



# Geothermal Development for Colorado

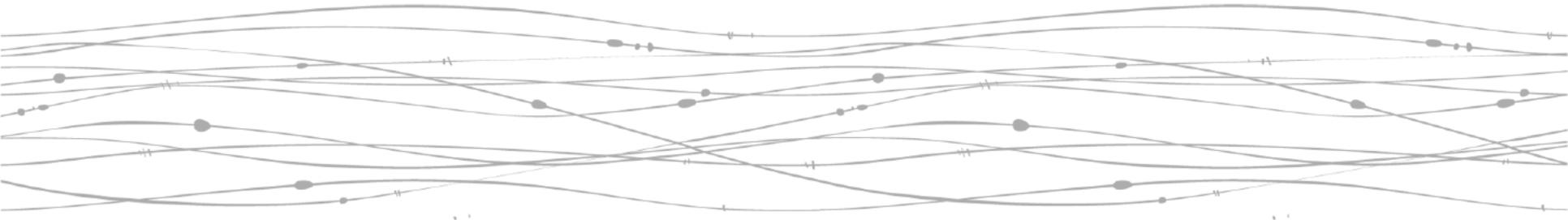




NREL – March 18, 2015

## *Advances in Geothermal Direct Use Workshop*

# The Importance of Shifting Exploration Models

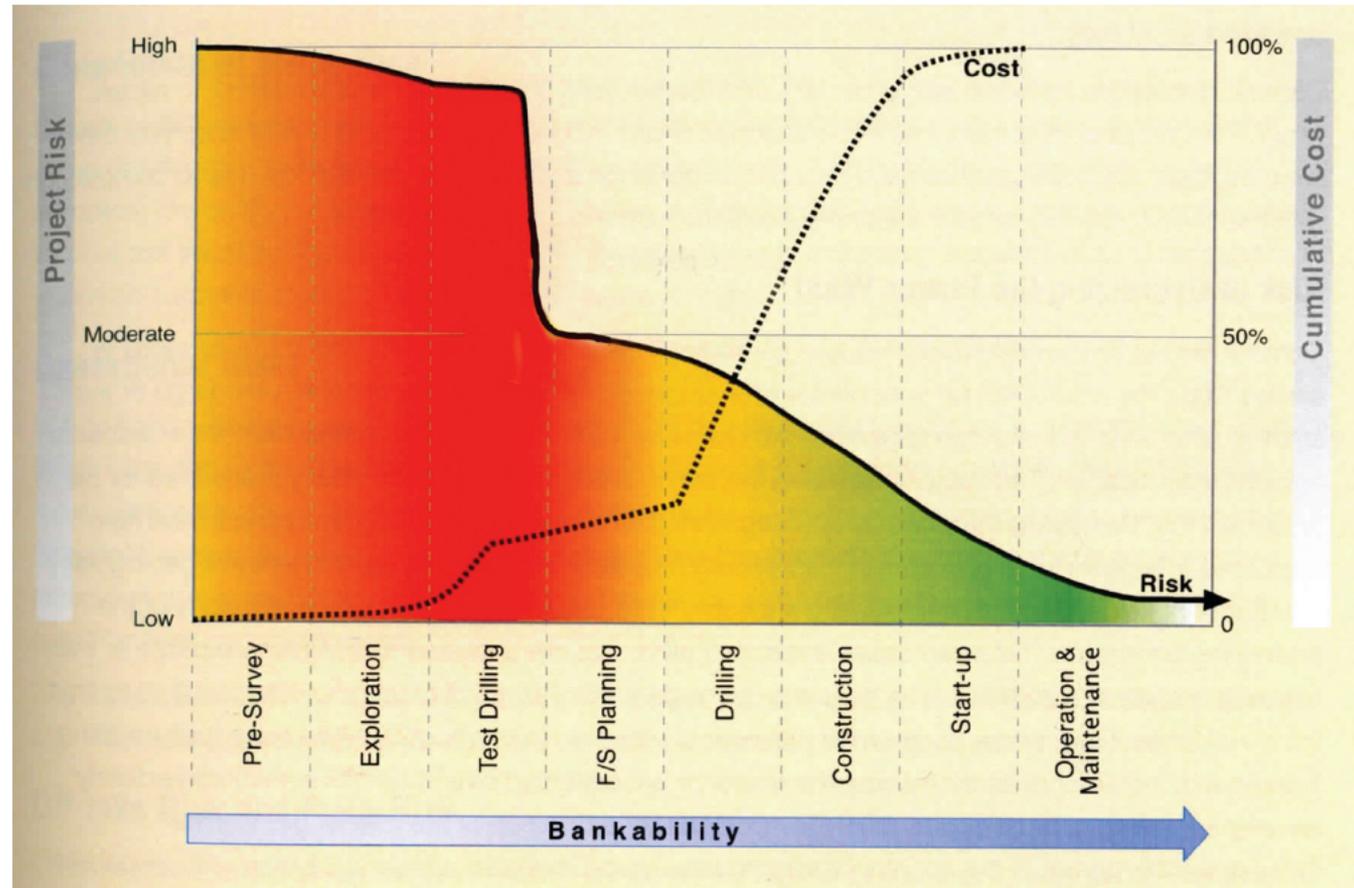


Our Goal is to Manifest Science in Economically  
Viable and Productive Projects.

The Constant Obstacle is Capital Investment

# Geothermal Exploration - Conventional

- \$6 to \$10 Million in Exploration balanced by utility purchases (PPA).
- Colorado has limited fields justifying investment in this model.
- Direct-use as a cascaded benefit is thus limited as well.



# Conventional Investor Class - Power Development

- What is their #1 priority? –TO MAKE MORE MONEY
- Who has the money? –Banks, Financial Institutions, Individual Investors
- How did they get the money they have? –By investing in assets that make money
- What is the sweet spot for \$10 M at risk? >20 MW
- Also adverse to Colorado historical regulatory and cultural (environmental) risks

## ■ ■ Broadened Investor Class via Direct-Use

- Local Government and State Government #1 Priority is Jobs
- Local Government and State Government #2 Priority is Economic Development
- Local and State Governments can support long term benefits from infrastructure investment
- Communities support local control of renewable resources and environmental protections
- There are private investors looking for environmentally beneficial renewable energy investment

# Shifting the Value Proposition – Pagosa Verde Model

The goal is heat – not power. Power becomes the secondary goal.

## Billy Ball - Direct-Use Only

Cashflows relative to capital expenditures are at a very attractive ratio and net profitability comparable to the Home Run. Less infrastructure and land impacts. Production wells less deep and less expensive.



## The Home Run Power Cascaded to Direct-use

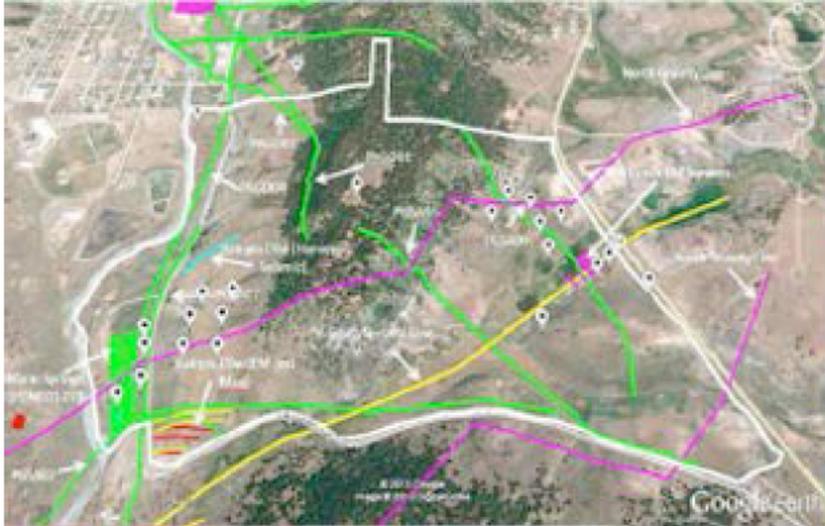




# Mitigate Risk by Lowering Exploration Costs Incrementally

Colorado School of Mines and other academic institutions are a vital resource

- Limit geophysical testing to most efficient protocols relative to site features and data correlations.
- Thermal Gradient wells to bracket resource targets and determine if deep or very hot resource is likely.
- Production wells budgeted based on gradient. If not promising for power, then well designs and depths engineered for direct use.



From DEVELOPMENT OF METRIC FOR MEASURING THE IMPACT OF ROAD FUNDING ON STATE GEOTHERMAL EXPLORATION  
 COALS Scott Jesse Katherine Young (Kilgus) Thomasson  
 National Renewable Energy Laboratory (2011)  
 Techniques (2013 NREL)

	Minimum Cost	Average Cost	Maximum Cost
Magnetic, Magnet and Radiogenic Gas Testing (MMR)	\$ 19,000.00	\$ 40,000.00	\$ 60,000.00
Controlled Source Frequency Domain Electromagnetics	\$ 1,000.00	\$ 3,000.00	\$ 14,100.00
Ultra Acoustic Manipulation	\$ 15,000.00	\$ 61,500.00	\$ 115,000.00
Direct Current Resistivity	\$ 118,000.00	\$ 206,000.00	\$ 1,200,000.00
Field Mapping	\$ 16,000.00	\$ 140,000.00	\$ 340,000.00
Geothermal Literature Review	\$ 2,400.00	\$ 6,000.00	\$ 10,000.00
Ground Gravity Survey	\$ 223,000.00	\$ 240,000.00	\$ 1,004,500.00
Ground Magnetism	\$ 2,000.00	\$ 41,000.00	\$ 202,000.00
Petrographic Analysis	\$ 4,100.00	\$ 6,000.00	\$ 9,000.00
Reflection Survey (Seismic)	\$ 250,100.00	\$ 421,000.00	\$ 1,100,000.00
Reflection Survey (Seismic)	\$ 2,000.00	\$ 6,000.00	\$ 11,000.00
Self Potential	\$ 11,000.00	\$ 81,000.00	\$ 310,000.00
	\$ 642,121.00	\$ 2,000,000.00	\$ 4,200,000.00

CSM Field Camp employed a generous suite of test regimes. Economics and geology should dictate the most effective correlative geophysical regimes relative to budget on targeted sites.



# ■ ■ Economics of Heat vs. Power Only

## Geothermal Binary Power Plant

- 3500 GPM
- $T \Rightarrow 220^{\circ}\text{F}$
- Power Plant Size max of 4 Mws
- Gross Revenue @ \$85/MW: \$2.9 Million
- Total Cost >\$26 Million
  - Field Development: \$8 Million
  - Power Plant: \$18 Million
- Simple Payback: 7.6 Years
- Jobs: 10

# ■ ■ Economics of Heat vs. Power Only

## Geothermal Agriculture/AquaCulture

- 3500 GPM
- $T = 165^{\circ}\text{F}$
- Peak Thermal Energy @  $122.5 \text{ MW}_{\text{th}}$  (Enough for **21 Acres** of Greenhouses)
- Revenue for a 21 acres of greenhouse: \$34.6 M Gross (\$5.2M Net)
- Total Cost \$15 to \$20 Million
  - Field Development: \$.5 to 3 Million
- Simple Payback: 3 to 4 Years
- Jobs: aprox. 8 per acre – 168 jobs for 21 acres

# ■ ■ Economics of Heat vs. Power Only

## Geothermal Direct Heating

- 3500 GPM
- $T = \langle \rangle 135^{\circ}\text{F}$
- Peak Thermal Energy @  $87.5 \text{ MW}_{\text{th}}$  (~2,000 Homes)
- Gross Revenue @ \$1000/Home: \$2.0 Million
- Total Cost \$21.5 Million
  - Field Development: \$6 Million
  - Centralized Heating District: \$15.5 Million\* In our model the Heating District is a customer. This lowers project cap total to around \$8M
- Simple Payback: 10.8 Years \* Our model – 5 yrs.
- Jobs: 12

## ■ ■ Direct Use Potential

**A 3500 gpm resource discovered through exploration that was too cool for power (<225F), could do a combination of greenhouses (5 to 20 acres) , residential or commercial facility heating (several hundred residences), manufacturing incentives and a combination of recreational and institutional benefits whose combined income, tax incentives and economic stimulus would rival or surpass income from a power plant while providing far more in the way of jobs and downstream benefit.**

**Versions of this scenario exist in Pagosa Springs, Poncha Springs/Salida and elsewhere.**

## ■ ■ Exploration for Heat/Direct-Use in Tandem with Power

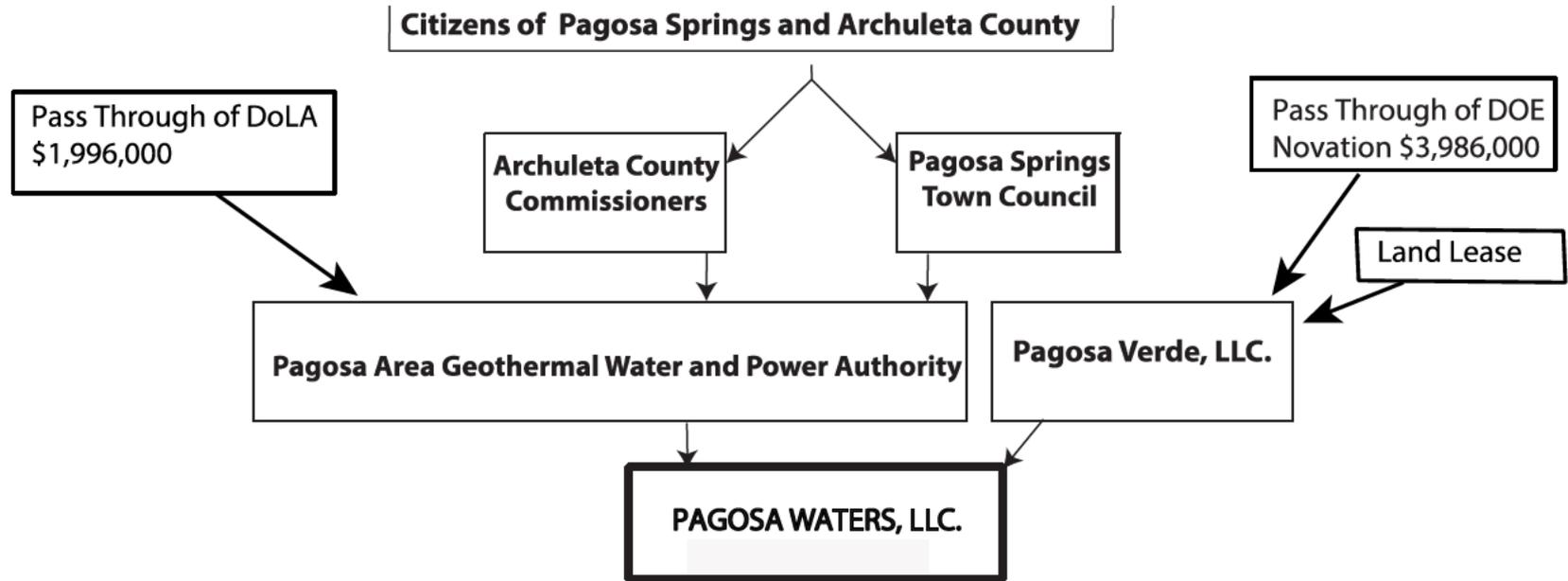
- **Geothermal heat enables year-round revenue for rural landowners or communities by reducing vulnerability to commodity coupled factors, economic volatility and weather.**
- Practical for small sites and limited resources
- Encourages incremental benchmarks for exploration expense reductions
- Time to revenue much shorter with Direct-use
- Strong incentives: Job creation and local economic stimulus
- Broadens investor class
- Enables local control of resources and revenue streams

# ■ ■ Finding the Money

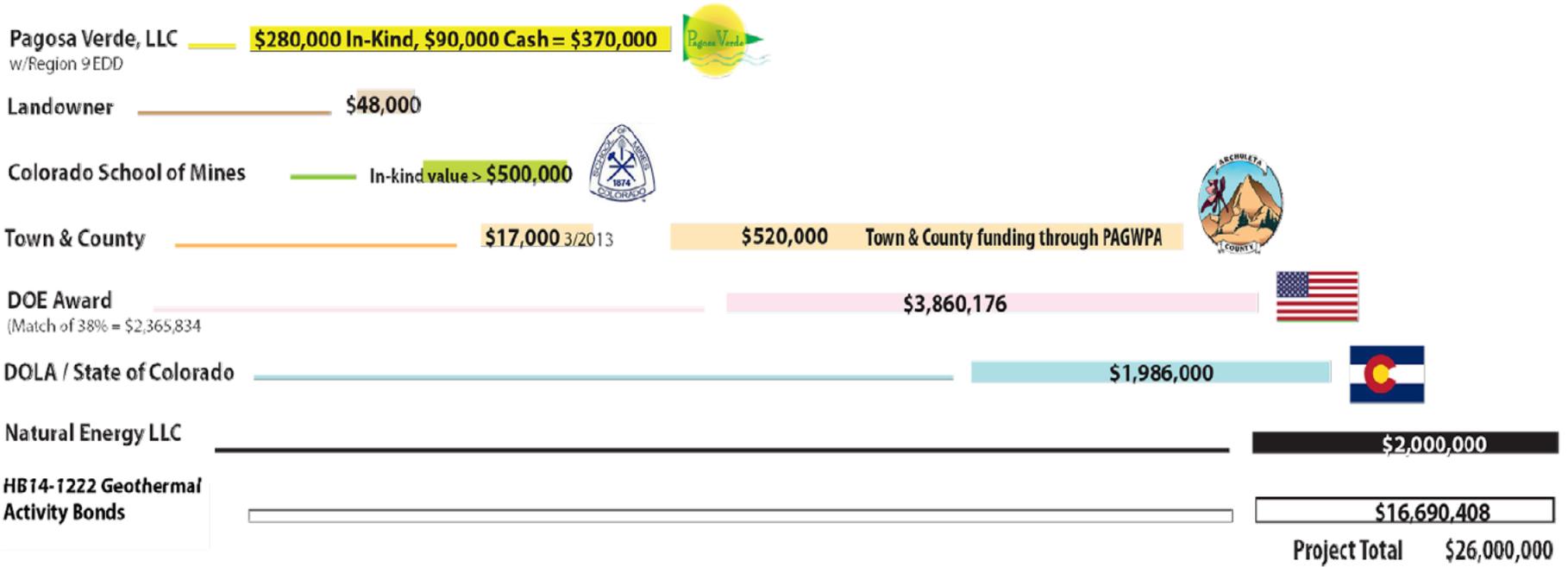
- 1. Create community and local governmental support**
- 2. Engage federal, state and local resources early in the planning**
  - Colorado Geological Survey**
  - Colorado Energy Office**
  - Regional Economic Development Agencies**
  - Department of Natural Resources – especially Water Division**
  - NREL: Data resources and expertise, Regulatory Road Map, etc.**
  - Federal and state grant opportunities and banking programs**
  - EPA/NEPA Regulations, policy and time frames**
- 3. Build a preliminary business plan/value proposition based on data, local needs and renewable resources in combination.**
- 4. Present the preliminary plan for the review of potential stakeholders and refine it based on reactions and input**
- 5. Consider the plan in terms of investor class needs (State =Jobs, Banks = collateral, community/ local government=economic development) (Private = ROI)**
- 5. Structure a capital plan based on analysis of all the options.**
- 6. Ask for the money**

# Community Scale Project Model

## Pagosa Waters LLC. Geothermal Power Project Ownership and Management



# ■ ■ Simplified Capital Structure



# Go Colorado!

Colorado  
statewide  
value cloud



- We have a team in place – federal and state institutions and public servants passionately supporting renewable energy projects.
- We have important programs in place:
  - Renewable Energy Standard
  - HB14-1222 Bond program for Geothermal Plant Construction
  - SB13-212 C-Pace Program for financing commercial renewable energy improvements
- We have proof-of-concept models
- We have Leadership and momentum

## Some thoughts:

- Support increased budgeting and support for academic programs like the CSM geophysical field camps, intern programs, thesis scholarships and so-forth
- Support increased funding and a broader mission for the Colorado Geological Survey
- Support the CEO policy push for geothermal development support
- Support DOE increased funding of Direct-Use technology and exploration programs
- Support elected officials that walk the walk

Thank you.

