



Technical Assistance to Identify Direct Use Applications and Technologies in Low-to-Medium Temperature Geothermal Systems in East Africa

Training and Capacity Building Workshop

Tanzania

July 2021





Agenda

1. Technical Evaluation
2. Project Identification
3. Commercial Evaluation
4. User Guide: Financial Model
5. Next Steps: Full Feasibility Study and Policy/Financial Support



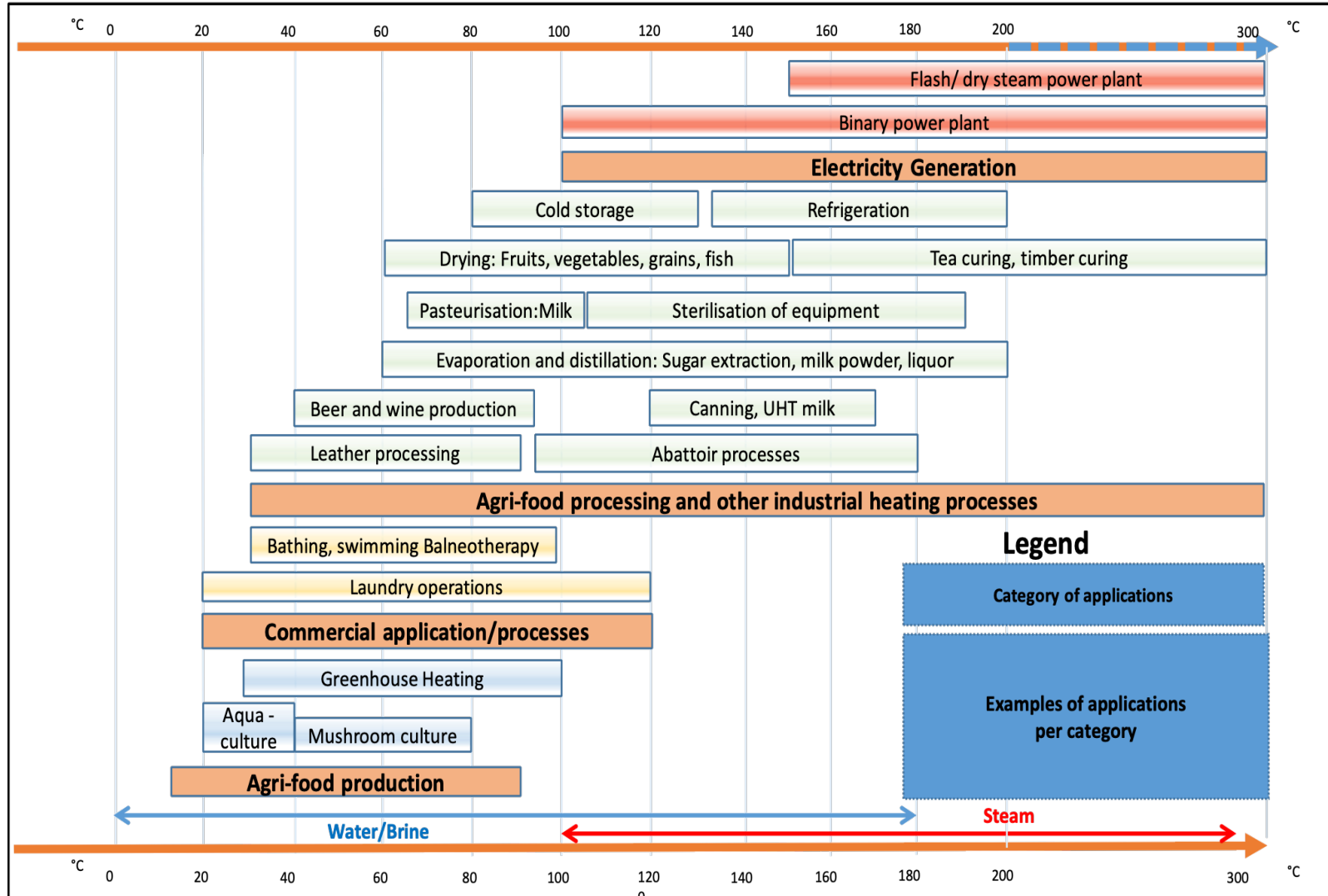
Source: IRENA 2020

1. Technical Evaluation

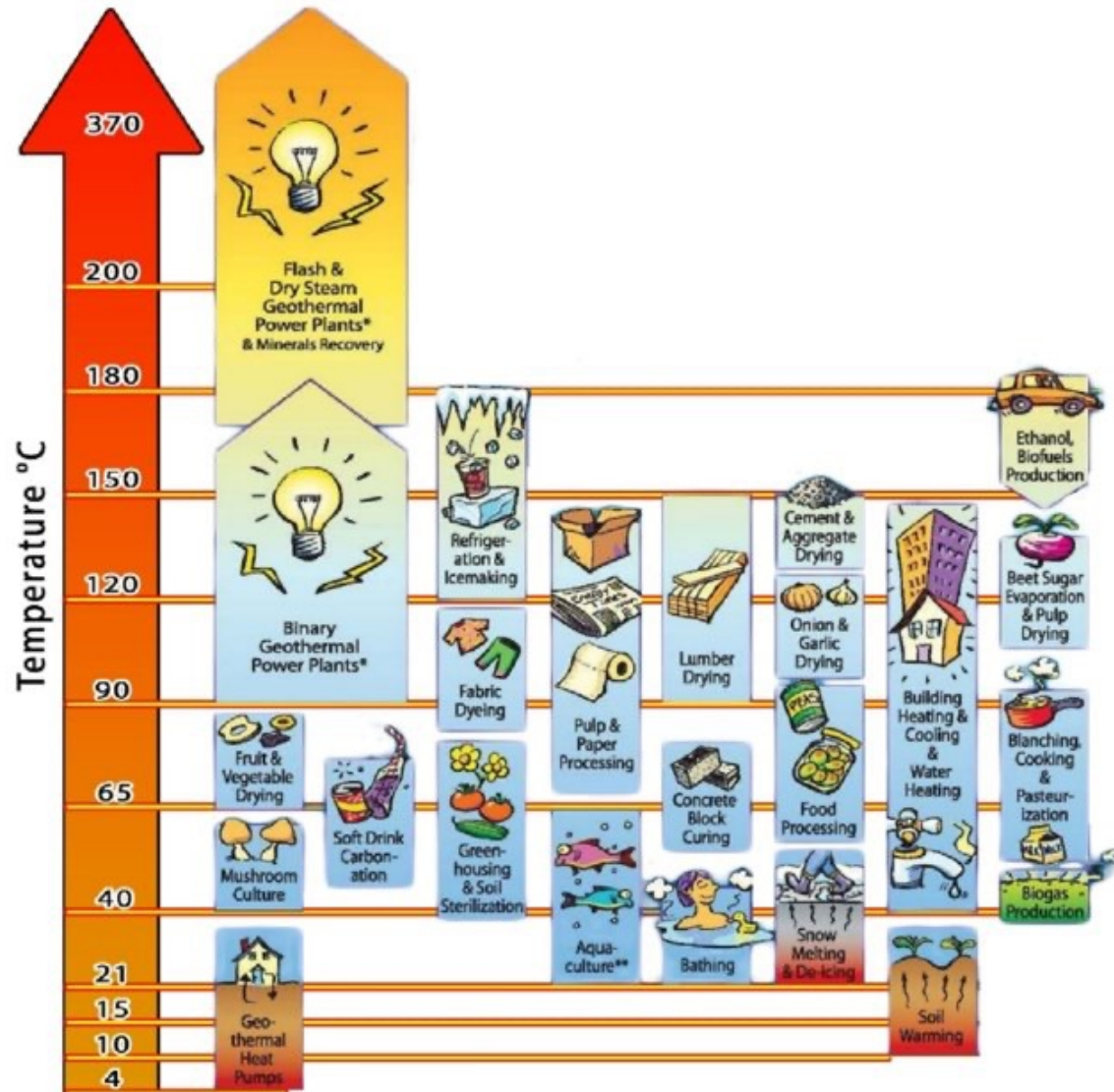


Lake Ngozi, Mbeya, Tanzania (*source: Think GeoEnergy*)

Geothermal Development in Africa



Direct Use Applications

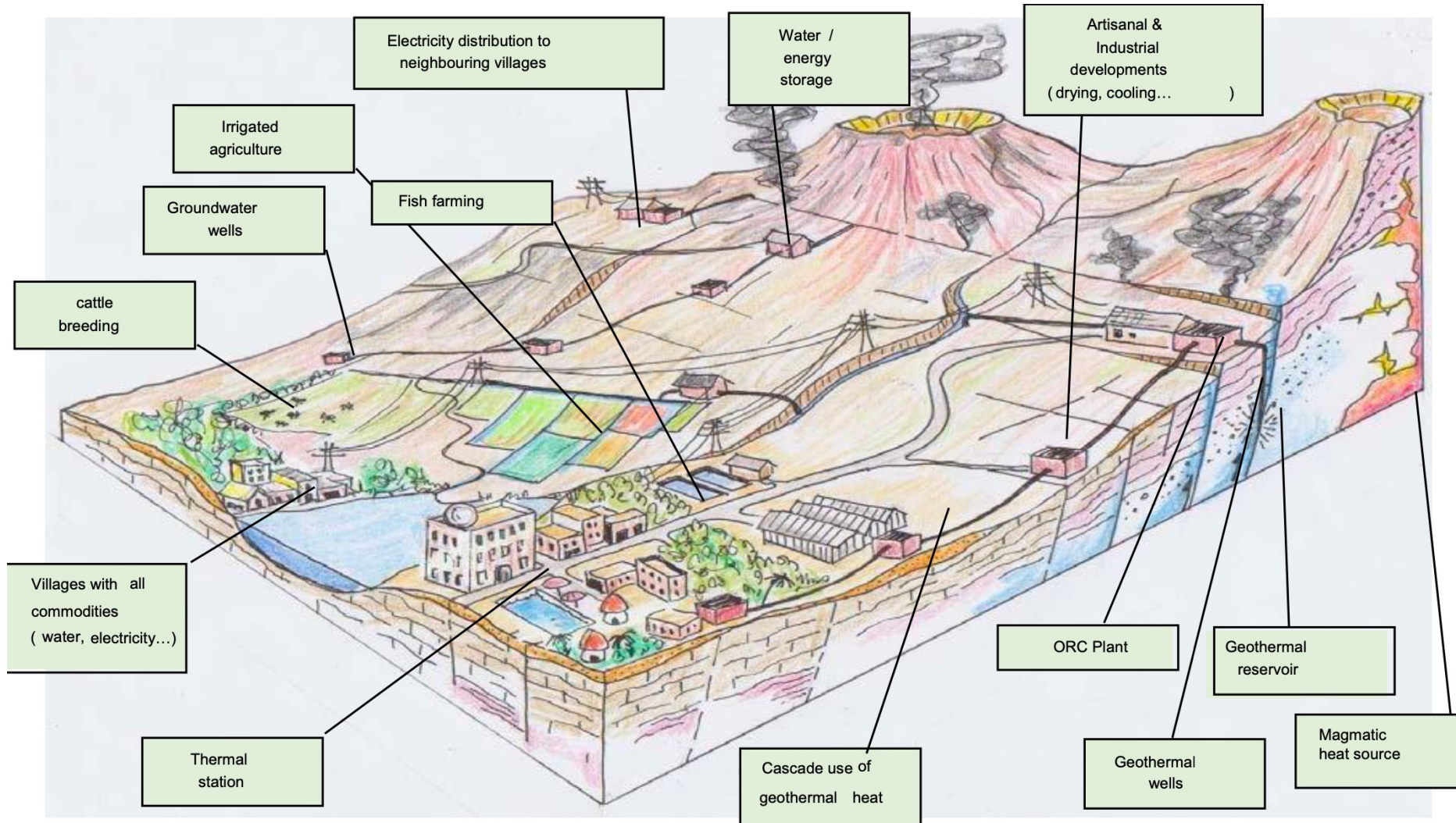


Source: The Lindal Diagram (after Lindal, 1973, Geothermal Education Office 2005)

Direct use of geothermal involves the use of underground hot water and steam (20-250°C) for a wide range of applications, including:

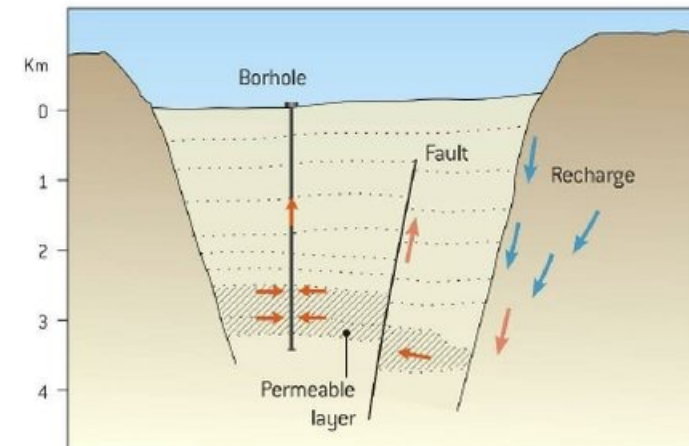
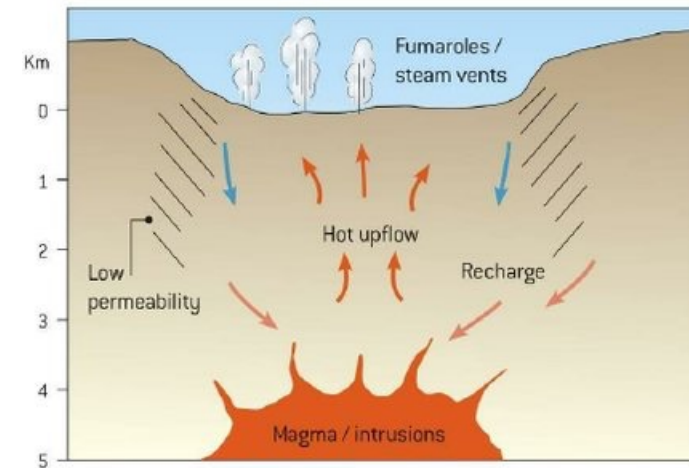
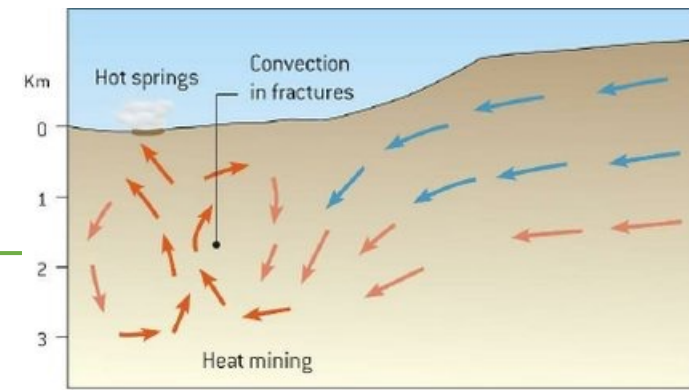
- Heating or cooling of buildings
- Growing of plants in greenhouses
- Drying fruits, vegetables and fish
- Heating water for fish farming
- Pasteurizing milk
- Melting snow
- District heating
- Spa and bath (balneotherapy)

Cascaded and Integrated Use of Geothermal Resources

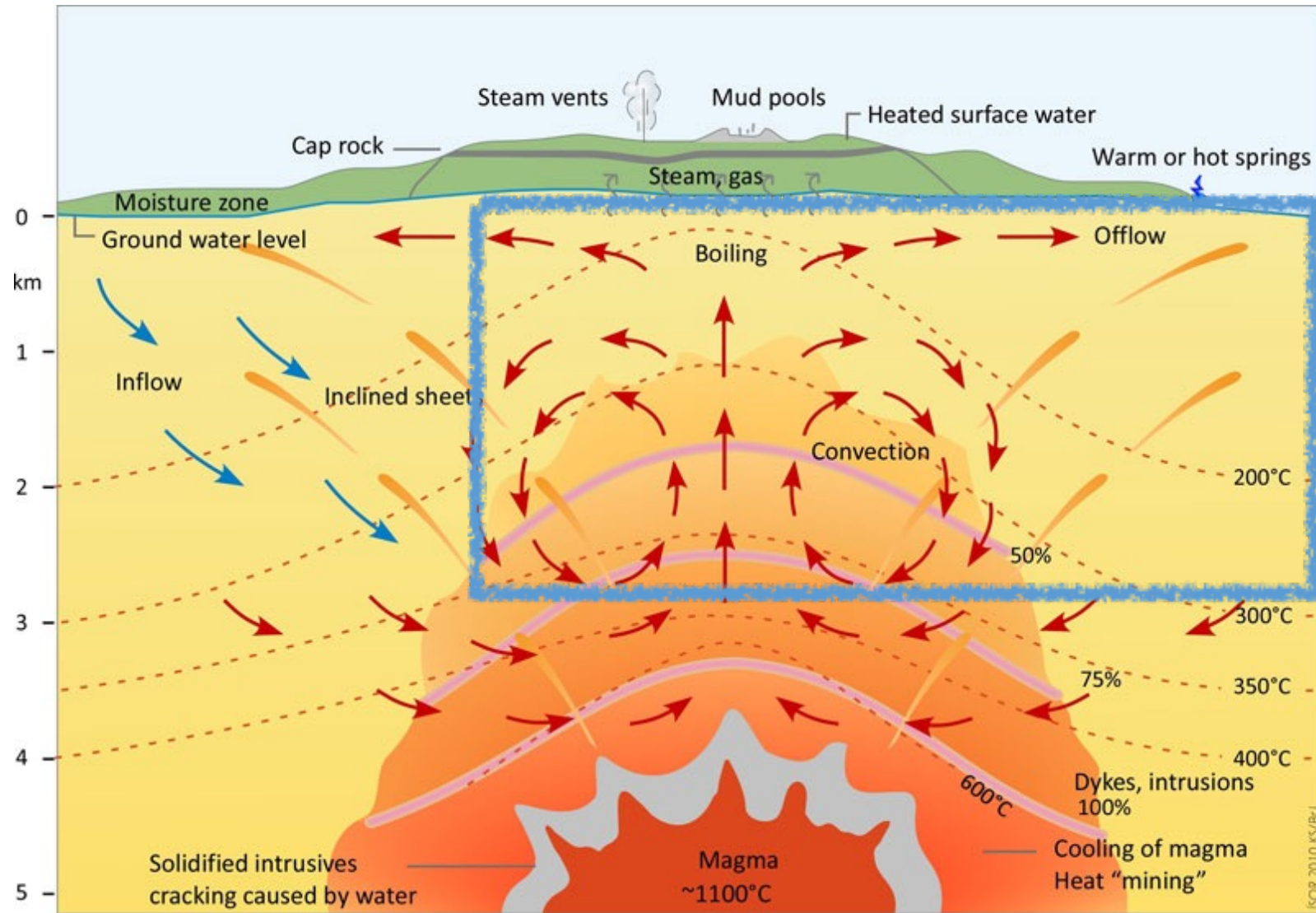


Geothermal Systems Classification

- A. Volcanic systems with heat sources being hot intrusions or magma
- B. Convective systems with deep water circulation in tectonically active areas
- C. Sedimentary systems with permeable layers at great depth
- D. Geo-pressured systems
- E. Hot dry rock or enhanced geothermal systems
- F. Shallow resources utilized through ground-scope heat pump application

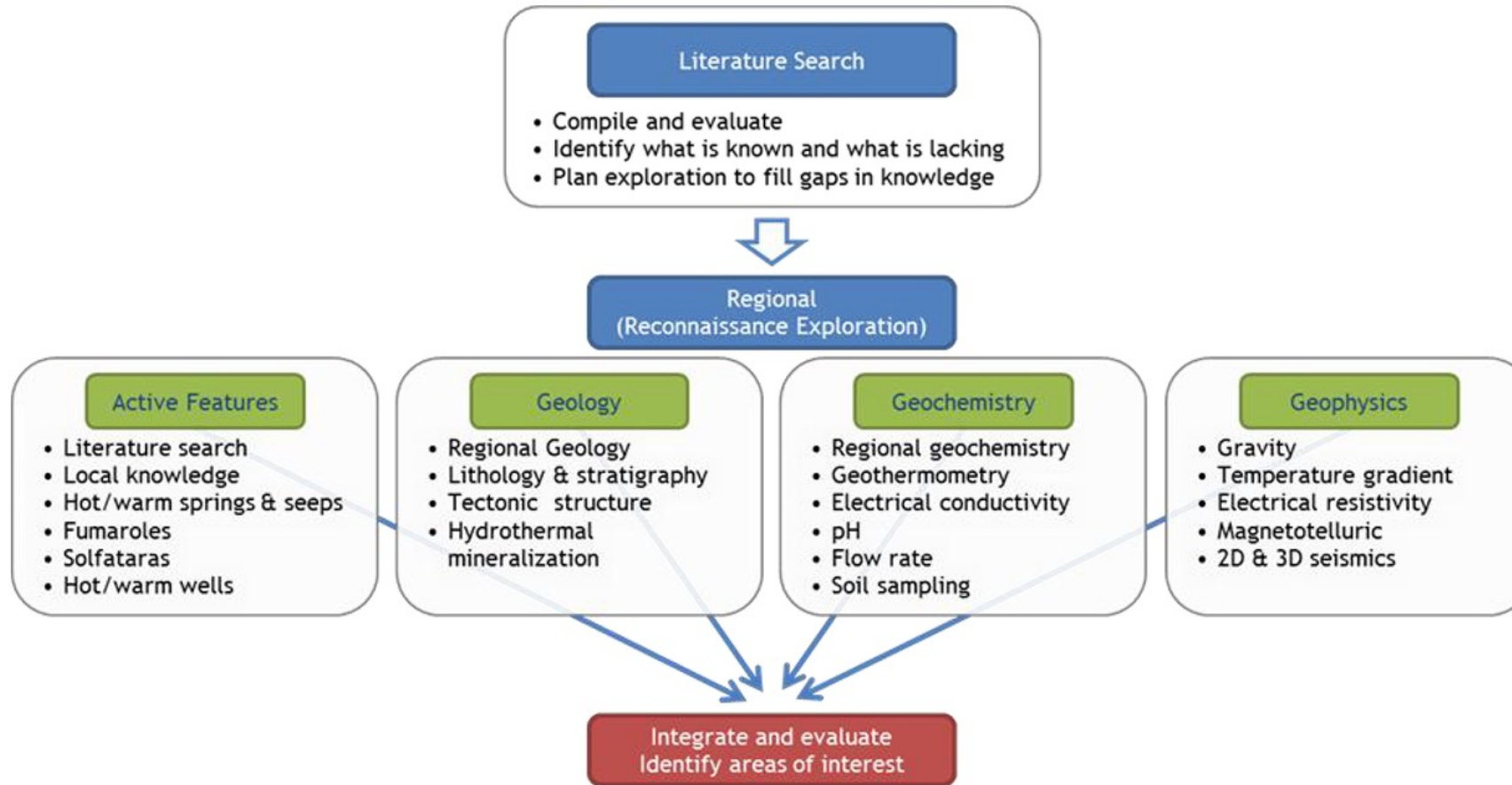


Conceptual Models

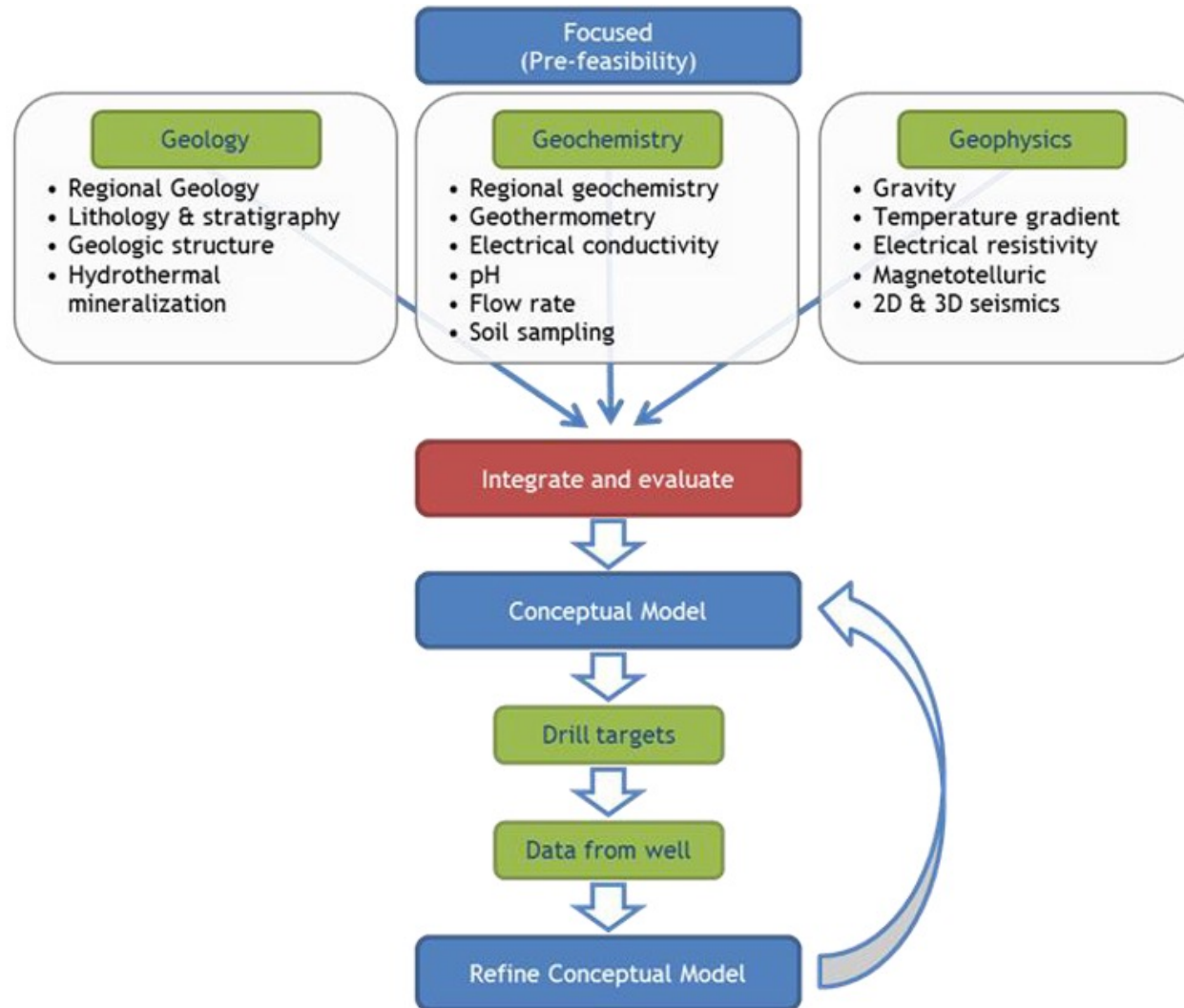


20-150°C

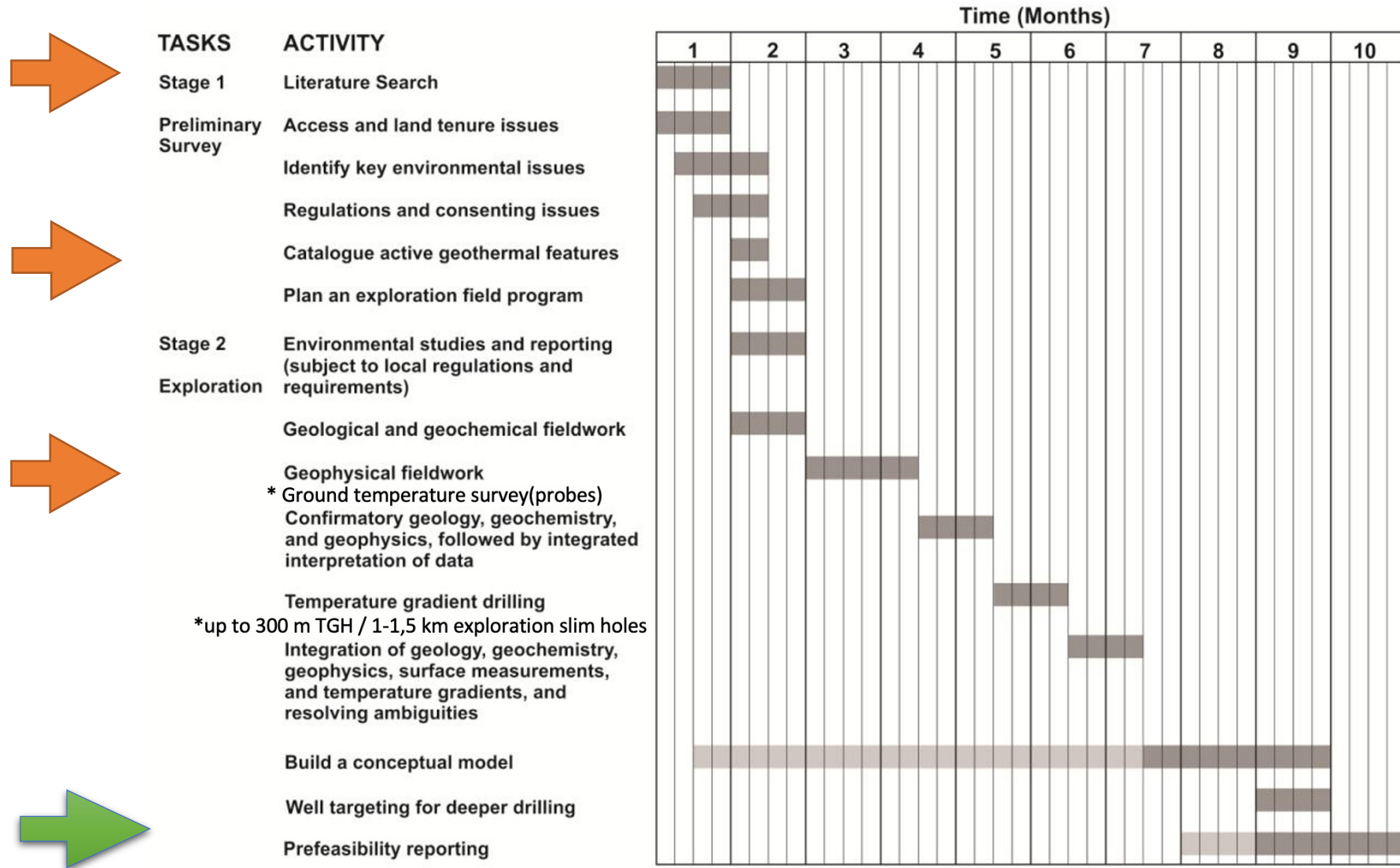
Geothermal Exploration: Best Practices



Geothermal Exploration: Best Practices



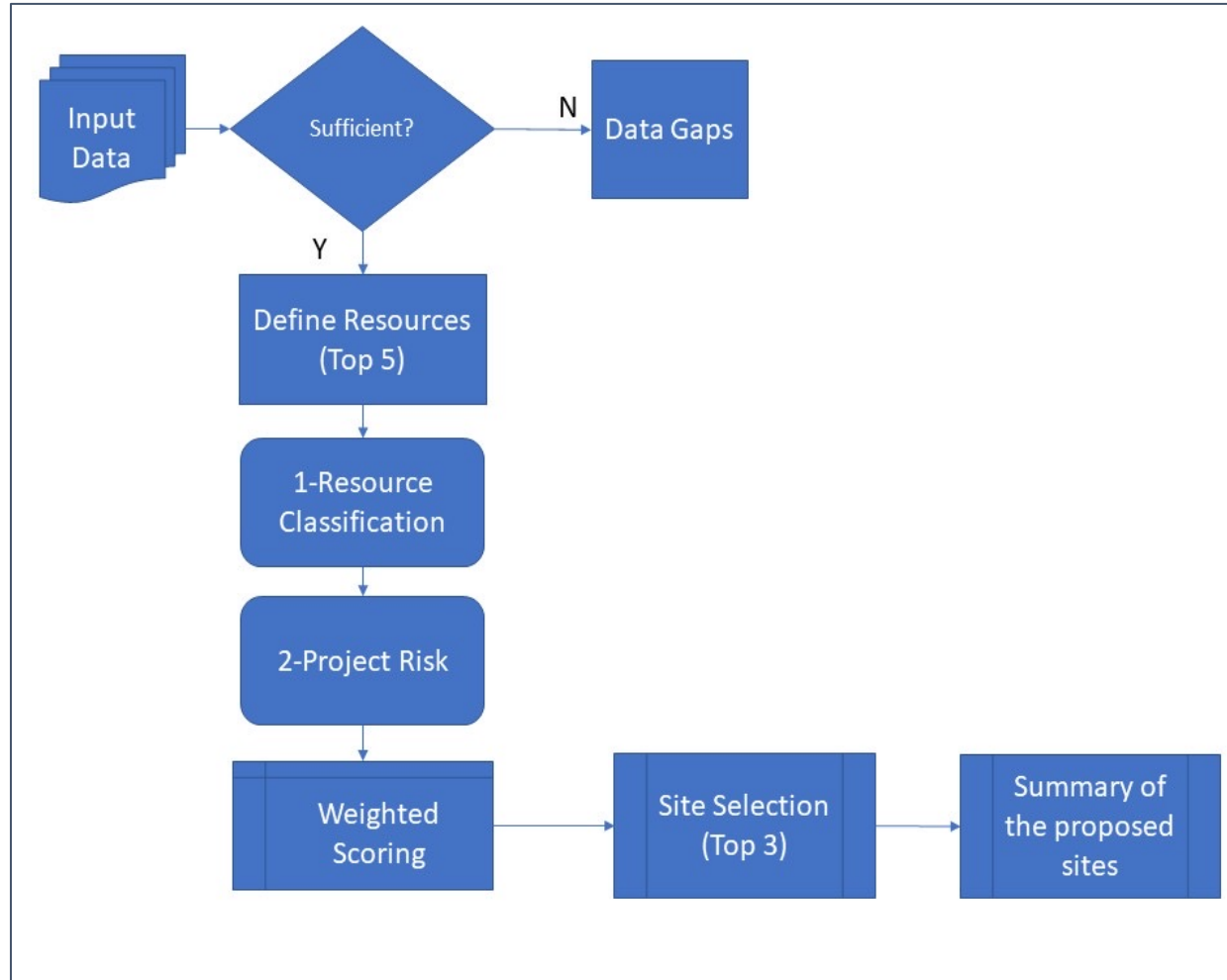
Geothermal Exploration Timeline



Source: Geothermal Exploration Best Practices, IGA, 2013

Site Selection Methodology

Data Analysis and Site Selection Approach



Key Components of Technical Evaluation

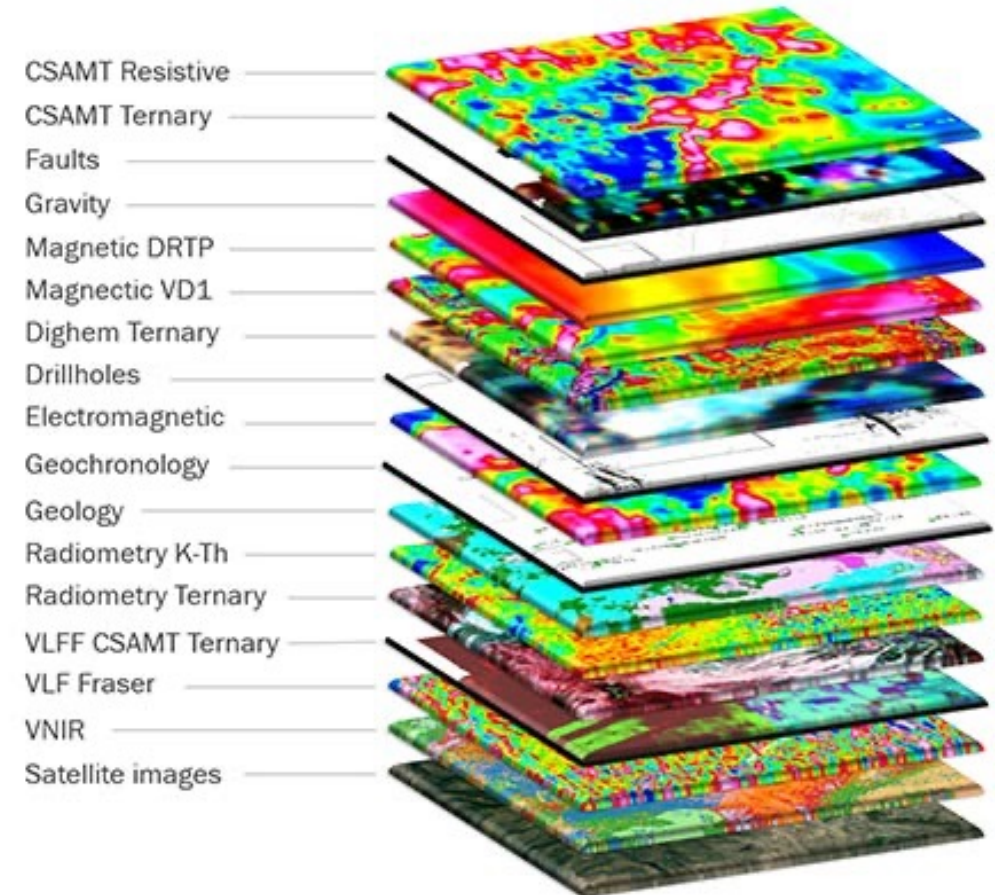


| TASKS | GUIDELINES | RELATED TOOLS TO BE USED |
|--------------------------------------|---|---|
| 1. COMPILING DATA | Data acquisition, compiling for the region/sites | Annexes 1 and 2 provide information on how to approach data compilation |
| 2. FILL IN DATA GAPS | Review best practices for data inputs; if appropriate collect data through available sources or conduct new surveys | Annex 3 describes best practices that are widely accepted by the International Geothermal Association (IGA) |
| 3. INITIAL FOCUS AREA | From the data collected, a regional or project-based focus can be developed | Available data and expert knowledge can focus on a specific site/region for development |
| 4. RESOURCE CLASSIFICATION | Defined criteria from this work can be utilized for any site - 1st phase analysis | Annex 4 lists the criteria to define the resource classification |
| 5. PROJECT RISK ASSESSMENT | Defined weighted scoring can be utilized for any site - 2nd phase analysis | Annex 5 lists the criteria and weight assigned for project risk status |
| 6. SITE RANKING AND SELECTION | Total score of each site will be used to categorize and rank the sites | Annex 6 provides an example from this study for different sites and their scores |

Key Components of Technical Evaluation

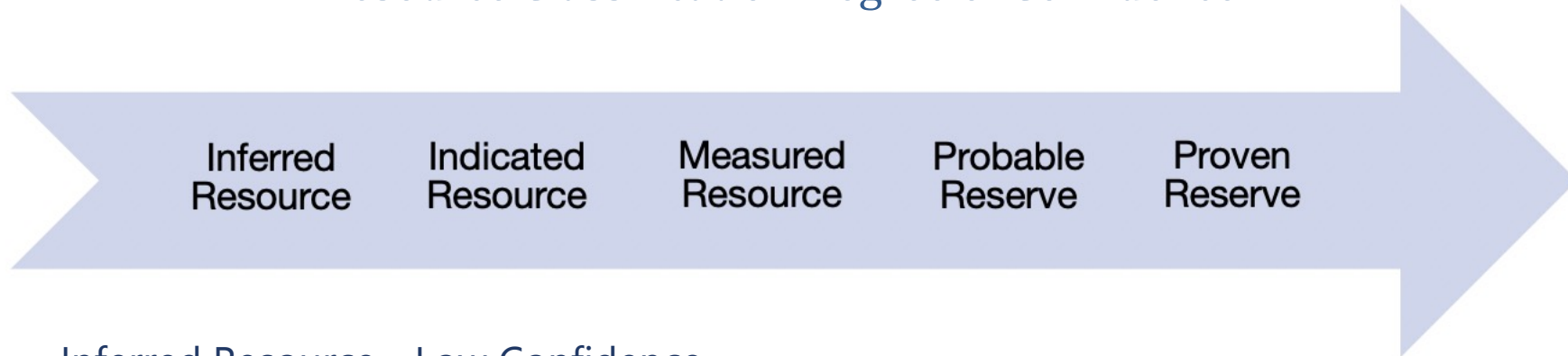
Direct Use Geothermal Site Selection: Key Issues

- Quantity of available data
- Quality of available data
- Data scale (regional – local)
- Gaps in data
- Integration of data (3G and other)
- Analysis and initial interpretation
- Drilling (size, depth, quantity etc.)
- Preliminary modelling
- Pre-feasibility reporting



Site Selection Methodology

Resource Classification Degree of Confidence



- Inferred Resource - Low Confidence
- Indicated Resource - Moderate Confidence
- Measured Resource - High Confidence
- Probable Reserve
- Proven Reserve

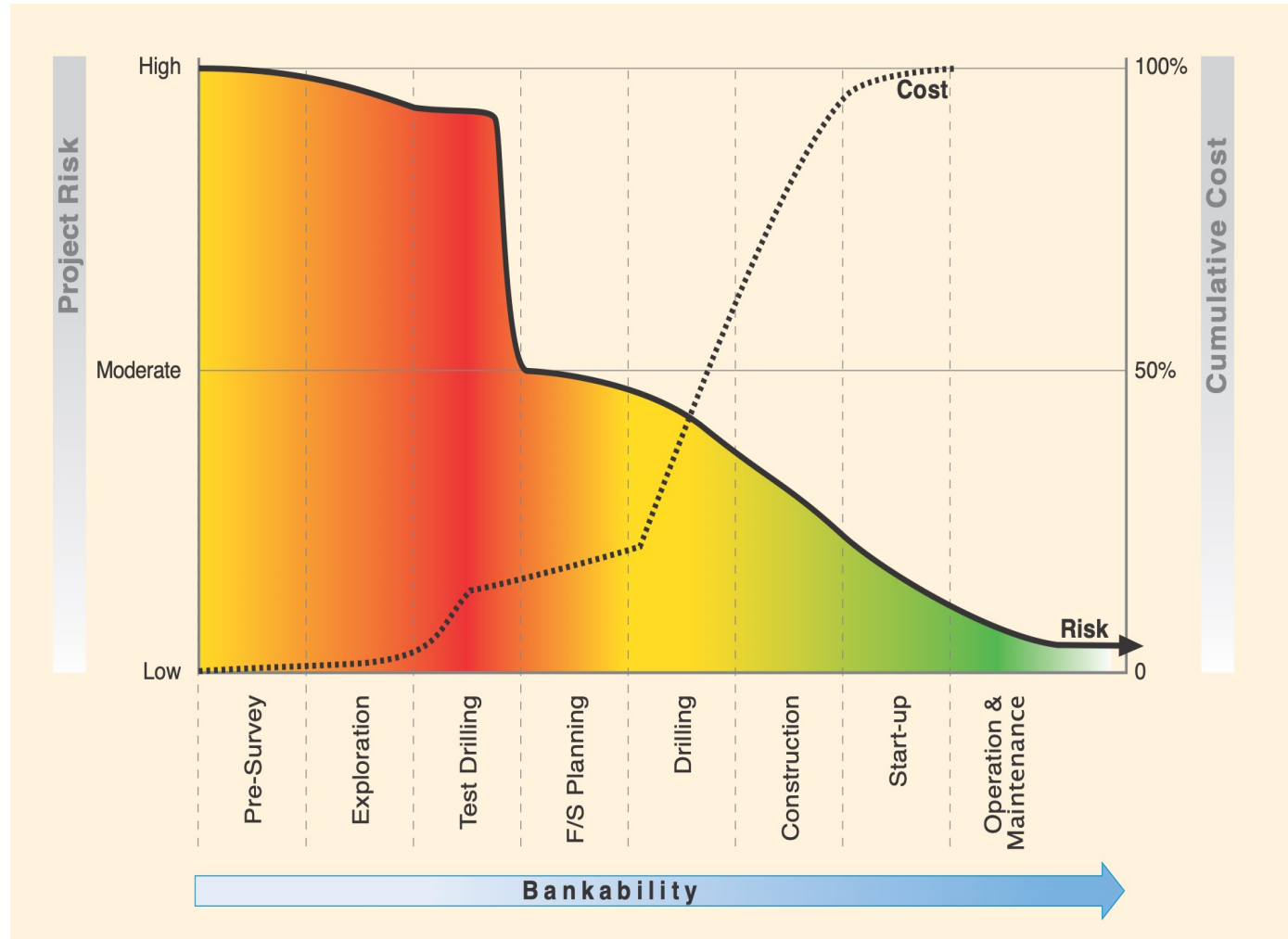
Site Selection Methodology

| | EXAMPLE | | New Defined Criteria | 0/1 |
|--------------------|----------|----|--|-----|
| A) Volume | Area | 1 | Surface manifestations | 1 |
| | | 2 | Geothermal Gradient | 1 |
| | | 3 | Geological analogy | 1 |
| | | 4 | Geophysical mapping | 1 |
| | | 5 | Estimated resource depth | 1 |
| Deliverability | Fluid T | 6 | Geothermometry | 1 |
| | | 7 | Offset Wells Data | 1 |
| Cut off T | | 8 | Min T for commercial operation | 1 |
| Permeability and P | | 9 | Shallow well/ spring P and T | 1 |
| | | 10 | Fault/ Aquifer permeability | 1 |
| Chemistry | | 11 | No fluid acidity, uncontrollable solids deposition | 1 |
| | | 12 | Fluid flow estimated | 1 |
| Recoverability | Porosity | 13 | Rock Type (litho-stratigraphic) | 1 |
| B) Volume | Area | 14 | Geophysics surveys | 1 |
| | | 15 | Shallow T gradients | 1 |
| | | 16 | Surface heat flow | 1 |
| | | 17 | Adjacent proven area | 1 |
| | | 18 | Depth from geophysics / adjacent wells | 1 |

- Inferred Resource - Low Confidence
- Indicated Resource - Moderate Confidence
- Measured Resource - High Confidence
- Probable Reserve
- Proven Reserve

Site Selection Methodology

Geothermal Project Risk and Cumulative Investment Cost

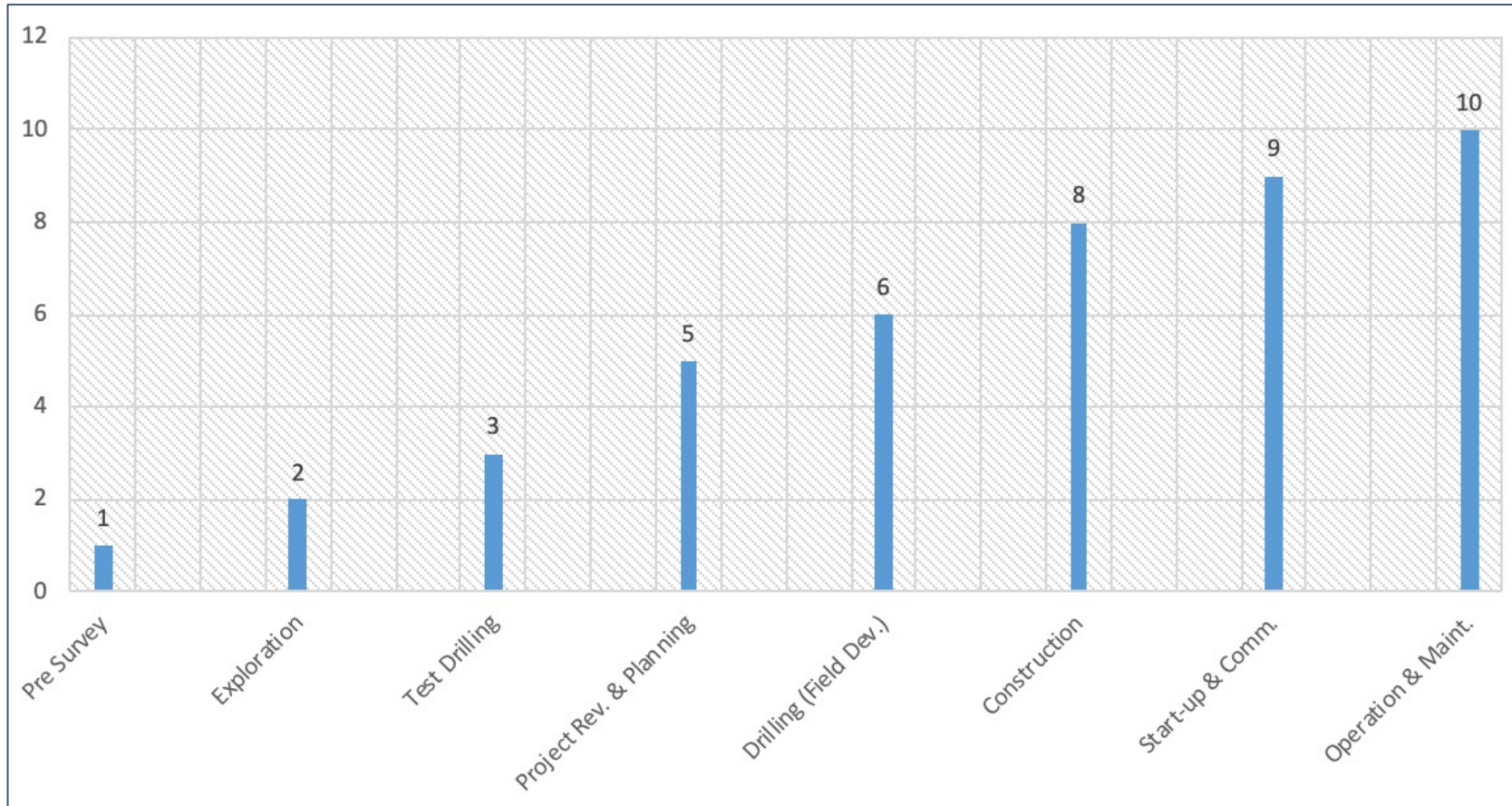


Source: World Bank ESMAP

Site Selection Methodology



Geothermal Project Development Status and Associated Weighted Score



Site Selection Methodology



| Project Risk | | | Risk | Risk |
|----------------------|------------------------------|-----|--------|----------------|
| Milestones | Details | 1/0 | Weight | Weighted Score |
| 1 Preliminary Survey | Data Collection | 1 | 1 | 1 |
| | Nationwide Survey | 1 | 1 | 1 |
| | Selection of Promising Areas | 1 | 1 | 1 |
| | Necessary Permits &EIA | 1 | 1 | 1 |
| | Planning of Exploration | 1 | 1 | 1 |
| 2 Exploration | Geological | 1 | 2 | 2 |
| | Geophysical | 1 | 2 | 2 |
| | Geochemical | 1 | 2 | 2 |
| | Soundings TEM/ MT | 1 | 2 | 2 |
| | Gradient & Slimholes | 1 | 2 | 2 |
| | Seismic Data Acquisition | 1 | 2 | 2 |
| | Pre-feasibility Study | 1 | 2 | 2 |
| 3 Test Drilling | Slimholes | 1 | 3 | 3 |
| | Full size wells | 1 | 3 | 3 |
| | Well testing&stimulation | 1 | 3 | 3 |
| | Interference Tests | 1 | 3 | 3 |
| | First Reservoir Simulation | 1 | 3 | 3 |

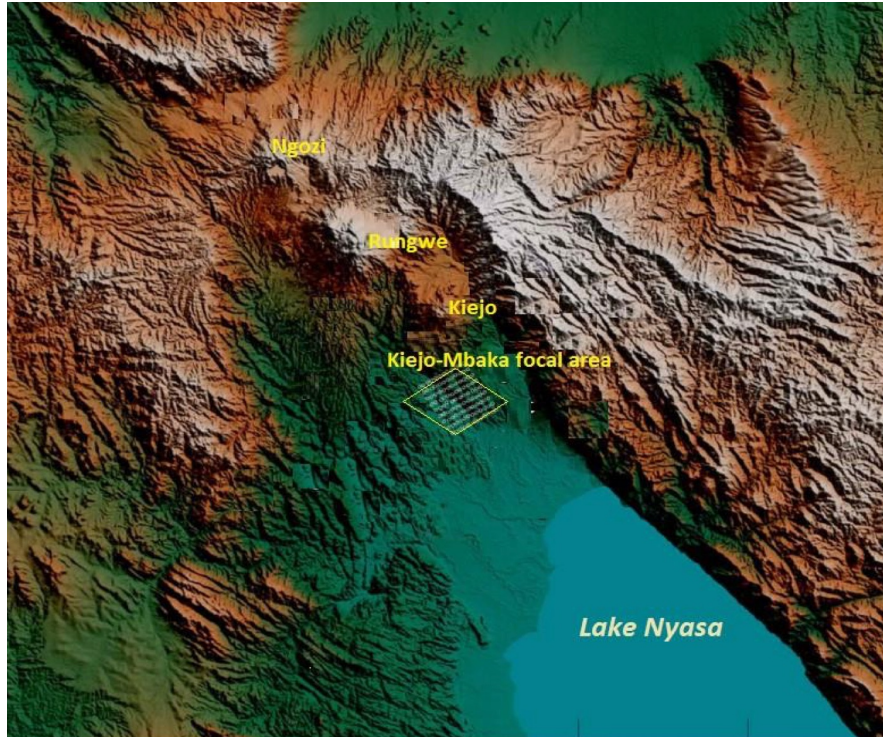
Stages of Geothermal Project Development:

- Pre-survey
- Exploration
- Test Drilling
- Project Review and Planning
- Drilling (Field Development)
- Construction
- Start-up and Commissioning
- Operation and Maintenance

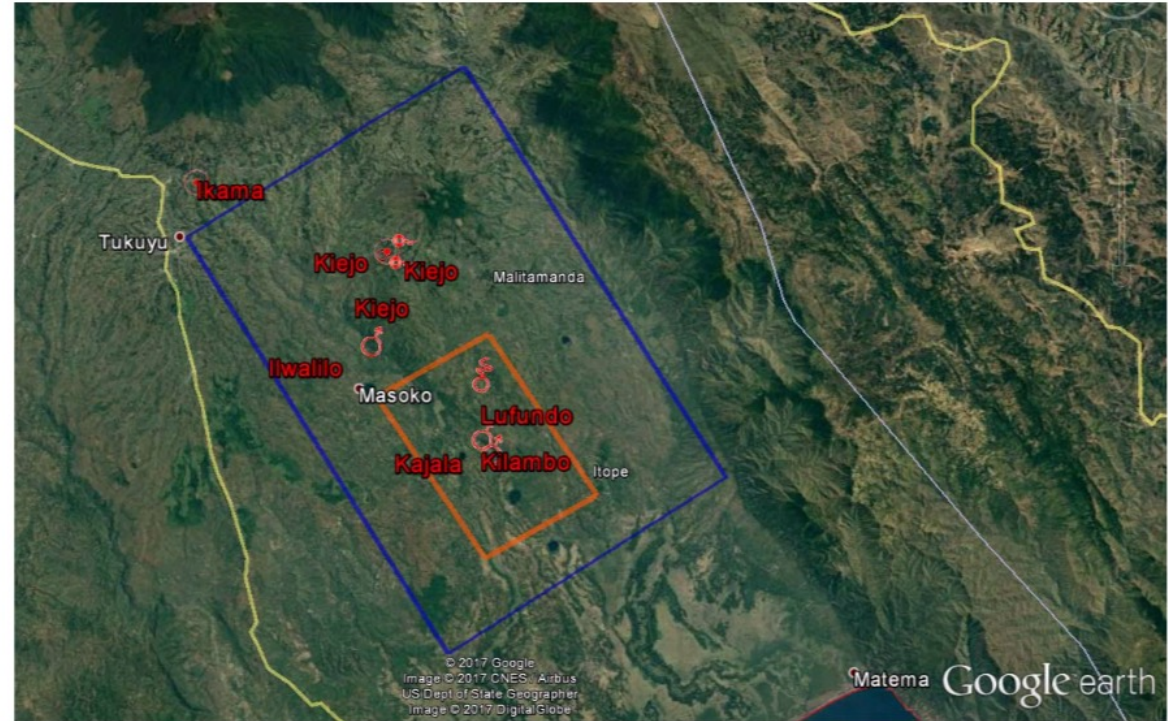
Kiejo-Mbaka Geothermal Site



Site Selection Approach and Methodology



Source: Kajugus et al, 2018



Source: Tanzania Geothermal Development Corporation

Geothermal Site Selection and Weighted Scoring

| No. | Geothermal Resource | Classification | Classification Score | Weighted Score |
|-----|---------------------|--------------------|----------------------|----------------|
| 1 | Kiejo-Mbaka | Indicated Resource | 20 | 22 |

2. Project Identification



Direct Use Geothermal Pilot Project at Menengai, Kenya (Source: Kenya GDC)

Project Identification and Development



Key considerations when selecting Direct Use geothermal technologies:

- Suitability of the geothermal resource
- Is there demand for heat energy on site
- Which product/service can benefit from available energy at the right cost
- Is the technology required to use the heat energy for the specific application – field tested
- Does the solution make sense economically
- Are there any regulatory or legal obstacles in executing the project
- Availability of human and physical resources
- Is the community fully supportive of the project

Project Identification and Development



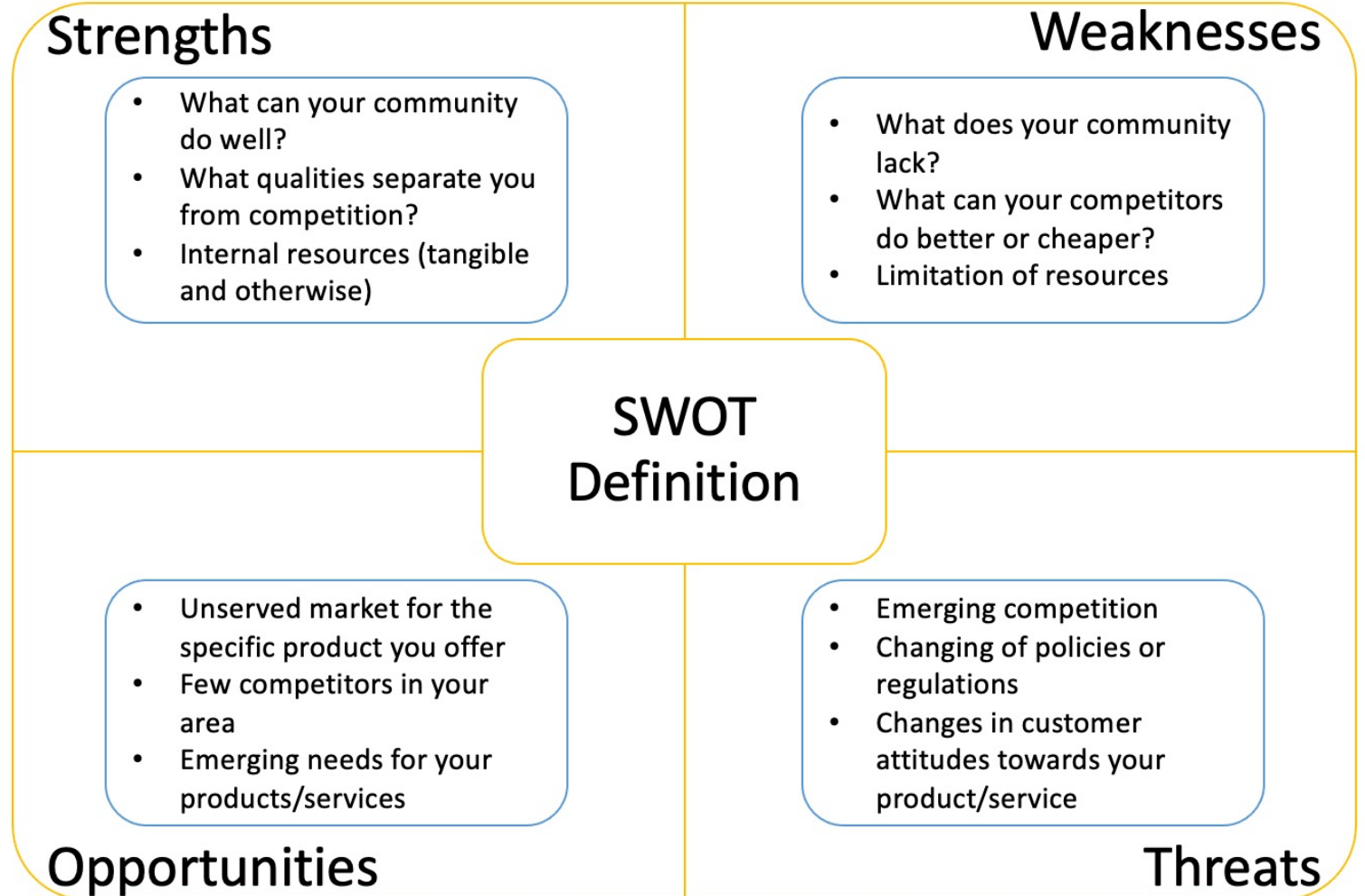
Key considerations when evaluating Direct Use geothermal projects:

- Is there an existing facility which serves the purpose, but is using fossil fuel?
- Access to affordable financing?
- Does this DU application require a community effort?
- Can this DU application play a pivotal role in larger scheme to promote economic development in the area – e.g., Industrial Park?

Project Identification and Development

S.W.O.T. analysis for selected DU technologies

- Aquaculture/fish farming
- Fish drying
- Crop/fruit/vegetable/grain drying
- Greenhouse heating
- Balneotherapy/spas
- Milk pasteurization
- Tea processing/tobacco curing
- Pyrethrum drying
- Chicken hatcheries



Environmental and Social Considerations



Pre-Survey and Exploration

Stakeholders:

Community, Lands, Agriculture, Water

Key Issues:

ESIA, biodiversity management plans, stakeholder engagement, land tenure, access, culture



- Risk Management
- Cultural heritage
- Community, health, safety and security
- Indigenous people
- Biodiversity conservation
- Land acquisition and resettlement

Drilling

Stakeholders:

Labor, Water, Community

Key Issues:

Environmental Audits, Health and Safety, permits (air, water, noise)



- Resource efficiency and pollution prevention
- Labor and working conditions
- Community health, safety and security
- Biodiversity conservation and sustainable management of resources

Operation

Stakeholders:

Labor, Community, NEMA

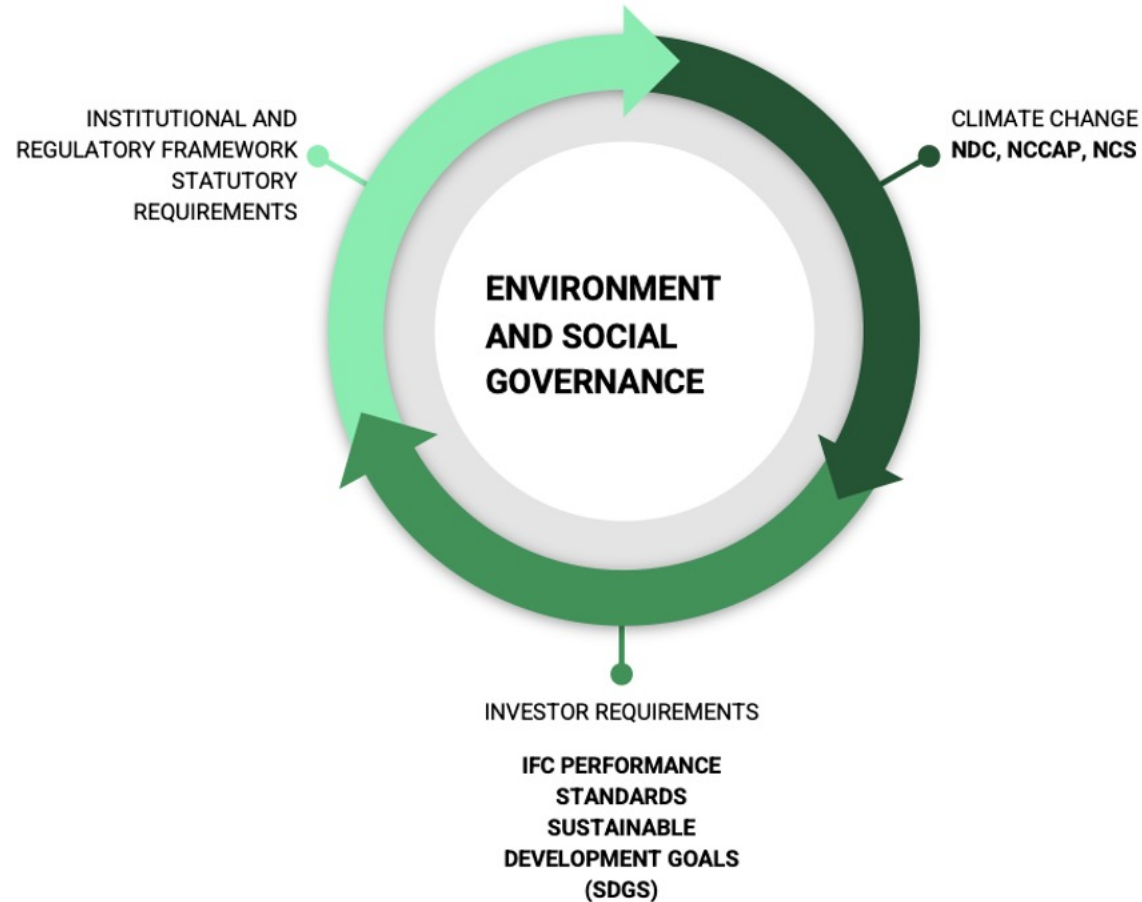
Key Issues:

Monitoring, auditing, industry best practices, standards (Environment ISO 14001: 2015; Health and Safety ISO 45001; critical habitats)



- Risk management
- Labor and working conditions
- Cultural Heritage

Environmental and Social Considerations



3. Commercial Evaluation



Grain dryer utilizing geothermal steam at Menengai, Kenya (Source: Kenya GDC)

Commercial Evaluation: Assumptions



Key Assumptions:

- A detailed financial analysis of each selected geothermal direct use technology/project was conducted to determine its viability and its ability to provide attractive returns to investors
- Two different approaches were taken in the financial analysis:
 - ✓ Greenfield projects
 - ✓ Retrofits
- The model assumptions including capital cost and operating cost estimates used are mainly based on publicly available information
- *A detailed feasibility study will be required to determine actual applicable costs*

Commercial Evaluation: Assumptions

Example: Vegetable/Grain Drying

- The total capital cost of a newly constructed geothermal vegetable drying plant with a 1-ton/batch capacity is estimated at USD 272,094 [TZS 630M]
- The operating costs for the first year of the vegetable drying plant operation is estimated at USD 234,395 [TZS 543M] with an annual escalation rate of 1%.

| Capital Expenses | |
|-----------------------------|----------------|
| CAPEX | Cost (USD) |
| Heat Exchanger | 20,000 |
| Pumps | 3,500 |
| Well Drilling | 30,000 |
| Fans | 3,000 |
| Pipes | 45,000 |
| Construction | 60,000 |
| Batch Dryer | 65,000 |
| Land Acquisition Cost | 1,624.04 |
| Blanching machine | 3,000 |
| Pre-cooling machine | 30,000 |
| Packaging equipment | 10,970 |
| Total CAPEX (\$ USD) | 272,094 |

| OPERATING EXPENSES | Units | Cost/Unit | 1st Year (USD) |
|-------------------------------------|------------|-----------|----------------|
| Cost of Fresh Veg (incl. Transport) | US\$/Kg | 0.26 | 142,915 |
| Electricity Costs | US\$/kwh | 0.13 | 13,910 |
| Equipment O&M | % of CAPEX | 10.0% | 27,209 |
| Labor (Non-payroll) | US\$/hr | 0.63 | 13,225 |
| Payroll | US\$/Yr | N/A | 16,067 |
| Insurances | US\$/Yr | 92 | 92 |
| Equipment Leases | US\$/Yr | - | - |
| Office and Admin Expenses | % of Rev | 0.5% | 1,451 |
| Distribution/Marketing Expenses | % of Rev | 0.5% | 1,451 |
| Utilities, Property Tax | US\$/sqft | 2.0 | 10,764 |
| Packaging | US\$/Kg | 0.09 | 7,309 |
| TOTAL OPEX | | | 234,395 |
| Opex Annual Inflatior (%) | | 1% | |

Commercial Evaluation: Cost Comparison

- A cost comparison analysis was undertaken to compare the cost of geothermal vegetable drying to alternative drying methods:
 - ✓ open air sun drying (via cabinet dryers)
 - ✓ greenhouse solar dryers
 - ✓ wood-fired systems
- The implicit cost of lost revenue due to inability to charge premium prices due to poor taste, quality etc. as a result of the drying system utilized was also incorporated into the analysis
- It was assumed that open-air sun-dried vegetables are sold at a price 50% less than the price assumed for other drying methods



Commercial Evaluation: Cost Comparison

The cost comparison analysis found that:

- ✓ Greenhouse solar drying has the least total annualized costs, followed by geothermal heat, wood-fired dryers and open-air sun drying.
- ✓ Switching to geothermal energy will result in costs savings of 6% and 70% compared to wood-fired dryers and open-air sun drying, respectively.

| | VEGETABLE DRYING ENERGY SYSTEMS COST COMPARISON | | | |
|--|---|--------------|--------------|--------------|
| | Open Air Sun Drying | Solar Drying | Wood | Geothermal |
| Capacity per Batch per Dryer (Kg) | 5.0 | 1,000.0 | 1,000.0 | 1,000.0 |
| No. of Batches per Year per Dryer | 300 | 600 | 600 | 600 |
| Max Annual Capacity per Dryer (Kg) | 1,500.0 | 600,000.0 | 600,000.0 | 600,000.0 |
| Volume of Veg Processed per Year (Kg) | 550,000 | 550,000 | 550,000 | 550,000 |
| No. of Dryers Required | 367.0 | 1.0 | 1.0 | 1.0 |
| Heating Equipment Costs per Dryer (\$) | \$300.00 | \$88,288.00 | \$158,000.00 | \$226,500.00 |
| Design Life - Heating Equipment (Yrs) | 5 | 20 | 20 | 25 |
| Annualized Capital Cost (\$/Yr) | \$22,020.00 | \$4,414.40 | \$7,900.00 | \$9,060.00 |
| Fuel Requirement (kg/Yr) | - | - | 79,019.35 | - |
| Fuel Costs (\$/kg) | \$0.00 | \$0.00 | \$0.11 | \$0.00 |
| Annual Op Costs - Fuel (\$/Yr) | \$0.00 | \$0.00 | \$8,692.13 | \$0.00 |
| Electricity Requirement (kWh/Kg) | - | - | 0.2 | 0.2 |
| Electricity Cost (\$/kWh) | \$0.00 | \$0.00 | 0.13 | 0.13 |
| Annual Op Costs - Electricity (\$/Yr) | \$0.00 | \$0.00 | \$13,910.42 | \$13,910.42 |
| Annual Op Costs - Labour (\$/Yr) | \$16,531.35 | \$13,225.08 | \$16,531.35 | \$13,225.08 |
| Annual Maintenance Cost (% of CAPEX) | 10% | 10% | 10% | 10% |
| Annual Maintenance Cost (\$/Yr) | \$11,010.00 | \$8,828.80 | \$15,800.00 | \$22,650.00 |
| Cost of Lost Revenue (\$/Yr) | \$145,109.25 | - | - | - |
| Total Annualized Costs (\$/Yr) | \$194,670.60 | \$26,468.28 | \$62,833.90 | \$58,845.50 |
| Total Annual Costs Savings (\$/Yr) | \$135,825.10 | -\$32,377.22 | \$3,988.40 | |
| Total Annual Costs Savings (%) | 70% | -122% | 6% | |

Commercial Evaluation: Assumptions



Key Assumptions:

- Revenue:** The local and export price of dried vegetables was assumed to be USD 3.69/kg [TZS 8,000/kg] based on the price of dried spinach in Nairobi. It was also assumed that 50% of the dried vegetables produced by the plant will be sold locally while the remaining 50% will be exported. The model also assumed an annual price escalation of 1%.
- Tax:** An annual corporate income tax rate of 30% is assumed, with no tax holiday in order to be conservative
- Sources of Funds:** The model assumed that the project will be financed with 30% equity and 70% debt, with no grants to be conservative
- Debt:** An annual interest rate of 16.9% was assumed based on average local commercial bank rates in Tanzania. It was assumed that the debt will be amortized annually over 10 years.

| REVENUE | USD |
|------------------------------------|------|
| Price of Dry Veg - Local (USD/Kg) | 3.69 |
| Price of Dry Veg - Export (USD/Kg) | 3.69 |
| % of Dry Veg Sold Locally | 50% |
| % of Dry Veg Exported | 50% |
| Price Escalation (Annual) | 1% |

| TAXES | |
|-----------------|-----|
| Tax Rate (% pa) | 30% |

| SOURCES | % of Total | \$ |
|---------------|----------------|----------------|
| Senior Debt | 70% | 190,466 |
| Equity | 30% | 81,628 |
| Grants/Rebate | 0% | - |
| TOTAL | 100.00% | 272,094 |

| SENIOR DEBT | |
|--------------------------|-------|
| All-in Interest Rate p.a | 16.9% |
| Term (Years) | 10 |

Commercial Evaluation: Summary of Findings



Based on these assumptions, the geothermal vegetable drying plant will generate:

- ✓ Average annual sales of 78,178kg of dried vegetable
- ✓ Average annual revenue of USD 325,811 [TZS 755M]
- ✓ Average annual net income of USD 29,014 [TZS 67M]

The investment opportunity is attractive with:

- ✓ After-tax equity IRR of 19.36%
- ✓ After-tax project IRR of 18.13%
- ✓ Payback period of 9 years
- ✓ Net cashflow to equity investors of USD 725,356 [TZS 1.6B] over the 25-year life of the project

| VEG DRYING RESULTS SUMMARY | |
|------------------------------|--------------|
| Avg Annual Sales (Kg) | 78,178 |
| Avg Annual Revenue | \$325,810.56 |
| Avg Annual Expenses | \$264,802.05 |
| Avg EBITDA | \$61,008.51 |
| Total CF to Equity | \$806,984 |
| Net CF to Equity | \$725,356 |
| Cash on Cash Return | 8.89x |
| After Tax Equity IRR | 19.36% |
| After Tax Project IRR | 18.13% |
| Payback Year | 9 |

Commercial Evaluation: Summary of Findings



A sensitivity analysis was conducted to determine the impact of change in key assumptions on the equity IRR

The results show that the project will not be viable at the production levels analyzed if:

- CAPEX increases by 40% to USD 381k [TZS 883M] and above, except for the 600,000kg production scenario
- OPEX increases by 20% to USD 281k [TZS 651M] and above.
- Avg. price decreases by 20% to USD 2.95 [TZS 6.8K] and below
- The results also show that under the current base assumptions for CAPEX, OPEX and pricing, the plant will not be viable if the quantity of fresh vegetables processed falls below 500,000kg, underscoring the value of economies of scale.
- In conclusion, it is clear from the sensitivity analysis that a slight increase in CAPEX/OPEX or decrease in prices will make the plant unviable.

| | | CAPEX | | | | | | |
|---------------|---------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| | | \$163,256 | \$217,675 | \$272,094 | \$326,513 | \$380,932 | \$435,350 | \$489,769 |
| | | -40% | -20% | 0% | 20% | 40% | 60% | 80% |
| Quantity (kg) | 19.36% | | | | | | | |
| | 300,000 | -1.70% | -10.89% | NEG IRR | NEG IRR | NEG IRR | NEG IRR | NEG IRR |
| | 350,000 | 8.55% | 0.00% | -5.73% | -13.61% | NEG IRR | NEG IRR | NEG IRR |
| | 400,000 | 18.88% | 7.58% | 0.98% | -3.72% | -8.38% | -15.40% | NEG IRR |
| | 450,000 | 31.39% | 15.16% | 7.00% | 1.62% | -2.39% | -5.79% | -10.22% |
| | 500,000 | 46.08% | 23.57% | 13.06% | 6.62% | 2.07% | -1.44% | -4.42% |
| | 550,000 | 61.75% | 33.48% | 19.36% | 11.69% | 6.35% | 2.41% | -0.72% |
| 600,000 | 77.71% | 44.53% | 26.59% | 16.75% | 10.69% | 6.15% | 2.67% | |





| | | OPEX | | | | | | |
|---------------|---------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| | | \$140,637 | \$187,516 | \$234,395 | \$281,273 | \$328,152 | \$375,031 | \$421,910 |
| | | -40% | -20% | 0% | 20% | 40% | 60% | 80% |
| Quantity (kg) | 19.36% | | | | | | | |
| | 300,000 | 24.24% | 6.15% | NEG IRR | NEG IRR | NEG IRR | NEG IRR | NEG IRR |
| | 350,000 | 36.69% | 13.81% | -5.73% | NEG IRR | NEG IRR | NEG IRR | NEG IRR |
| | 400,000 | 50.64% | 22.07% | 0.98% | NEG IRR | NEG IRR | NEG IRR | NEG IRR |
| | 450,000 | 65.21% | 31.87% | 7.00% | NEG IRR | NEG IRR | NEG IRR | NEG IRR |
| | 500,000 | 79.98% | 42.94% | 13.06% | NEG IRR | NEG IRR | NEG IRR | NEG IRR |
| | 550,000 | 94.81% | 54.71% | 19.36% | -8.77% | NEG IRR | NEG IRR | NEG IRR |
| 600,000 | 109.66% | 66.78% | 26.59% | -2.35% | NEG IRR | NEG IRR | NEG IRR | |

| | | Price | | | | | | |
|---------------|---------|---------|---------|---------|---------|---------|---------|---------|
| | | \$2.21 | \$2.95 | \$3.69 | \$4.43 | \$5.17 | \$5.90 | \$6.64 |
| | | -40% | -20% | 0% | 20% | 40% | 60% | 80% |
| Quantity (kg) | 19.36% | | | | | | | |
| | 300,000 | NEG IRR | NEG IRR | NEG IRR | 5.89% | 23.69% | 47.36% | 73.88% |
| | 350,000 | NEG IRR | NEG IRR | -5.73% | 14.74% | 39.49% | 70.04% | 101.43% |
| | 400,000 | NEG IRR | NEG IRR | 0.98% | 24.63% | 57.33% | 93.09% | 129.01% |
| | 450,000 | NEG IRR | NEG IRR | 7.00% | 36.54% | 75.78% | 116.18% | 156.58% |
| | 500,000 | NEG IRR | NEG IRR | 13.06% | 49.80% | 94.36% | 139.27% | 184.14% |
| | 550,000 | NEG IRR | NEG IRR | 19.36% | 63.64% | 112.97% | 162.35% | 211.68% |
| 600,000 | NEG IRR | NEG IRR | 26.59% | 77.68% | 131.57% | 185.42% | 239.22% | |

4. User Guide: Financial Model



Financial Model: Entering Inputs

| | |
|---|---|
|  | <p>Blue text in grey cells denotes active user-defined inputs. The user is responsible for modifying these cells in line with the scenario being evaluated. These active inputs feed directly into the calculation sheets to determine the results.</p> |
|  | <p>Blue text in green cells denotes inactive user-defined inputs. The user is responsible for modifying these cells in line with the scenario being evaluated. However, these inactive inputs have no impact on the results.</p> |
|  | <p>Black text in grey cells denotes inputs that cannot be varied by the user. These cells should not be modified.</p> |
|  | <p>Black texts in white cells are either in-built or calculated automatically. These cells should not be modified.</p> |

Financial Model: Description of Key Inputs



Project Details: The username, project name and project location should be entered in cells C7, C8 and C9, respectively. Select the appropriate country from the dropdown list in cell D9.

Capital Expenses: The CAPEX line items should be entered in cells B13 to B28, while the associated cost data should be entered in cells C13 to C28.

Revenue Inputs: The local price and export price of the dried product should be entered in cells J7 and J8, respectively.

Technical Inputs:

- The quantity of fresh vegetables to be processed annually should be entered in cell G25, while the average moisture content of fresh vegetables and the desired moisture content of dried vegetables should be entered in cells G26 and G27, respectively.
- The percentage of dried vegetables lost due to inspection, the quantity of electricity required, the required drying time per batch, and the washing, peeling, slicing, packaging, etc. time should be entered into cells G30, G32, G33 and G34, respectively.
- The quantity of fresh vegetables processed per batch, the number of batches per day per dryer, the land space required per dryer, the assumed total drying station land size and the annual plant output degradation should be entered in cells G36, G38, G42, G43, and G44, respectively.

Financial Model: Description of Key Inputs



Sources of Funds: The percentage of the CAPEX of the project to be financed by debt, equity and grants should be entered into cells F14, F15 and F16, respectively.

Debt Inputs: These include assumptions on the interest rate and tenor of the project debt. The user should input the annual interest rate in cell G20 and the debt tenor (in years) in cell G21.

Tax Inputs: The annual corporate income tax rate assumption should be entered in cell J14.

Depreciation Inputs: The useful life of the plant should be entered in cell J17 while, the salvage value of the plant, which is its resale value at the end of its useful life, should be entered in cell J19.

Operating Expenses: The OPEX line items should be entered in cells L7 to L22, while the associated cost data should be entered in cells N7 to C22. The assumed annual escalation of the operating expenses should be entered into cell N23.

Financial Model: Description of Key Inputs



Plant Labor: The number of kilograms of fresh vegetables processed per dryer batch per labor, the number of batches per day per dryer, the plant operating time in days per week and weeks per year should be entered into cells M38, M40, M42, and M43, respectively.

Payroll:

- The list of the vegetable drying firm's employees should be entered in cells L27 to L34, while the associated annual all-in salary assumptions should be entered in cells N27 to N34.
- The dropdown options in cells M27 to M34 also allow the user to determine which employees will be excluded or included on the payroll. The base case scenario of the model assumes that the CEO will not be on the payroll and will only be paid via distribution of earnings.

Financial Model: Operating the Model



- ✓ Results are automatically calculated and displayed in the “Summary” tab and in data tables on the “Inputs” sheet
- ✓ “Calculation Options” should be set to “Automatic” for the results to be generated automatically
- ✓ If this option is not set to “Automatic” the user will need to press “Calculate Now” after any input is changed to calculate accurate results

Financial Model: Understanding the Results

The main outputs are displayed in the “Summary” tab and include:

- ✓ After-tax equity IRR
- ✓ After-tax project IRR
- ✓ Cash-on-cash equity return
- ✓ Payback period (in years)
- ✓ Total cashflows
- ✓ Net cashflows

Other model outputs:

- ✓ Average annual sales
- ✓ Average annual revenue
- ✓ Average annual expenses
- ✓ Earnings Before Interest Depreciation and Amortization (EBITDA)

These outputs are used to measure the commercial viability and attractiveness of the project.

Financial Model: Understanding the Results



Outputs are used to determine the project's ability to adequately service debt:

- ✓ Average Debt Service Coverage Ratio (DSCR)
- ✓ Minimum DSCR

A sensitivity analysis is conducted to determine the impact of change on the equity IRR to measure the project's viability. The results of this analysis are color-coded so that scenarios with equity IRR:

- ✓ greater than 15% are **green (attractive)**
- ✓ between 10-14.9% are **yellow (manageable)**
- ✓ below 10% and negative are **red (unfavorable)**

NB: Scenarios with results showing as "NEG IRR" mean that the negative value is too small to be displayed.

User Guide: Financial Model



QUESTIONS

5. Next Steps



Kiejo-Mbaka, Field activities - October 2016

Full Feasibility Study

What will a full feasibility study entail?

- Quantify the geothermal resource – on a long-term basis
- Perform a market study of the product/services demanded in this area – prioritize
- Select the appropriate technology – field tested
- Define any legal/commercial/regulatory issues which need to be addressed
- Collect cost data on all major elements of the desired facility
- Develop a business plan considering CAPEX, Opex and financing costs
- Prepare a financial model reflecting the Business Plan
- Perform sensitivity analysis
- Quantify the Environmental adders

Policy Support

What steps can TGDC and other relevant public agencies take to promote development of direct use technologies?

- ❑ Prepare a sector roadmap to identify and map specific geographic areas of interest for potential development with extensive input, participation and support from beneficiary communities at/near project sites
- ❑ Enact supportive policies and regulations which will make it easier to develop direct use projects, including:
 - ✓ Streamline geothermal concession and permitting processes (“one-stop-shop” approach)
 - ✓ Consider the concept of “eminent domain” for direct use projects
- ❑ Remove any customs, VAT or other duties on direct use equipment that is imported into the country

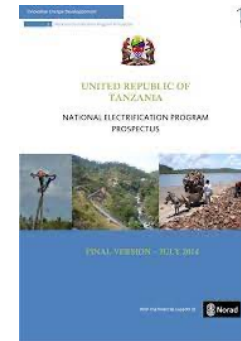
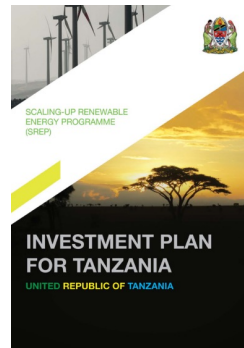
Policy Support

- ❑ Raise awareness of the benefits of and opportunities associated with direct use geothermal applications and technologies through various channels, including:
 - ✓ Integrate public awareness campaigns into energy policy framework and implementation plans
 - ✓ Organize online forums, conferences and workshops on direct use geothermal aimed at engaging with industry associations and other private sector partners and stakeholders

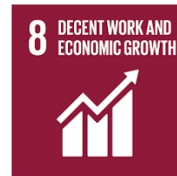
- ❑ Partner with academia and the private sector to:
 - ✓ Promote R&D in this field to promote innovation
 - ✓ Integrate the topic into curricula/education programs
 - ✓ Develop and implement new certification programs in direct use technologies to build local technical capacity for long-term O&M of projects

Policy Support

- ❑ Establish linkages between direct use geothermal technologies and national action plans and long-term energy sector strategies aimed at decarbonization/climate change mitigation (e.g., NDCs, SDGs)



Linkages to Climate Action and Sustainable Development Goals



Funding Support

- ❑ With support from development partners, provide financial support for direct use project development, including:

- ✓ Grants
- ✓ Concessional loans
- ✓ Risk Mitigation
- ✓ Other



Thank You!

Asante

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