

# GREENFIRE ENERGY

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**CO<sub>2</sub>-based Geothermal Power (“CO<sub>2</sub>G™”)  
&  
The St. Johns Dome**

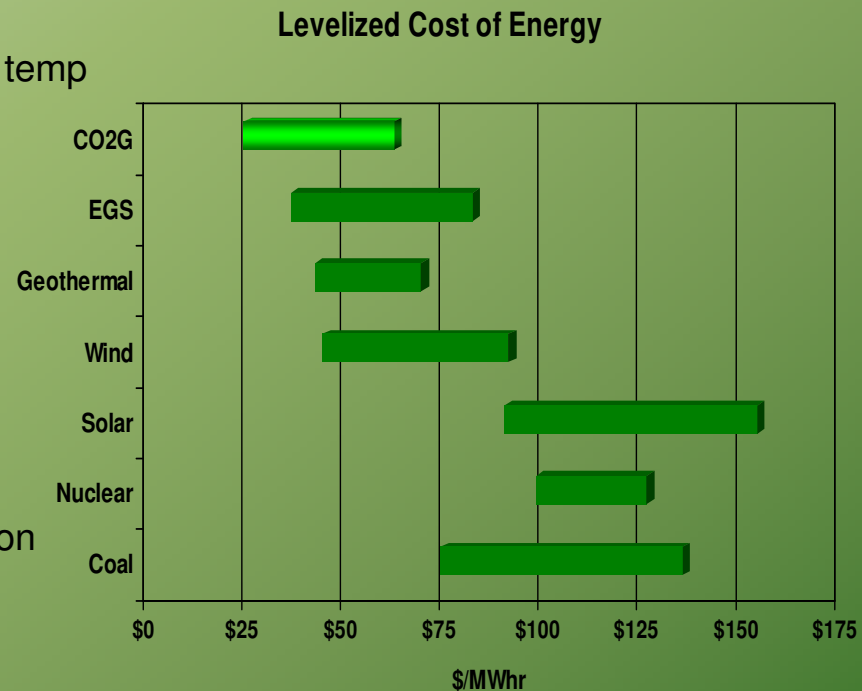
# GreenFire Energy

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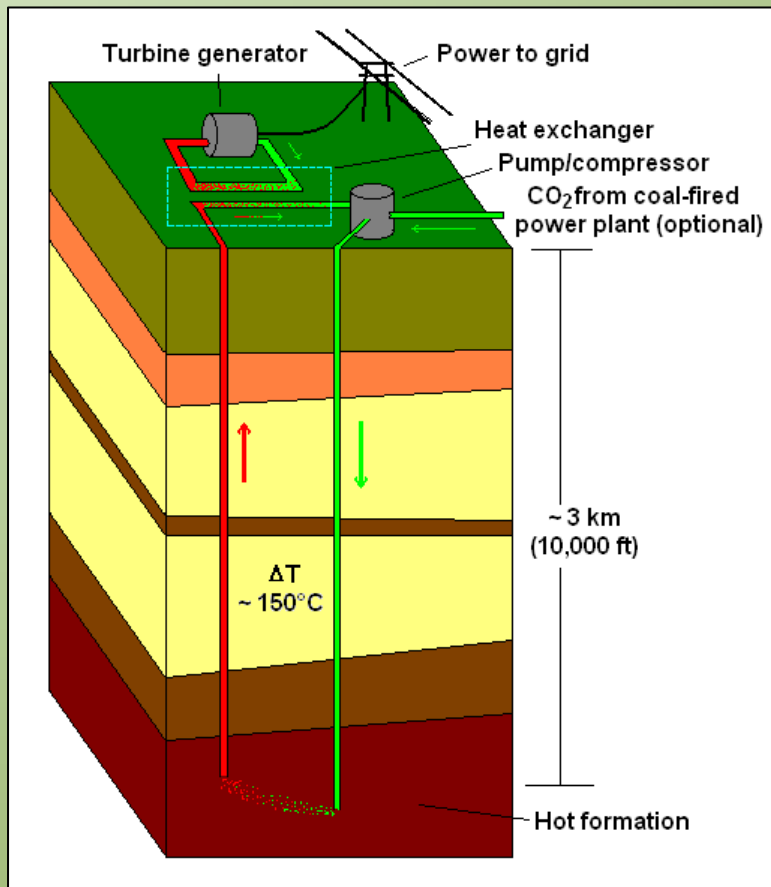
- Renewable energy startup headquartered in Los Angeles and Salt Lake City
- Four partners with relevant management and industry experience
  - Geologist/Business
  - Oil & Energy Industry Specialist (technical and financial)
  - Chemist
  - Environmental Scientist
- Distinguished advisory board
  - Financial
  - Technical

# Objective & Benefits: “CO<sub>2</sub>G™”

- GreenFire will develop, commercialize and produce a new form of geothermal power
  - GreenFire calls this “CO<sub>2</sub>G™”
  - CO<sub>2</sub> is the working fluid instead of water
  - Geothermal Resource: moderate depth & temp
- Benefits:
  - Renewable, baseload energy
  - Low production cost
  - Permanent CO<sub>2</sub> sequestration
  - Low water consumption
  - Make-up energy for CCS
- GreenFire will have:
  - Estimated multiple-year lead on competition
  - Large barriers to entry for competitors



# Why should CO<sub>2</sub>G™ be less expensive than other geothermal technologies?



- Lower capital costs
  - Reduced need for cooling towers, pumps
  - More efficient at shallower depths ⇒ lower drilling costs
  - Lower exploration risk
  - Greater potential for debt financing (commercial scale)
- Lower operational costs
  - Thermosiphon effect reduces pumping
  - Expansion vs temperature more favorable for CO<sub>2</sub>

# Requirements for an ideal site

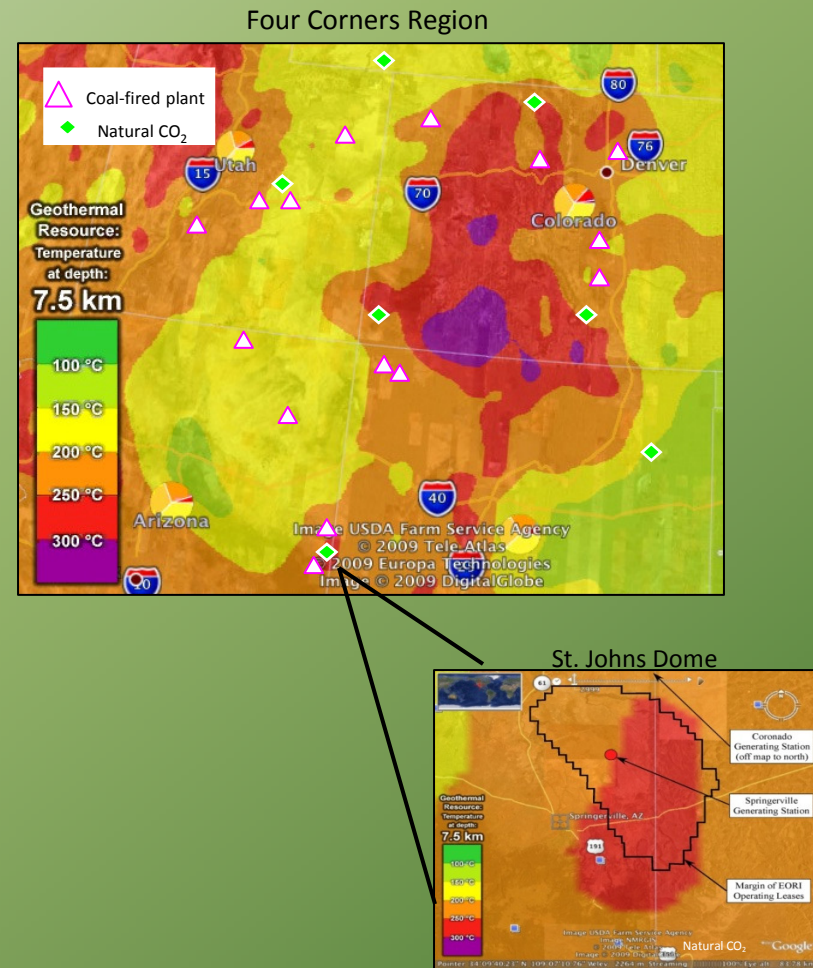
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<u>Requisite Characteristic</u>	<u>St. Johns Dome Characteristic</u>
Good geothermal prospect	✓ St. Johns Dome overlies one
Large volume of low cost CO <sub>2</sub>	✓ 450 MM tons (current estimated reserves)
Good geologic “cap” (a.k.a. “seal”)	✓ St. Johns Dome even holds helium
Fossil-fuel power plants for long-term CO <sub>2</sub> supply	✓ Local plants emit 19 MM tons/year; Regional plants emit 90 MM tons/year
Local connection into the power grid	✓ Available at local power plants



# St. Johns Dome is unique for CO<sub>2</sub>G<sup>TM</sup>

- No other comparable site identified in North America
  - Geothermal heat
  - Source of CO<sub>2</sub>
  - Proximity to power plants and electrical transmission lines
- No comparable site identified in Australia
- Possible comparable sites in Europe
- Insufficient information for other continents
- It is at the center of a great concentration of CO<sub>2</sub> sources (as carbon taxes are implemented, this will come into play)



# Status & Market Opportunity

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- Technology Status: Nascent Stage
- Initial site has been identified
  - Optimal site in North America
  - Binding agreement in place for exclusive development of the CO<sub>2</sub> resource
- GreenFire is in process of locking up all regional geothermal leases
  - This effectively eliminates competition
- Combine with Carbon Capture & Sequestration (CCS)
  - Long-term goal: facilitate economics of CCS at regional coal-fired power plants
  - Intend to use captured CO<sub>2</sub> from these plants
  - Success not dependent upon this goal; can succeed with only natural CO<sub>2</sub> deposit
- 4,000 megawatt opportunity = \$2.3 billion EBITDA, in perpetuity
  - Opportunity with only naturally occurring CO<sub>2</sub>: 800 MW, \$466MM/year, 25 years
  - Assumes \$0.07/kWh profit, 95% operating capacity

# Target Market

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- Initial target market: the power grid
  - GreenFire's inexpensive power can be sold to "the grid" for public consumption as soon as it is ready
- Long-term target market: nearby coal-fired power plants
  - CCS systems require energy = 1/3 of a power plant's output ("energy penalty")
    - Inexpensive baseload power required
  - GreenFire intends to use the CO<sub>2</sub> from these plants to generate additional power
    - CO<sub>2</sub>G™ using all of the CO<sub>2</sub> from a plant will produce approximately 1/3 of its output
  - If CCS is mandated, CO<sub>2</sub> emitters will require cheap, baseload power and a location to sequester their carbon – GreenFire will provide both
    - This makes GreenFire's CO<sub>2</sub>G™ truly unique
  - 2 major plants in immediate vicinity, 4 more in region, 600 in U.S., 3,000 worldwide
- ***If this market never materializes, GreenFire will be successful with natural (dome) CO<sub>2</sub> and initial target market***



# Execution Strategy & Timeline

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- Phase I

- Assemble technical development team (has been identified)
- Acquire all regional geothermal leases
- Finalize Joint Venture for CO<sub>2</sub> resource (binding MOU in place)
- Submit grant apps for federal funding
- Geophysics – drill core wells for data collection
- Approx. \$5MM, 24 months

- Phase II

- Design, construction and operation of demonstration Plant, 2 megawatts (MW)
- Success achieved by end of year 5 (timeframe may be shortened)
- ***Lucrative exit opportunity for early stage investors***
- Approx. \$27MM, 36 months

- Phase III

- Large-scale commercialization (by a major energy company); expand in 50 MW modules
- Drive capital cost from \$4MM per MW down to \$500K per MW
  - \$4MM down to \$2MM through decreased exploration costs and equipment reductions
  - \$2MM down to \$500K through debt leveraging
- 800 megawatts by end of year 10 (natural CO<sub>2</sub>); 4,000 megawatts by end of year 20 (w/ CCS)

# Funding Strategy

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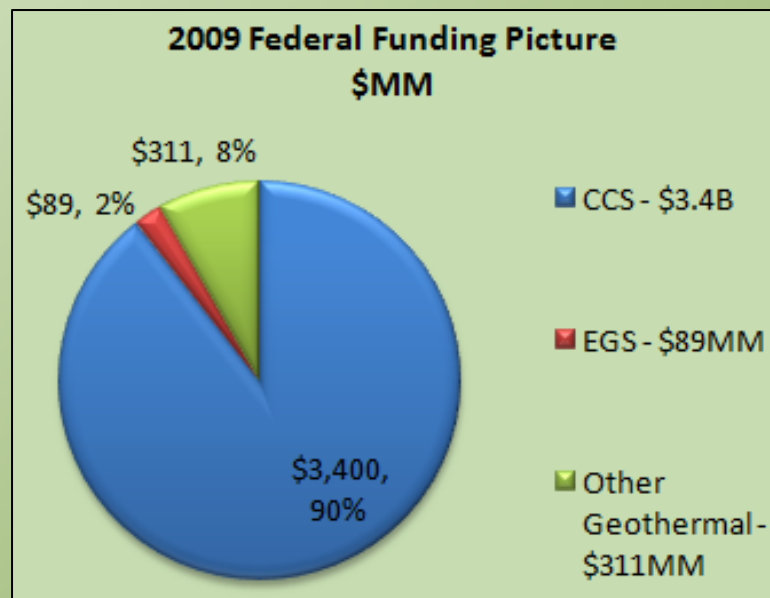
## **GreenFire intends to seek a mix of both private and federal funding**

- Estimated capital requirement through demonstration plant: \$32MM
- Federal funding opportunity of up to \$16MM (all through DOE)
  - ARPA-E
  - Geothermal Funding Programs, both EGS and Conventional
  - Carbon Capture & Sequestration (CCS) Programs
  - Renewable Energy Loan Guarantees (for commercialization)
- Remainder will require private investment
  - GreenFire's initial private capital requirement is \$5MM
- Power plants/utilities may augment private investment as CCS is implemented
  - Tucson Electric & Power (Units 1 & 2 at Springerville)
  - Tri-State Generation & Transmission (Unit 3 at Springerville)
  - Salt River Project (Unit 4 at Springerville and Coronado)
  - Arizona Public Service (Cholla)

# Federal funding for green energy:

## Unique funding window

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This is the 2009 funding picture; 2010 and beyond will continue to be significant

- CO<sub>2</sub>G<sup>TM</sup> sequesters CO<sub>2</sub> by losing working fluid into formation (5% - 40% / year)
- Significant competitive advantage relative to other EGS and geothermal projects
- May provide up to \$16MM in funding (through demonstration phase)

# Value of GreenFire & CO<sub>2</sub>G™

The value of GreenFire's CO<sub>2</sub>G™ project depends on power production, which in turn depends on whether we use just natural dome CO<sub>2</sub> or add CO<sub>2</sub> from CCS

CO <sub>2</sub> Source	CO <sub>2</sub> G Generating Potential (MW)	Earnings (at \$0.07/kWh)
CO <sub>2</sub> from Dome Only	800	\$466MM
Add CO <sub>2</sub> – Local Generators	778	\$453MM
Add CO <sub>2</sub> – Regional Generators	2362	\$1.4B
Total CO <sub>2</sub> G potential	3939	\$ 2.3B

**Notes:**

1. It is estimated that CO<sub>2</sub>G™ will generate 1/3 of a coal-fired power plant's capacity/output with all of its captured CO<sub>2</sub> (not applicable to the natural CO<sub>2</sub> from the dome)
2. It is estimated that GreenFire's CO<sub>2</sub>G™ plant will operate 95% of the time
3. \$0.07/kWh earnings is based on the CA PUC 2011 25-year Baseload Market Price Referent \$0.12111 less our cost \$0.051/kWh
4. Local generating stations consist of Springerville and Coronado @ 2,333 MW total capacity
5. Regional generating stations consist of Cholla, Navajo, San Juan & Four Corners @ 7,085 MW total capacity

# Investment Summary & Exit Strategy

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- GreenFire seeks \$5MM at a pre-money valuation of \$20MM
- Justification:
  - Used values from conventional geothermal industry
  - \$2.5MM per MW value (premium value for conventional geothermal)
  - 800 MW potential for just natural CO<sub>2</sub> yields potential value of \$2B
  - 1% of that value is \$20 MM
  - Other valuable factors:
    - Unique project site (optimal in North America)
    - Lack of competition
    - Far greater opportunity with local anthropogenic CO<sub>2</sub> sources
    - World-wide potential, both natural and anthropogenic CO<sub>2</sub>
- Exit Strategy and Estimated Value
  - GreenFire intends to sell to major energy company following successful demonstration (4 - 5 years)
  - Estimated sale price for St. Johns Dome project alone on the order of \$2B



# Competitive Analysis

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- One possible competitor: AltaRock Energy
  - They have applied for DOE grant \$\$ for initial testing at a Utah site – poor location
  - They hold exclusive license for core technology
  - GreenFire is in negotiations for a sublicense and/or partnership
  - A GreenFire/AltaRock “partnership” would effectively eliminate competition
- No other significant competition is known at this time
  - Even if competitors exist, we have the optimal site in North America; gives GreenFire a significant competitive advantage
- GreenFire anticipates a 10-year market lead in this technology before carbon capture and sequestration becomes widespread
  - Market lead will allow GreenFire to generate significant array of relevant intellectual property
  - In particular, we anticipate patents in areas such as thermal reservoir preparation and in heat exchange

# Evaluation of Risks

## Risk Matrix – GreenFire’s CO<sub>2</sub>G™ is a New Technology

<i>Risk Sector</i>	<i>Risk &amp; Effect</i>	<i>Solution</i>
Technology Risks	Loss of unexpectedly large volumes of CO <sub>2</sub> into the geologic formation; reduces power generation and changes cost dynamics (efficiency loss)	There may not be a solution to this risk
	It proves impossible to create the “thermosiphon” effect; reduces system efficiency, requires additional equipment and energy inputs	Install more compressors and pumps (costly solution, both CapEx and OpEx)
	Hydrofracturing will cause seismic movement (earthquakes), as it may have in other areas; leads to bad press/PR issues no matter how small	St Johns Dome is in an area of low seismic risk, unlike other areas where this has been tried (see “Seismic Risk” slide for more info)
Business Execution Risks	AltaRock Energy currently holds the exclusive license on the core technology patent; without a sublicense agreement or partnership, GreenFire cannot proceed.	GreenFire is currently in negotiations with AltaRock; all indications are that an agreement will be reached.
	GreenFire’s current management team is not capable of bringing business to commercialization, causing progress and growth to stall	GreenFire intends to exit upon successful completion of demonstration; targeting sale to a major energy company capable of commercialization and growth
Market Factors/ Conditions Risks	EORI does not commit any additional CO <sub>2</sub> from the dome for geothermal power production beyond demonstration; without anthropogenic CO <sub>2</sub> , this project will be limited to demonstration-scale	GreenFire believes the CO <sub>2</sub> will prove more valuable for geothermal energy than for tertiary oil recovery; technology could be exported as well
	Power plants don’t implement CCS; there will be no anthropogenic CO <sub>2</sub> to add to the project	St. Johns has enough CO <sub>2</sub> to run a geothermal power plant for 25 years at 17 MM tons/year

# Summary: A uniquely compelling story

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- Uniquely suitable site for CO<sub>2</sub>-based geothermal
  - Geothermal heat plus CO<sub>2</sub> availability
  - Nearby power plants
  - Nearby electrical transmission
  - Possibility of handling CCS from multiple plants
- Unique funding opportunity
  - Large barriers to entry
  - Uniquely attractive for CCS funding and other federal funding programs

# Appendix Slides

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The following slides are provided as additional information:

1. *Geothermal Technology Comparison*
2. *Use of Funds*
3. *Seismic Risk*
4. *Carbon Capture & Sequestration Costs*
5. *Carbon Trading: Competitive Advantages*
6. *Comparison with BrightSource Solar Project*

# Geothermal Technology Comparison

- Conventional geothermal sites have been optimized
  - Not too many sites left in the world for development
- Alternative geothermal technologies show tremendous potential
  - There is an endless supply of subterranean heat, *if* it can be tapped
- GreenFire's CO<sub>2</sub>G™ should have the lowest cost of the alternatives

Geothermal Technology Comparison					
Type	Depth	Heat Requirement	Working Fluid	Fracturing Required?	Pump through Formation?
Conventional	Shallow	Moderate to High	Water	In some cases	Yes
EGS*	Deep	High	Water	Yes	Yes
CO <sub>2</sub> G	Shallow	Moderate to High	CO <sub>2</sub>	Possibly	No

\*EGS stands for “Engineered” or “Enhanced Geothermal Systems,” also known as “Hot Dry Rock” technology



# Use of Funds

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GreenFire is currently seeking \$5MM in startup funds, to be used for the following purposes for two years:

- 24 months of operating expenses..... \$1.5MM
- Legal fees..... \$500K
- Costs associated with preparing proposals for the DOE..... \$500K
  - Includes grant writers, consultants, lobbyists and others needed for proposals
- Geophysical data collection, drilling of exploratory core wells and other field work.... \$1.5MM
- Obtaining geothermal leases..... \$1MM

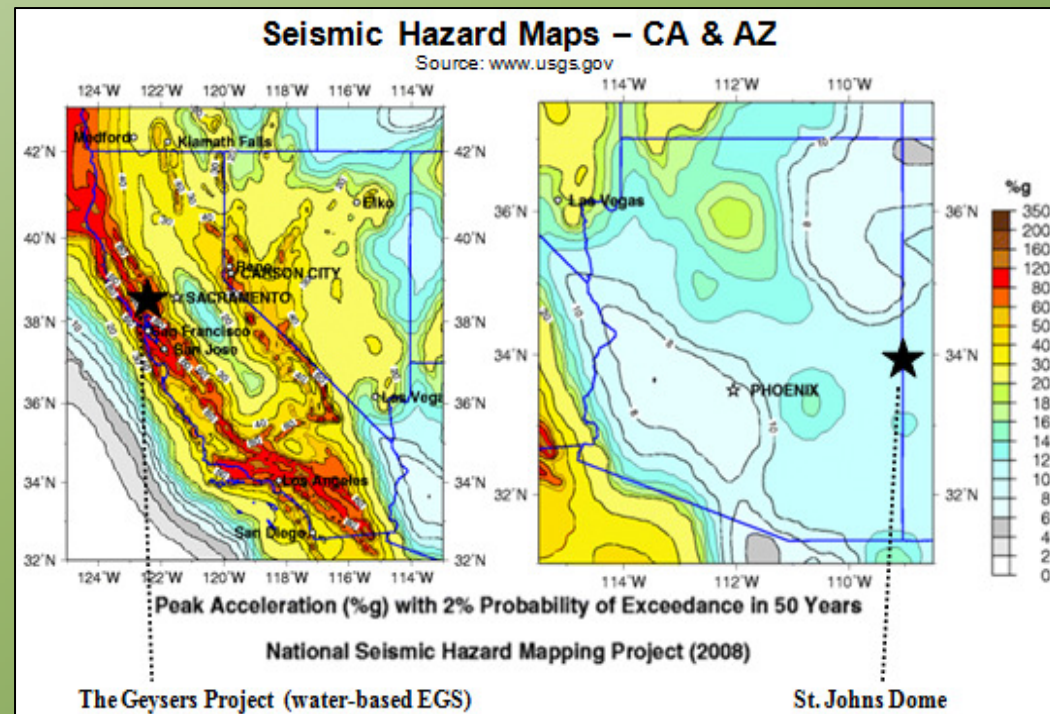
•With successful data collection at the conclusion of the startup phase, GreenFire anticipates being ready to begin construction of the development-stage plant.

•Construction and operation of the geothermal energy plant for the demonstration phase are projected to require in excess of \$27MM.

•Thus, total costs from startup through demonstration-phase operations are projected to exceed \$32MM, which includes a sizeable contingency fund.

# Seismic Risk

- Geothermal projects employing hydrofracturing may be associated with seismic activity
  - Two projects in Europe
  - The Geysers project in California
- Seismic activity has been minor, despite bad publicity
  - Seismic activity is unavoidable with high pressure fluid injection
- These projects are in areas of moderate to high seismic risk
- GreenFire's location at the St. Johns Dome is in an area of low seismic risk



Comparison of Seismic Risk

# Carbon Capture & Sequestration Costs

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## **Today's Estimated Costs:**

- Capture & Compression: \$55/ton
  - Transportation: \$10/ton
  - Sequestration: \$5/ton
- \$70/ton approx. total cost

## **Estimated Cost Savings with GreenFire's CO<sub>2</sub>G™ System:**

- Cheaper baseload energy: (\$5/ton)
- GreenFire to pay for carbon: (\$10/ton)
- Storage cost eliminated: (\$5/ton)

**GreenFire projects eliminating about \$20 of the \$70/ton for CCS**

# Carbon Trading: Competitive Advantage

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- Experts project \$15/ton improvement in CCS costs by 2030
  - Due to improvement in capture technology
  - CO<sub>2</sub>G™ eliminates sequestration costs and power utilities receive revenue for their CO<sub>2</sub>
  - Therefore, CO<sub>2</sub>G™ provides a significant cost improvement in the next few years; it is additive to future capture technology cost improvements
- Regional coal fired power plants around St. Johns Dome can take advantage of a unique situation in the country with respect to CCS
  - Under a carbon trading program, CO<sub>2</sub>G™ gives utilities in the St. Johns Dome area a significant competitive advantage

# Comparison with BrightSource solar project (Ivanpah, CA)

	BrightSource	GreenFire
Investment	\$3B	\$2B
Power produced	400 MW	800 MW
\$ / MW	\$7.5MM	\$2.5MM
Baseload?	No	Yes
Sequester CO <sub>2</sub> ?	No	Yes
Surface acres req'd	Up to 7,000	~100

BrightSource is a concentrated solar development in the Mojave Desert (CA). It is an example of a project that has been partially funded and has a power purchase agreement (PPA) in place.