federal government, local and regional governments and private Colorado investors to collaborate in market development through a self funding growth mechanism.

The structure for such a trust exists. Versions have supported the gas and oil industry growth for a century. Pagosa Verde has discussed and researched this with leaders of the DOE, the World Bank, private investors and Colorado economic developers. I would like the opportunity to explore its benefits as a collaborative endeavor led by our elected Colorado officials.

**Colorado Stature 30-20-1203:**

- (1) "Board" means the board of county commissioners of a county or a city and county.
- (2) "Clean energy" means energy derived from biomass, as defined in section 40-2-124 (1) (a) (I), C.R.S., geothermal energy, solar energy, small hydroelectricity, and wind energy, as well as any hydrogen derived from any of the foregoing.
- (3) "Cooperative electric association" shall have the same meaning as set forth in section 40-9.5-102, C.R.S.
- (4) "Eligible applicant" means an individual property owner or a group of property owners that do not own the entirety of a cooperative electric association and that seek to construct, expand, or upgrade an eligible clean energy project located or to be located on the applicant's property.
- (5) "Eligible clean energy project" means a project owned by an eligible applicant that produces or transmits clean energy for public benefit only, has a nameplate rating of no more than fifty megawatts and is not a part of a larger project with a nameplate rating of more than fifty megawatts, and is located within the certificated service area of a cooperative electric association. "Eligible clean energy project" includes transmission lines to the point of entry to the power grid of a cooperative electric association, a generation and transmission electric corporation or association, or any federal agency and any other equipment or facility, including, but not limited to, substation upgrades needed to deliver the clean energy produced by an eligible clean energy project to a market.

**30-20-1203. Eligible clean energy project financing - county approval - private activity bond financing.**

- (1) An eligible applicant may apply to the board of the county or city and county in which it proposes to construct, expand, or upgrade an eligible clean energy project for assistance in the financing of the project. Subject to the requirements and limitations specified in federal law, the "Colorado Private Activity Bond Ceiling Allocation Act", part 17 of article 32 of title 24, C.R.S., and subsection (2) of this section, if the board approves the application, it may provide financing assistance by issuing tax-exempt private activity bonds in a minimum amount of one million dollars on behalf of the eligible applicant.
  - (2) A board shall issue tax-exempt private activity bonds on behalf of an eligible applicant to finance an eligible clean energy project subject to the following requirements and limitations:
    - (a) The board shall enter into agreements with the eligible applicant under which:
      - (I) The board agrees to loan to the eligible applicant the net proceeds of the bonds issued so that the eligible applicant can finance all or a portion of the eligible clean energy project; and
      - (II) The eligible applicant agrees that it has the sole responsibility to pay, either directly or indirectly through the board or a bond trustee, all financial obligations owed to bondholders and that it shall provide and maintain any reserve deemed necessary by the board to ensure that the financial obligations are paid;
    - (b) The bonds issued shall specify that bondholders may not look to any county or city and county revenues for repayment of the bonds. The bonds shall further specify that the only sources of repayment for the bonds are revenues provided by the eligible applicant, property of the eligible applicant, or credit enhancement obtained by the eligible applicant that may be pledged to the payment of the bonds; and
    - (c) The repayment term for the bonds issued shall not exceed ten years.
  - (3) Because private activity bonds are payable only from the sources specified in paragraph (b) of subsection (2) of this section, such bonds shall not be deemed to create county or city and county indebtedness or a multiple-fiscal year obligation within the meaning of any provision of the state constitution or the laws of this state, and a board may issue such bonds without voter approval.
  - (4) The rates charged by an eligible applicant for the delivery of clean energy produced by an eligible clean energy project shall be set to allow recovery of all costs necessarily incurred to deliver the clean energy to a market, including, but not limited to, the costs of substation upgrades, transmission lines to the point of entry to the power grid of a cooperative electric association, and any wheeling charges imposed by a cooperative electric association.
- Source: L. 2008: Entire part added, p. 1316, § 3, effective May 27.



***Pagosa Verde provides leadership in transitions from need to actuality in sustainable agriculture and renewable energy projects. Expertise in education, research, design, engineering, financial structuring, relationship building and public/private partnering allow Pagosa Verde to develop projects where key ownership and economic benefit remains in the local community.***



***Jerome Smith*** - Involved for 30 years in the transitions of science and technology into new markets. This included management of market growth and product development with Stoneage Tools, CBS, Sony, Teac/Tascam, Warner Bros., Lucas/Skywalker, Universal Studios and others. In 2008 Jerry founded Pagosa Verde. He is committed to overcoming adaptive inertia in people, businesses and culture as opportunities appear from the disciplined imagination of scientists, engineers, artists and businessmen. He is a former farmer, horseman, soldier and surfer and a happily married man with three children. He lives in Pagosa Springs because it's fairly far from everywhere and just wild and western enough to feel like home.



***Sally High - Sustainable Agriculture, Community Education & Relations***

Sally received the Presidential Innovation Award for Environmental Educators from the White House Council for Environmental Quality and the Environmental Protection Agency. She has presented about environmental and sustainability concepts for the Colorado Alliance of Environmental Educators and the National Council for the Social Studies. Sally teaches Clean Energy and Greenhouse Gardening. She serves on the Board of Directors of the Geothermal Greenhouse Partnership and the Colorado State University Extension Advisory Committee for Archuleta County. Sally coordinates the Geothermal Greenhouse Partnership's Colorado Environmental Film Festival Caravan. Sally has a BA in Sociology and Anthropology, graduate work in the social sciences and education and an MA from the University of Northern Colorado. She is a Sustainability Fellow with the Green Education Foundation, a member of the Colorado Alliance of Environmental Educators, and the Colorado and National Councils for the Social Studies. Sally is a founding member of Pagosa Verde.



***Kirsten Skeehan - Operations, Contracts and Regulatory Management***

Kirsten has a Bachelor of Science in Resource Management from the U.S. Naval Academy and a MBA from George Washington University. As a commissioned officer, Kirsten was involved in intelligence, computers and worldwide secure communications. After seven years active duty, she joined the Navy Reserve and served at the Pentagon Navy Command Center. At Fannie Mae Kirsten managed construction of major computer centers, mainframe to distributed technology transitions and managed large operational and support staffs. Kirsten serves on the Archuleta County Housing Authority and is co-owner of Pagosa's finest bakery. Kirsten was instrumental in improvements to the Pagosa geothermal heating system and relationships between stakeholders.



***Dan Hand - Site Evaluation, Project Engineering and Development***

Dan is a licensed Professional Engineer with 29 years of experience. His background includes many years in the private sector developing and designing alternative energy projects including geothermal, biomass, solar, hydropower, and wind resources as well as a faculty position at West Point (United States Military Academy) in the Department of Mechanical Engineering. Dan is experienced in the areas of project development, resource development, project funding mechanisms, power cycle analyses, economic analyses, and modeling. Dan is dedicated to helping clients develop indigenous resources in an environmentally sound, economically feasible and beneficial manner.