

HRP GeoPower

The Potential for Engineered
Geothermal Power in South Africa



Agenda

- Current Energy Situation in South Africa
- What is Geothermal Energy
- Conventional Geothermal versus Engineered Geothermal Systems
- Engineered Geothermal Power
- Engineered Geothermal Projects World Wide
- Typical High-Level Project Overview
- Southern Africa Geothermal Potential



Current Energy Situation in SA

- Current and medium term supply constraints are hampering large capital project development in the following industries:
 - Mining in Platinum, Chrome, Manganese
 - Beneficiation in Platinum, Chrome, Manganese, Aluminium
 - Manufacturing in Steel, Motoring, High Tech
- Energy is contributing to an ever increasing, not directly controllable, operating cost
- Demand for base load power
- Increasing fossil fuel costs

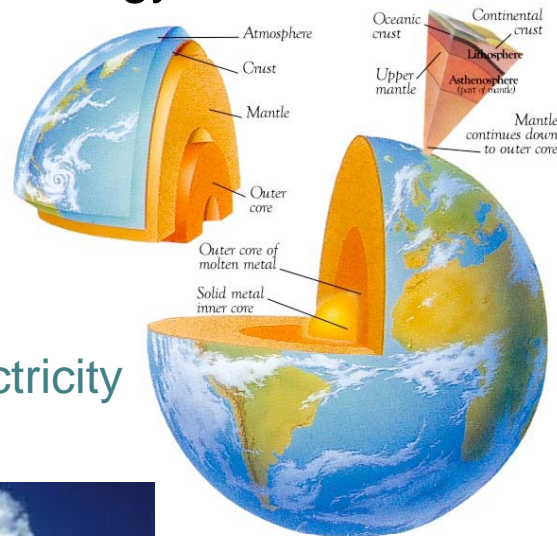
Governmental Objectives:

- Demand for jobs
- Industrial development/Critical Infrastructure drive
- Carbon emission reduction
- Rural development improvement demands
- Electricity regulatory landscape unresolved



What is Geothermal Energy

- Heat Energy from the Earth
- Sources of Geothermal Energy:
 - Magmatic
 - Radioactivity
 - Tectonic
- Common uses
 - Heating
 - Making Base Load Electricity

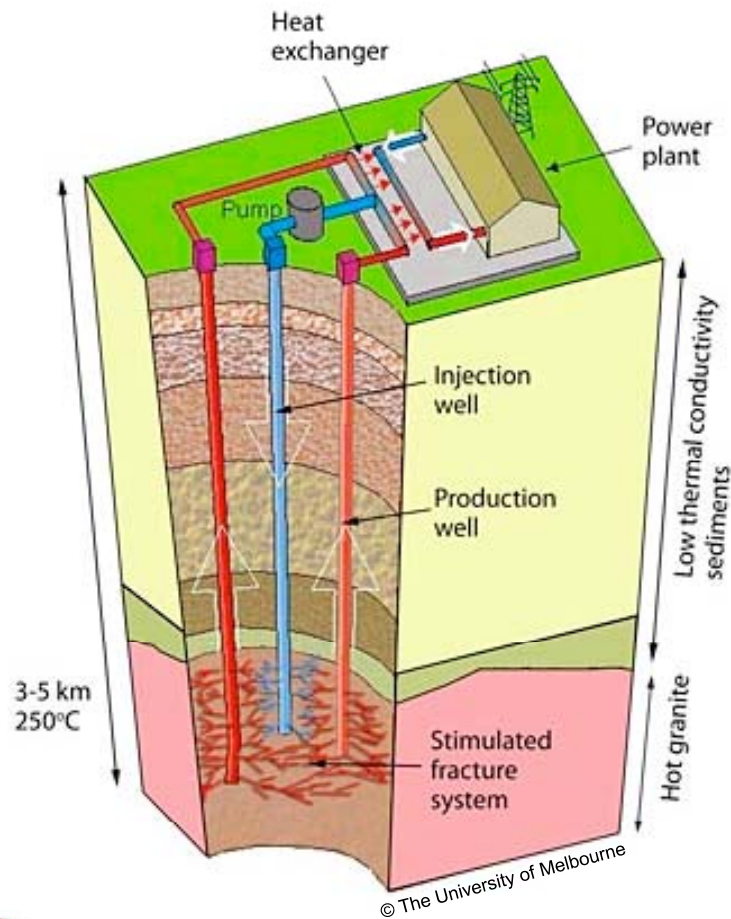


Conventional Geothermal versus Engineered Geothermal Systems



Primary Heat Source	Magmatic	Magmatic & Radioactive
Primary Resource	Deep Hot Aquifer	Artificially Created Aquifer in Hot Dry Rock
First Plant Built	1912 Italy	1970's Las Alamos
Worldwide Capacity Installed	10,715 MW	255MW
2020 Projected Worldwide Capacity	32,000 MW (Current Project Pipeline)	2,500 MW (Current Project Pipeline)
Biggest Developers	USA, Indonesia, Kenya, Philippines, Mexico, New Zealand, Japan, Iceland, Italy	USA, Australia, Hungary, Germany, France, UK, Tasmania,
Limiting Factors	Presence and Depth of Hot Aquifers	Depth of Hot Dry Rock
Depths	2,000-3,500 meters	2,000-6,000 meters
Advantages	Uses Steam Turbines, Air Cooled, Combined Heat & Power,	Easier to find Hot Rock, Air Cooled ORC's, Combined Heat & Power
Disadvantages	Locations, Drilling Costs, Gases	Hydraulic Fracturing (NO CHEMICALS), Drilling Costs
Risks	Aquifer Runs Dry, Managing the Water in the Aquifer	Seismic Activity during EGS Development, Drilling Depths Managing the Heat Source

Engineered Geothermal Power



- Hot Rock Zone drilled using oil rigs
- Hot Rock Zones are created through Hydraulic Fracturing (NO CHEMICALS)
- Power plant built on the surface
- Uses any source of waste water for hot rock injection where possible
- Uses existing oil drilling technology
- Uses existing Organic Rankine Cycle Technology
- Uses Air Cooling
- Can also provide District Cooling and Heating
- Does not affect ground water
- Power Plant has a small footprint



Engineered Geothermal Power Worldwide

Project	Country	Developers	Size	Depth (m)	Temp. (°C)	Status
Soultz	France	ENGINE	1.5MW	5059	200	Operational
Landau	Germany	Geo X GmbH	3MW	3400	160	Operational
Mauerstetten	Germany	Exorka International Ltd	4-5MW	4545	130	Drilling
Metzingen	Germany	Green Energy	8-10MW	5000	170	Feasibility Phase
Paralana	Australia	Petratherm	260MW	4003	200	Resource Drilling
Frome Project	Australia	Geothermal Resources Ltd	500MW	1809	96	Feasibility Phase
Olympic Dam	Australia	Green Rock Energy	400MW	1935	106	Test Drilling
Patchawarra	Australia	Green Rock Energy	50MW	3000	140	Test Drilling
Geelong	Australia	Greenearth Energy	12MW	4000	150	Feasibility Phase
Penola	Australia	Panax Geothermal	500MW	4015	171	Well Testing Phase
Hutton	Australia	Panax Geothermal	TBD	2250	140	Exploration Development
Tirrawarra	Australia	Panax Geothermal	TBD	3500	160	Exploration Development
Koroit	Australia	Hot Rock Ltd	50MW	2800	130	Validation Drilling
Copper Basin	Australia	Geodynamics	25-50MW	4950	250	Pilot Plant Operational
Parachilna	Australia	Torrens Energy Ltd	TBD	4500	240	Validation Drilling
Roxby	Australia	Southern Gold	TBD	4500	220	Feasibility Phase
Charlton-Lemont	Tasmania	KUTh Energy Ltd	TBD	3600	150	Feasibility Phase
Nicholas Fingal	Tasmania	KUTh Energy Ltd	TBD	3200	150	Feasibility Phase
The Geysers, CA	USA	Calpine	250MW	3852	180	Operational & Upgrading
Bend, Oregon	USA	Davenport Newberry	120MW	3000	205	Test Plant Complete
Bristol Bay, AL	USA	Naknek Electric Association Inc.	25MW	4300	250	Resource Drilling
Desert Peak, NV	USA	Ormat, Geothermex	11-50MW	1200	155	Field Expansion Operational
Raft River, ID	USA	US Geothermal	10-36MW	1855	145	Field Expansion Operational
United Downs	UK	Geothermal Engineering Ltd	10MW	5000	170	Drilling
Eden Project	UK	EGS Energy Ltd.	3MW	4000	190	Commencing Drilling
Carpathian Basin	Hungary	CEGE Ltd	10MW	4000	200	Well Testing

Complied By HRP ©



High-Level Overview

Financials Based on a 50 MW Plant (subject to resource)	
Project Capital Cost per MW	R 54 million
Project Capital Cost with Contingency & Underwriting	R 70 million
Total Construction Period post feasibility	24 - 36 months
First Capacity Online post feasibility	13 Months
Operating Cost as Percentage of Revenue	5.00%



Strengths	Threats
<ul style="list-style-type: none"> • Close proximity to the grid • Renewable green energy • Base load power • Low operating costs • Low complexity • Long plant life • Low maintenance costs • Low water consumption • Capital cost comparable to Concentrated solar or Nuclear, but O&M lower • Proven technology • Number of EGS sites worldwide with similar temperature ranges to the SA 	<ul style="list-style-type: none"> • Seismic activity due to hydraulic fracturing, but manageable • Geothermal resource cooling, but managed through resource monitoring • That there is adequate water • The geology of the rock strata • The well drilling costs • Lead times and availability of oil drilling rigs • Availability of funding
Opportunities	Weaknesses
<ul style="list-style-type: none"> • Scalability and sustainability of plant • A strategic energy source for the future • The additional benefit of district refrigeration and heating • Not reliant on Refit tariffs 	<ul style="list-style-type: none"> • The capacity of the plant is limited by size of and sustainability of the geothermal resource • Heat exchanger scaling • Drilling operations would require a lot of water • Energy requirements of drilling rigs



Closing

The Potential:

- Across the entire South Africa is more than the current total generation capacity
- Can be generated where the power is needed most

Interesting Facts:

- AU\$400million market of 11 EGS companies on the AUS STX
- Google has invested more than \$10million in EGS development
- Germany Boosts Geothermal Tariff
- Kenya targets 800MW by 2017
- Uganda targets 450MW



Thank You

Andrew Ochse

+27 83 288 3737

andrewo@hrpgeopower.com

Geoff Meyer

+27 82 370 7070

geoffm@hrpgeopower.com

Graham Gavine

+27 82 495 3482

grahamg@hrpgeopower.com

