



CALIFORNIA ENERGY COMMISSION

Renewable, Baseload Geothermal Power Using Supercritical CO₂ Technology (ECO2G™)

January 28, 2016



GreenFire Energy
Clean. Affordable. Global. Always on.

4300 Horton Street, Unit 15
Emeryville, CA 94608
Office: (888) 320-2721
www.greenfireenergy.com



John R. Muir

- Senior Vice President – Business Development
- GreenFire Energy, Inc.
 - GreenFire Energy’s ECO2G™ technology could transform the global geothermal power industry by overcoming the risk and resource constraints that have severely limited hydrothermal projects, and will generate clean, safe and reliable power at competitive prices.
- MBA with 30 year’s experience focusing on disruptive technology development for large opportunity markets





Andrew J. Van Horn

- Senior Advisor
- GreenFire Energy Advisory Board
- Ph.D. with 35+ year's experience as an economic, technical and regulatory consultant to utilities, EPRI, EPA, IPP generators, and energy and environmental market participants





GreenFire Energy Inc. Reinventing Geothermal Power

Mission

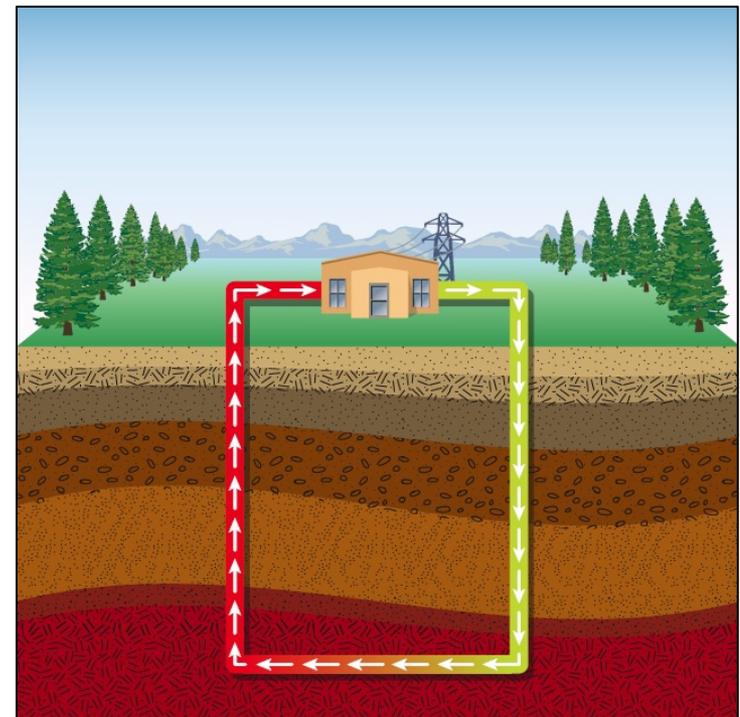
Develop utility-scale CO₂-based geothermal energy (ECO2G™) technology for global applications

- Develop, demonstrate, and commercialize ECO2G™
- Identify, finance, develop, and operate sites in the United States and abroad

Market

Multi-billion dollar market for electrical power that increasingly requires:

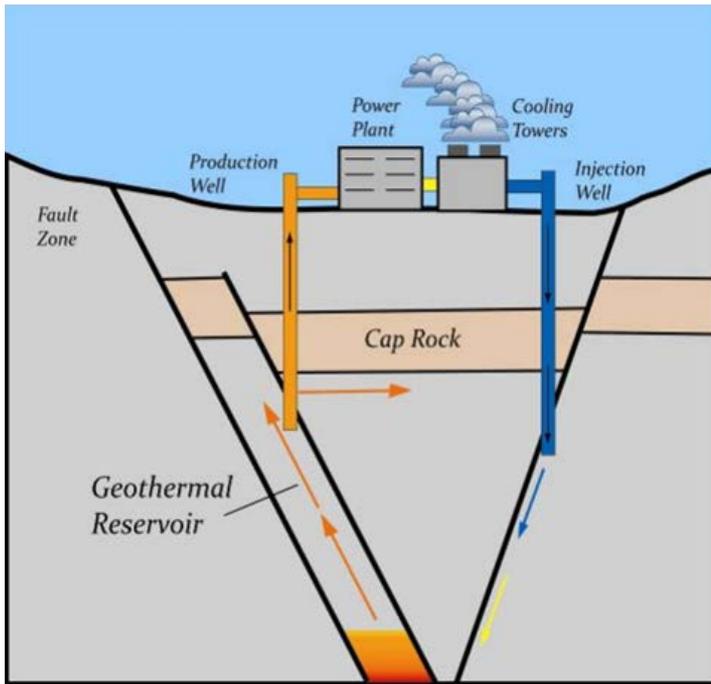
- Renewable fuel and power resources
- Zero carbon emissions
- Limited water consumption
- 24/7 baseload availability with flexible dispatch
- Commercial scale
- Competitive costs
- Global applications





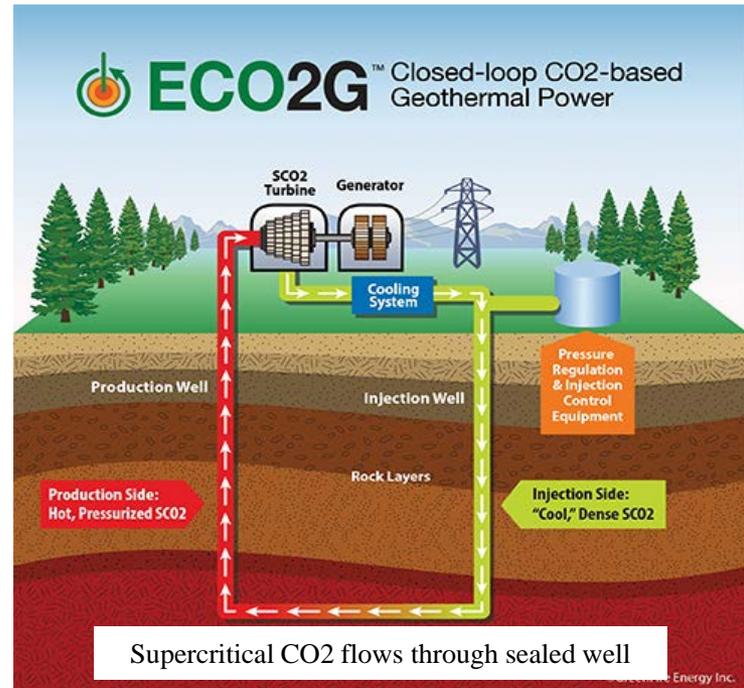
ECO2G™ Revolutionizes Geothermal Power Generation

Conventional Hydrothermal



Requires heat, water and permeability

Closed-Loop CO2 Geothermal



Requires heat



ECO2G Unique Capabilities

- Greatly expands the range of geothermal power
 - Does not depend on natural fractures (permeability)
 - Reduces consumption of increasingly scarce water
 - Uses much higher percentage of a given resource
 - Accesses heat that conventional geothermal can't use
- Substantially reduces risk and project time
 - Sufficient heat is the main requirement; reduces drilling risk
 - Scalable in 1 to 5 MW increments to match supply needs over time
 - Easier permitting (no fracking, injection, waste water)



ECO2G Can Provide California:

- Renewable zero carbon power generation to help reach the RPS goal of 50% retail sales by 2030
- Reliable 24/7 dispatchable baseload generation
- Replacement baseload capacity as existing units retire
- Rejuvenation and expansion of existing geothermal power sites
- Development of additional geothermal resources that cannot be accessed with conventional technology
- Resource diversity to complement intermittent solar and wind
- Reduced water consumption
- Renewable fuel source with secure on-site delivery.



Research and Development Needs

- Identification of existing geothermal sites that would benefit from additional capacity,
- Simplification of permitting/licensing for greenfield sites and additions on existing sites,
- Testing and comparison of flexible operations at conventional & ECO2G geothermal.



GreenFire Energy Team and Relationships

Management Team

- Joseph Scherer, CEO: Attorney/MBA with 30+ years experience in project finance including renewable energy
- Dr. Alan Eastman, Chief Technology Officer: PhD in chemistry with 37 patents, industrial experience
- John Muir, VP Business Development: MBA with several successful exits in technology ventures
- Mark P. Muir, Senior Consulting Scientist: MBA and geologist specializing in hydrogeology
- Joseph Osha, CFO : MBA/CFA with extensive public and private market experience in renewable energy

Advisory Board

- Dr. Leland “Roy” Mink: Former Director of DOE Geothermal Technologies Program; expertise in geology, hydrogeology, and geothermal resource characterization
- Lou Capuano, Jr.: 40 years of geothermal drilling expertise; widely recognized industry expert; current President of the Geothermal Resources Council (GRC)
- Halley Dickey: 40 years of experience in power generation systems development; expert in geothermal power system design and SCO2 turbines
- Dr. Andy Van Horn: 35+ years experience as economic, technical and regulatory consultant to utilities, EPRI, EPA, IPP generators, and energy and environmental market participants

Collaborating Research Partners

- U.S. Department of Energy
- Lawrence Berkeley National Laboratory
- Pacific Northwest National Laboratory
- University of Utah
- Electric Power Research Institute



Appendix: Additional Slides



Barriers to increasing geothermal power

- Technical barriers
 - Site feasibility and transmission availability
 - Declining conventional geothermal steam fields & unproductive wells
 - Reliance on current wet and dry steam generation technology
 - Need to integrate below- and above-ground design and demonstrate ECO2G
- Economic, legal, regulatory and contractual barriers
 - Wholesale power prices that pay for performance
 - Ancillary service/flexibility revenues that compensate for lost baseload revenue
 - Reduced interconnection costs/permitting, siting & licensing time
 - Ability to restructure existing contracts and revise new contract terms
 - The usual financing & commercialization hurdles

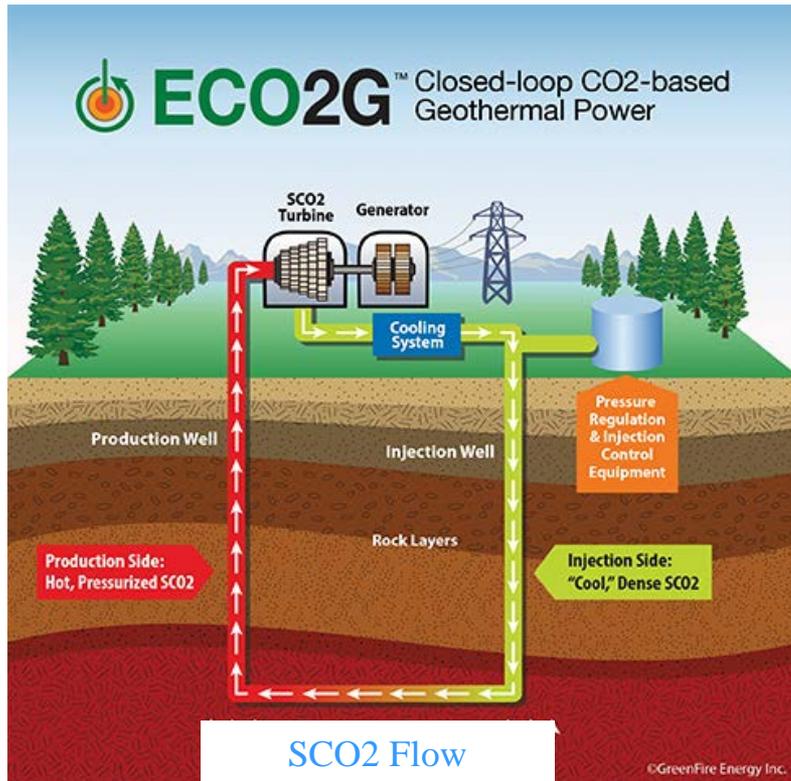


GreenFire Challenges/Requests

- Funding to study the potential for re-invigorating existing sites such as The Geysers, Coso and Imperial Valley
- Fast-track permitting of ECO2G installations within conventional geothermal project sites
- Recognition of the importance of clean, baseload power to:
 - balance California energy requirements,
 - meet renewable power goals,
 - reduce water consumption and carbon emissions.



ECO2G™: Advanced Technology Enables a Superior Business Model



Expands the range of geothermal; globally replicable

- Generates power where EGS and hydrothermal cannot

Lower risk and project time

- Virtually eliminates failed wells, the highest component of geothermal risk
- Can augment underperforming projects with no risk to existing system
- Easier permitting, reduced project timeframe
- Modular design scales up or down to match resource and demand
- Standardized components enable volume and learning curve cost reductions

Higher efficiency and profitability

- Extracts much more heat from a given resource compared to hydrothermal
- CO2 turbines enable efficient power cycles
- Flexible power generation is very attractive to utilities

Safe, environmentally sustainable

- No GHG emissions
- No geothermal process water consumption
- No fracking, shearing, or induced seismicity
- No waste streams
- No dangerous chemicals or explosives

A Revolution in Power Generation
Renewable, baseload utility-scale power that
addresses both climate change and water
consumption issues