Well 15b – Dawn August 2019 steam venting from 250m

Kalahari GeoEnergy Ltd

BWEENGWA RIVER PROJECT

Ongoing Feasibility Study at Bweengwa River on an initial ±6MWe as part of a more substantial resource, which is yet to be constrained

Opportunities, challenges and lessons learnt

Kalahari GeoEnergy Ltd,
Block D, 759 Independence Avenue, Woodlands, LUSAKA
Telephone: (+260) 0211 840431 | www.kalaharigeoenergy.com

Zambia's Geothermal Energy Opportunity

Zambia has the geologic setting for multiple geothermal energy targets

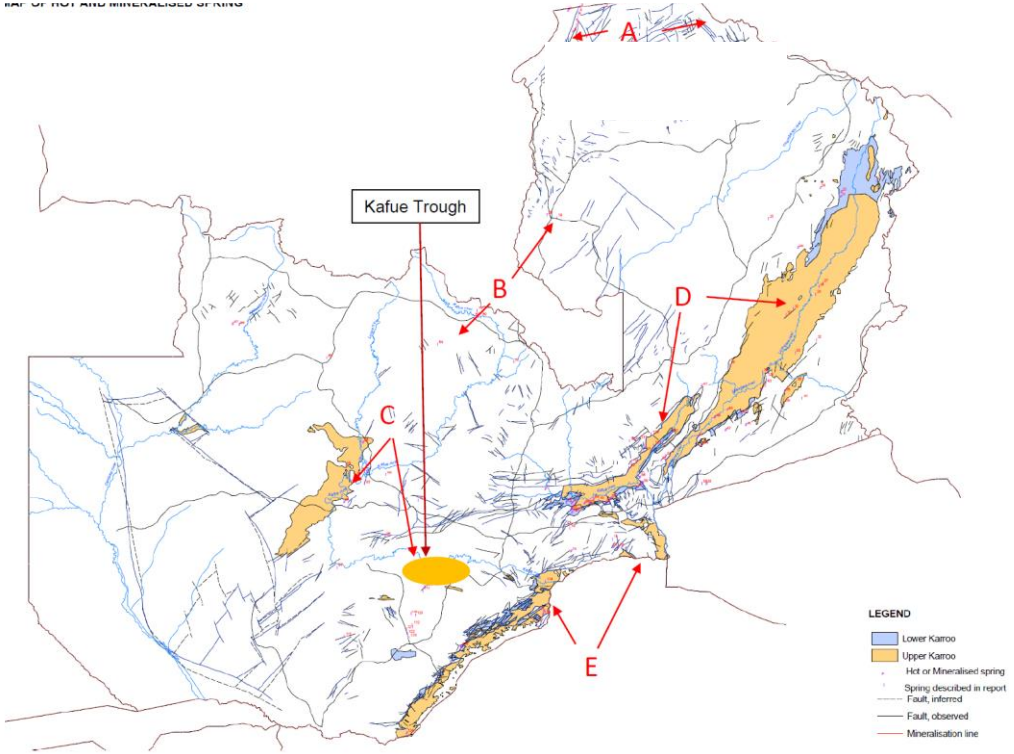
- As yet little geological work relevant to geothermal energy undertaken.
- Geological Survey's 1974 reconnaissance of Hot & Mineralised Springs. 86 springs identified; some hydro-chemistry.
- Zambian-Italian Government joint Geothermal Project mid 1980's: 220kW Turboden binary geothermal pilot plant installed at Kapisya, Sumbu, Lake Tanganyika; programme curtailed by insufficient understanding of geo-technical data;
- ZESCO proposes to redevelop Kapisya; also exploration of other targets.
- Kalahari GeoEnergy Ltd conducted regional Country wide reconnaissance 2011-2012; currently exploring the Kafue Trough, a Karoo era basin, with focus on Bweengwa River target.
- Extent of known geothermal systems in Zambia's Karoo (Permian) Basins may be greater than 1,000MW; warrants exploration to support energy mix.

Groups of Hot Springs in Zambia:

A: Mweru – Lake Tanganyika and

B: Mansa and Copperbelt, being SE extensions of E. African Rift, with major rift structures

C: Kafue Basin and Trough. D: Luangwa and Luano Valleys. E: Zambezi Valley; being Karoo basins



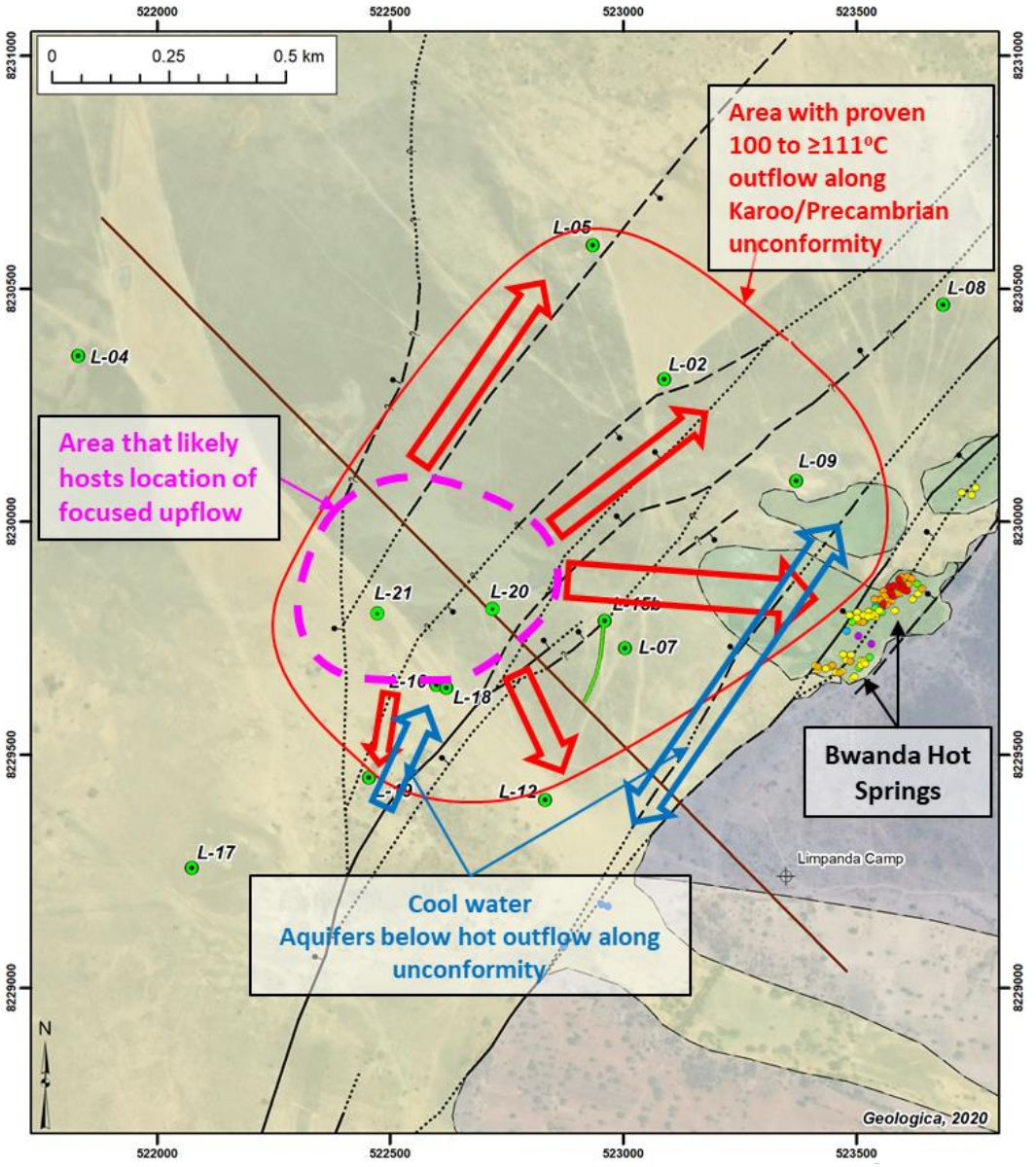
Location of Kafue Trough and main groups of Hot Springs

Regionally, geological evidence of:

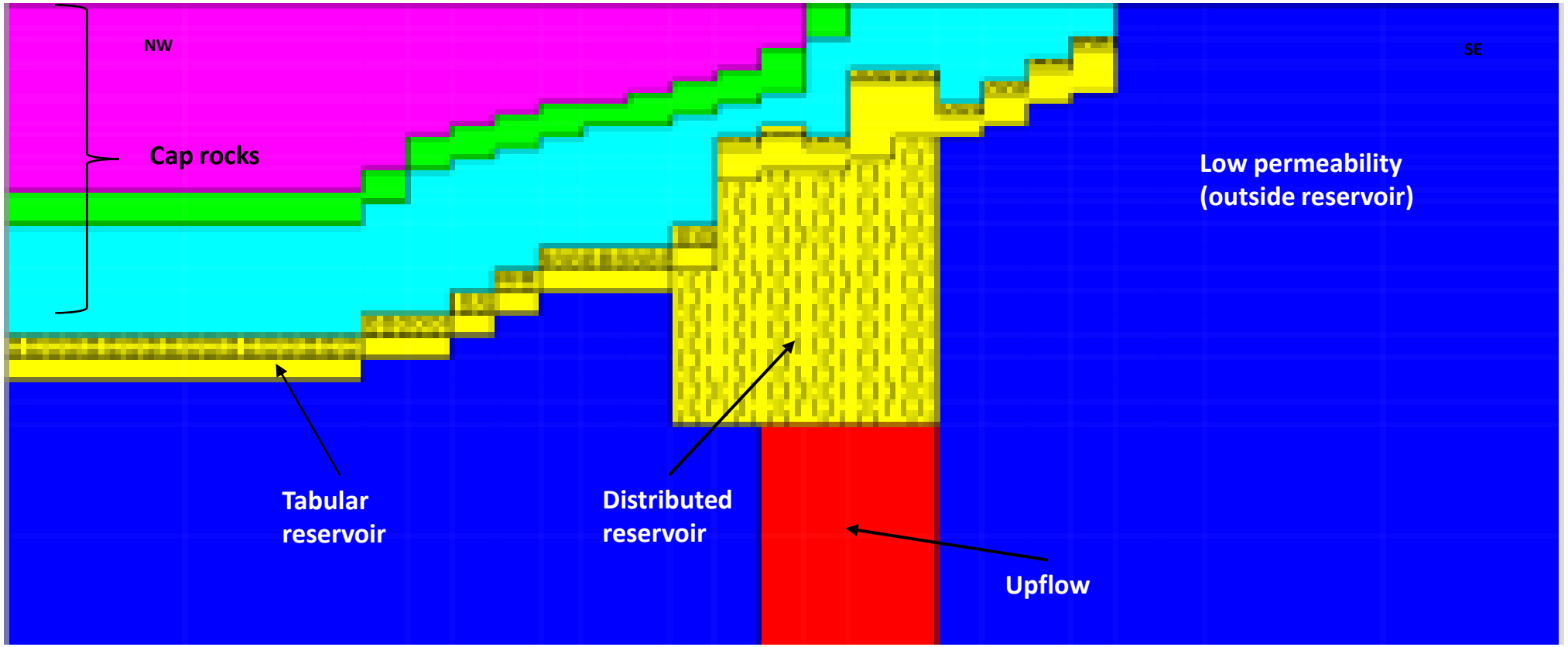
- Mantle thinning in western Zambia associated with plume-fed melt.
- Insipient rifting associated with East African Rift westward from Lake Malawi to Barotse Basin

Bweengwa Exploration, Conceptual Model, Resource and Next Steps

- Systematic exploration sine 2012 has identified six geothermal energy targets in the Kafue Rift, which forms part of the southwestern extensions to the East African Rift Valley, in southwest Zambia with an estimated resource of 12-15 MWe of constant renewable base-load power.
- The Bwanda system comprises a shallow tabular reservoir at a depth of ca. 200-500m with a temperature of 108-110^{O}C at the unconformity of the pre-Cambrian basement and Karoo sedimentary basin fill. This is fed by deeper 130-150^{O}C upflow in faults within the basement rocks.
- Concentrations of up to 2.3% helium have been identified in gasses released by the geothermal fluid, as assayed by Oxford University Earth Sciences Department in the UK.
- Project work thus far includes geology, geophysics, hydrochemistry, LiDAR, and the drilling and testing of 21 temperature gradient holes and slim wells totalling 6,156m. Further drilling and testing is to be undertaken 2021 to de-risk the reservoir boundaries.
- Ongoing FS funded by the United States Trade and Development Agency (USTDA) and conducted by Geologica Geothermal Group (Geologica) is due for completion in Q4 2021.
- Direct application of thermal energy for aquiculture, horticulture, dairy and crop processing, to generate social uplift and food security for the communities are integral to the project.
- The project thus far has been funded by Kalahari GeoEnergy shareholders, the Renewable Energy Performance Platform (REPP) and USTDA



Resource Modelling – Cross Section of Numerical Model



Cap Rock: The Karoo sequence with mud and siltstones acting as the seal

Tabular reservoir: Permeability on the unconformity between the Karoo and the Pre-Cambrian Gneiss. Buoyant, hot reservoir fluid flows up-dip and some of it discharges into the Bwanda Hot Springs

Distributed reservoir: Permeability where the fault zone cuts though the Pre-Cambrian Gneiss

Upflow: Focused on inclined faults, with exact location and temperature uncertain

Low permeability (outside reservoir): The Pre-Cambrian Gneiss outside the fault zone

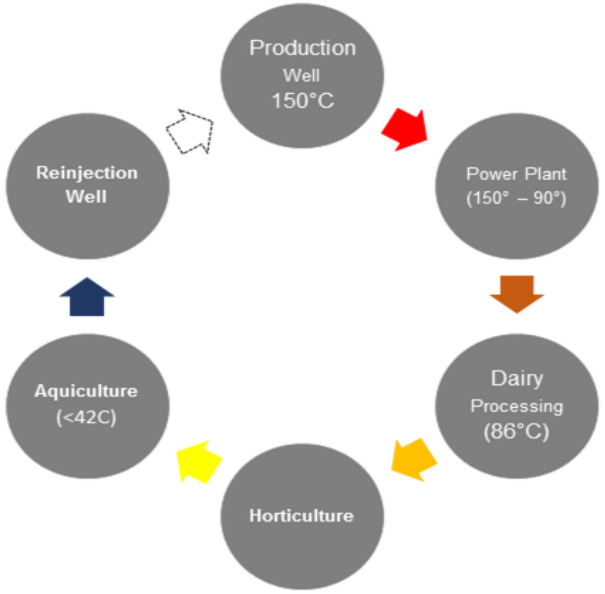
Bwengwa River – Secondary revenue streams: Cascading Direct thermal energy applications

Geothermal: Energy beyond Power
Rural Enterprise Hub: The Opportunity from Energy

KGE recognises that the value of geothermal is Energy rather than just Power. Direct applications lead to social uplift, local investment and development, food security /climate resilience and at Lochinvar, environmental enhancement. As well field is contagious to park boundary.
A good example of circular economic development!

Removal of domestic/wild animal conflict is catalyst for wildlife population and habitat recovery in Park, leading to Increased Tourism and revenue.

Cascade Energy Applications: in addition to power production for grid distribution, the project should support a micro-grid for the immediate community which includes the wildlife and fishery protection offices, and cascaded direct energy for pertinent applications including dairy processing, horticulture and aquaculture. The Government are supportive of the opportunity to create a Rural Enterprise Hub with sustainable employment to be outside the Park on Traditional land. Precedents for such an enterprise include the Maori Tuaropaki Trust in NZ and positive feasibility studies conducted for Geothermal Development Corp. Kenya.



Project Objectives – The Quadruple Bottom Line

1. Economic Activity – Power Plant (The Hub) and the cascaded Applications of direct heat – Dairy processing, horticulture, aquiculture and chilling/heating.

2. Social uplift – sustainable employment

3. Climate Mitigation and Food Security - enhanced dairy, horticulture and aquiculture methods

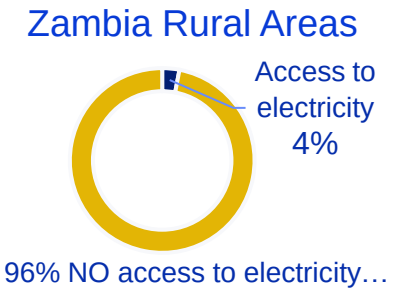
4. Environmental Enhancement – of Lochinvar National Park, achieved through the management of human and domestic animal encroachment and security leading to tourists/revenue

Zambia – The opportunity for sustainable, independent power production

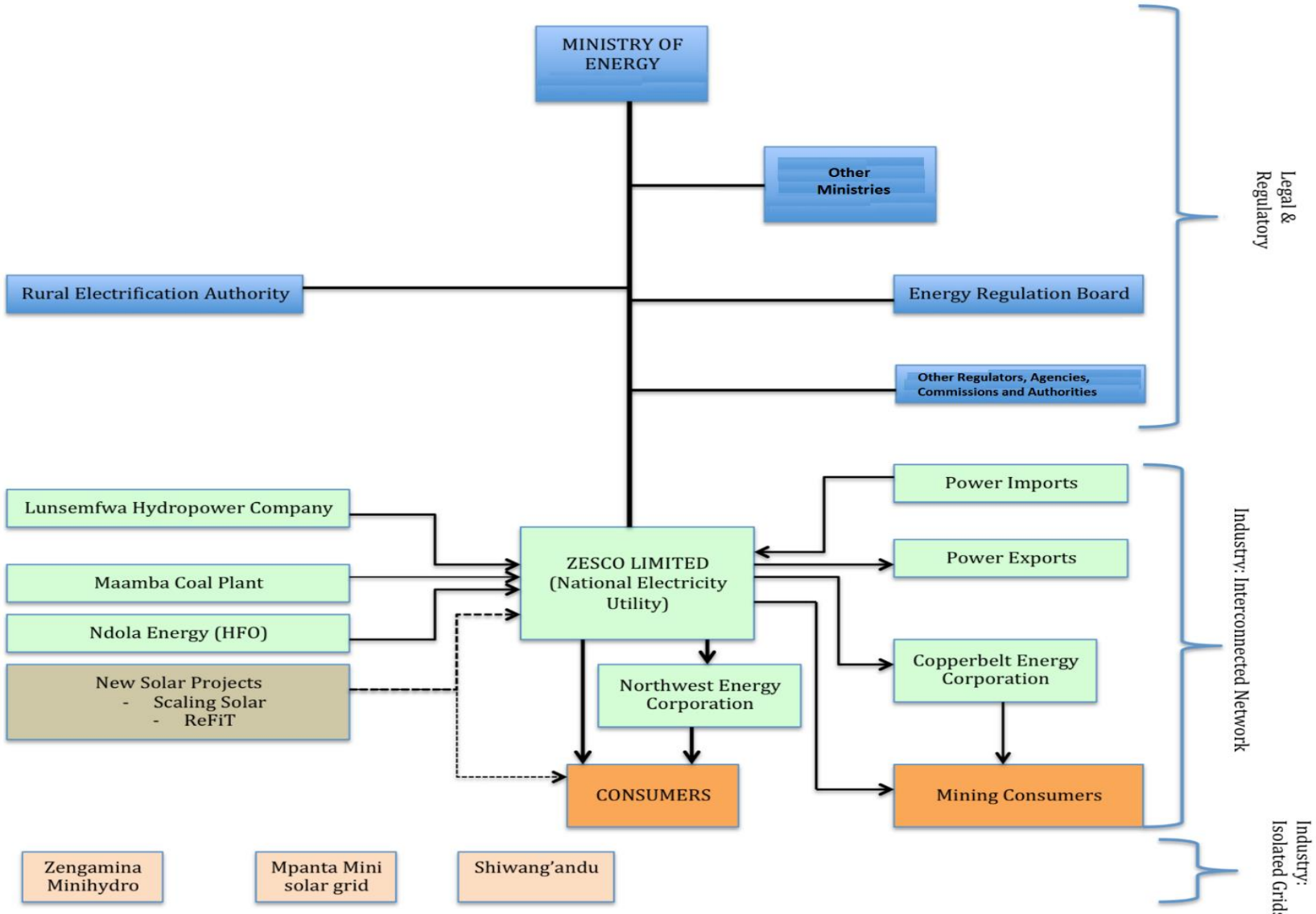
Energy:

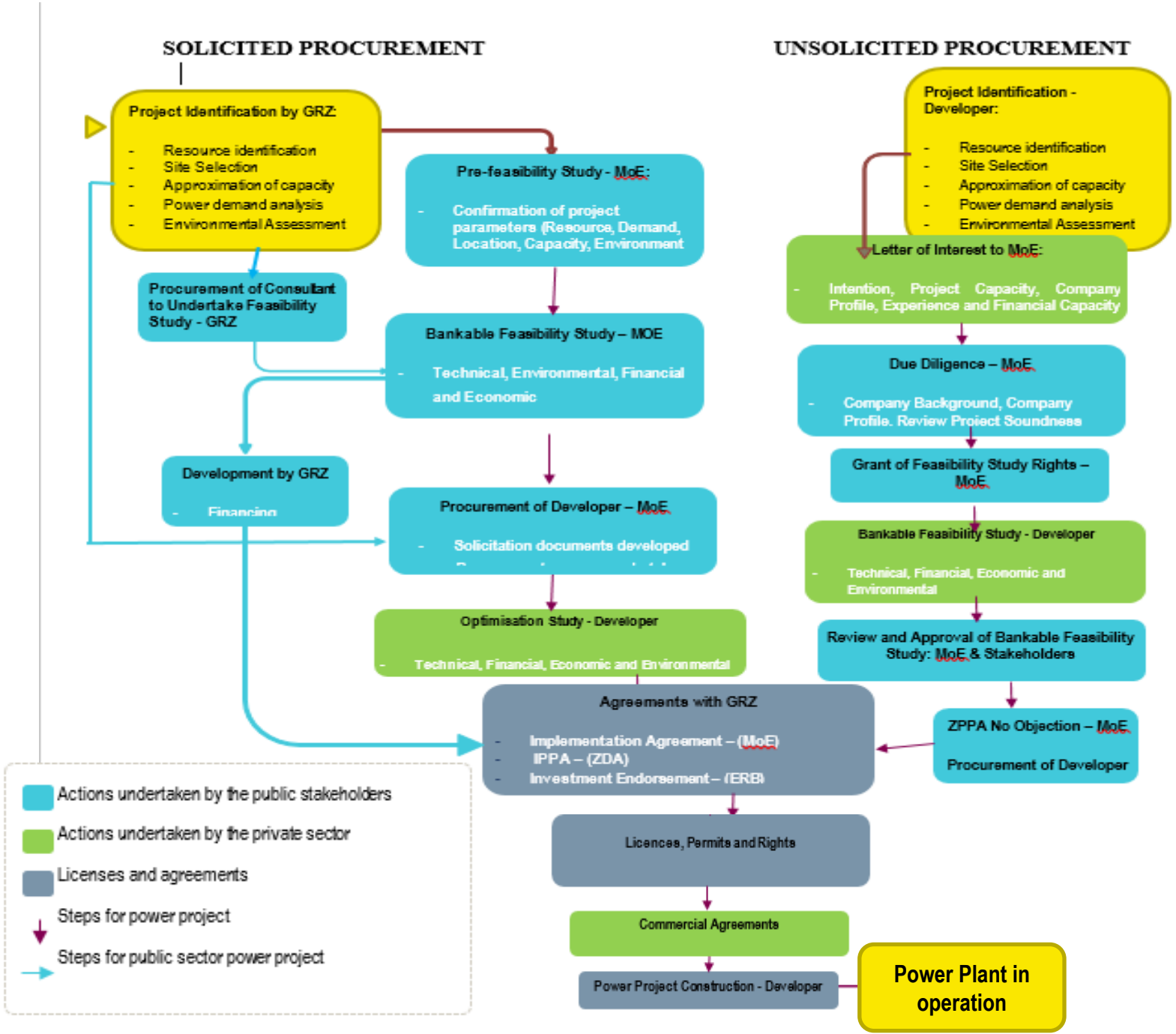
- Power: Installed Capacity 2,981MW but operating ±70%. 80% hydro, 10% Thermal coal, 6% Diesel and HFO, 3% Solar (2021)
- Generated by: Zambia Electricity Supply Co “ZESCO” (large scale hydro), Mamba Colliery (thermal coal), Copper Belt Energy (HFO and Diesel + distribution to mines) and Enel Green Power (Solar)
- Estimated 4,500MW needed by 2030
- Domestic access 14% of capacity, But 96% of rural population have NO access to electricity
- Mines use 78% of Capacity (2020). Restricted capacity impacts on revenue and thus tax base. Global copper demand to increase by 7MT/pa by 2030 to support push for EV’s. A ramp-up and developing new mines would require significant additional power
- Climate change / Deforestation is proving catastrophic to surface and ground water with impact on hydro power generating capacity
- Active diversification sought: significant Solar solicited, further baseload capacity sought to avoid of grid instability
- Moves to Cost reflective tariffs and off-taker reform
- Liberal regulatory regime (Electricity Act 2019) : Supports private power generation, transmission and sale to any buyer including end users, intermediaries and distributers (not restricted to para-statal).
- Previous geothermal work includes Kapisya, a 220kW pilot plant, a 1980’s Zambian-Italian joint venture. Plant was not commissioned due to low well temperatures and lack of understanding of the fault system.

70% of all primary energy utilised in Zambia is from firewood and charcoal.
The country has one of the highest rates of deforestation on our planet – 250,000 Ha/pa



Structure of the Electricity Industry in Zambia




SOLICITED PROCUREMENT
Project Identification by GRZ:
- Resource identification
- Site Selection
- Approximation of capacity
- Power demand analysis
- Environmental Assessment
Pre-feasibility Study - MoE:
- Confirmation of project parameters (Resource, Demand, Location, Capacity, Environment
Procurement of Consultant to Undertake Feasibility Study - GRZ
Bankable Feasibility Study – MOE
- Technical, Environmental, Financial and Economic
Development by GRZ
- Financing
Procurement of Developer – MoE
- Solicitation documents developed
Optimisation Study - Developer
- Technical, Financial, Economic and Environmental
UNSOLICITED PROCUREMENT
Project Identification - Developer:
- Resource identification
- Site Selection
- Approximation of capacity
- Power demand analysis
- Environmental Assessment
Letter of Interest to MoE:
- Intention, Project Capacity, Company Profile, Experience and Financial Capacity
Due Diligence – MoE
- Company Background, Company Profile. Review Project Soundness
Grant of Feasibility Study Rights – MoE
Bankable Feasibility Study - Developer
- Technical, Financial, Economic and Environmental
Review and Approval of Bankable Feasibility Study: MoE & Stakeholders
ZPPA No Objection – MoE
Procurement of Developer
Agreements with GRZ
- Implementation Agreement – (MoE)
- IPPA – (ZDA)
- Investment Endorsement – (ERB)
Licences, Permits and Rights
Commercial Agreements
Power Project Construction - Developer
Power Plant in operation
Actions undertaken by the public stakeholders
Actions undertaken by the private sector
Licenses and agreements
Steps for power project
Steps for public sector power project

Challenges and Lessons learnt

Key Challenges	Comment
Definition of Africa Geothermal	All about EARS. All Karoo sedimentary basins have mid-low enthalpy geothermal systems
Regulatory	Work with sponsor ministry, Capacity building, Consider Pilot/Demo Plant
Funding	Secure initial capital, Avoid boring investors with repeat stories or applying too early
Risk Mitigation	Regularly review results against model. Use low cost methodology (Slim wells v production for exploration) GRMF terms too onerous for low cost/frontier operations
Expect to take some Risk	Seldom are all elements of a project aligned. Exploration before PPA.
Contractors	Global name = expensive and long lead time. Less experience = learning on your job, so employ experience supervisor. Own, not hire key ancillary equipment and instruments
Advisors	Chose carefully, develop relationships to avoid repeat (costly) familiarisation
Promotion	Choose platforms carefully. ARGeo still no interest outside EAR
Ask for advice	Geothermal is a small industry with lots of passion – reach out and ask for advice /opinion.