THE REPUBLIC OF UGANDA

MINISTRY OF ENERGY AND MINERAL DEVELOPMENT

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

Training and Capacity Building Workshop

Uganda

July 2021

GreenMax Capital Advisors


Jalua
Alid
Borawli (Southern)
Debahu
OBOCK
Tendaho
DJIBOUTI
Teo
Lake Abhe 2
Yangudi
Amoissa
Dofan
Tedecha
Tulu Moye
Duguna
ETHIOPIA
Boku
UGANDA
Panyimur
Kibiro
Namarunu
Silali
KENYA
Western rift valley
Buranga
Bogoria
Homa hills
Menengai
Eburru
Mtagata -Kagera
Kinigi
RWANDA
Majimoto
Olkaria
Lake Natron
Bugarama
Chyullu Hills
Ibadakuli - Shinyanga
Mugara
Mwananyamala
Dodoma-Singida-Kondoa Block
TANZANIA
Rukwa Block
Lower Rufiji Basin
Kisaki - Morogoro
Ngozi
Songwe-Mbeva
Kapisya
Kiejo-Mbaka
Mwankenja 2
Ngala
Mbande

Agenda

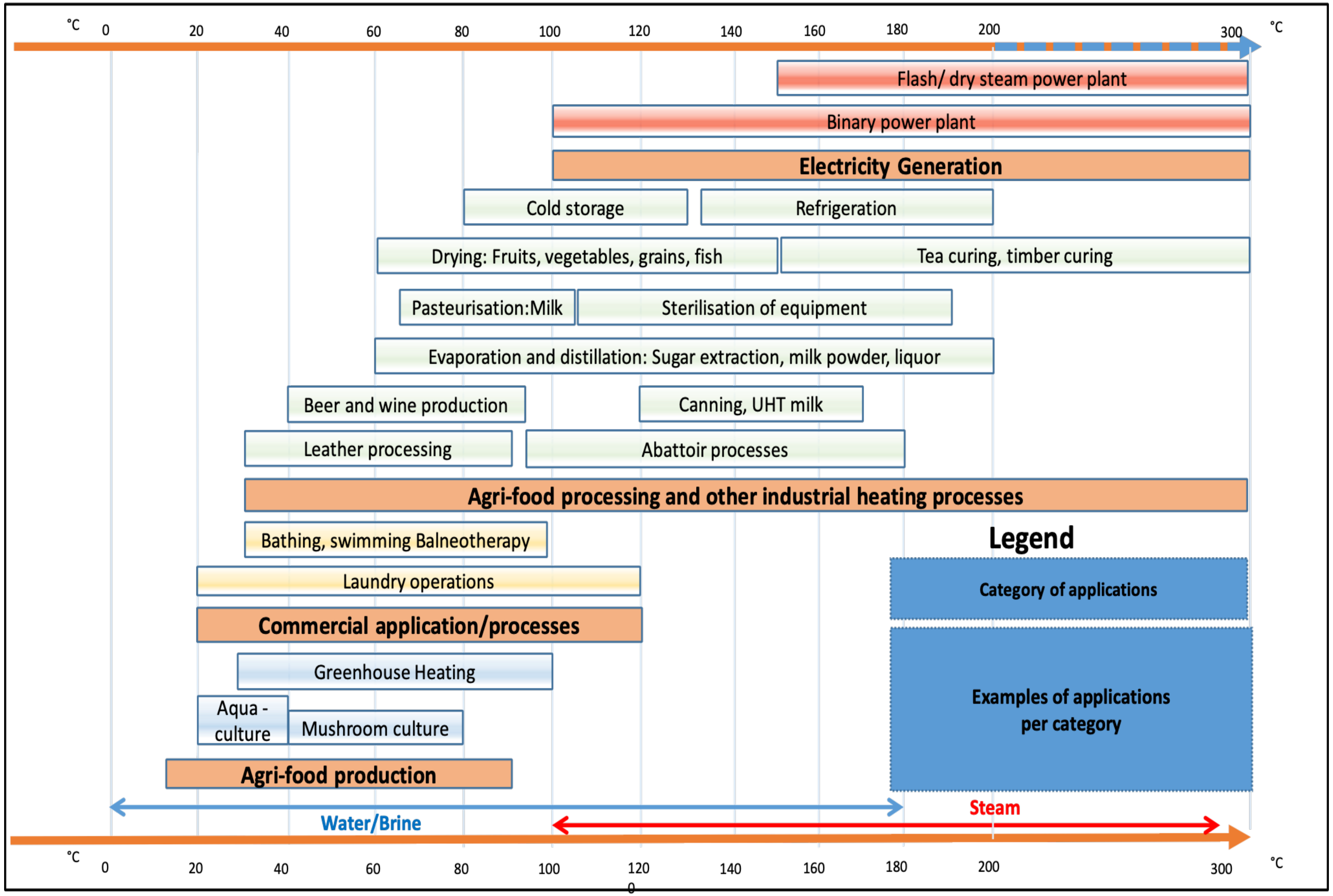
1. Technical Evaluation
2. Project Identification
3. Commercial Evaluation
4. User Guide: Financial Model
5. Next Steps: Full Feasibility Study and Policy/Financial Support

Source: IRENA 2020

1. Technical Evaluation

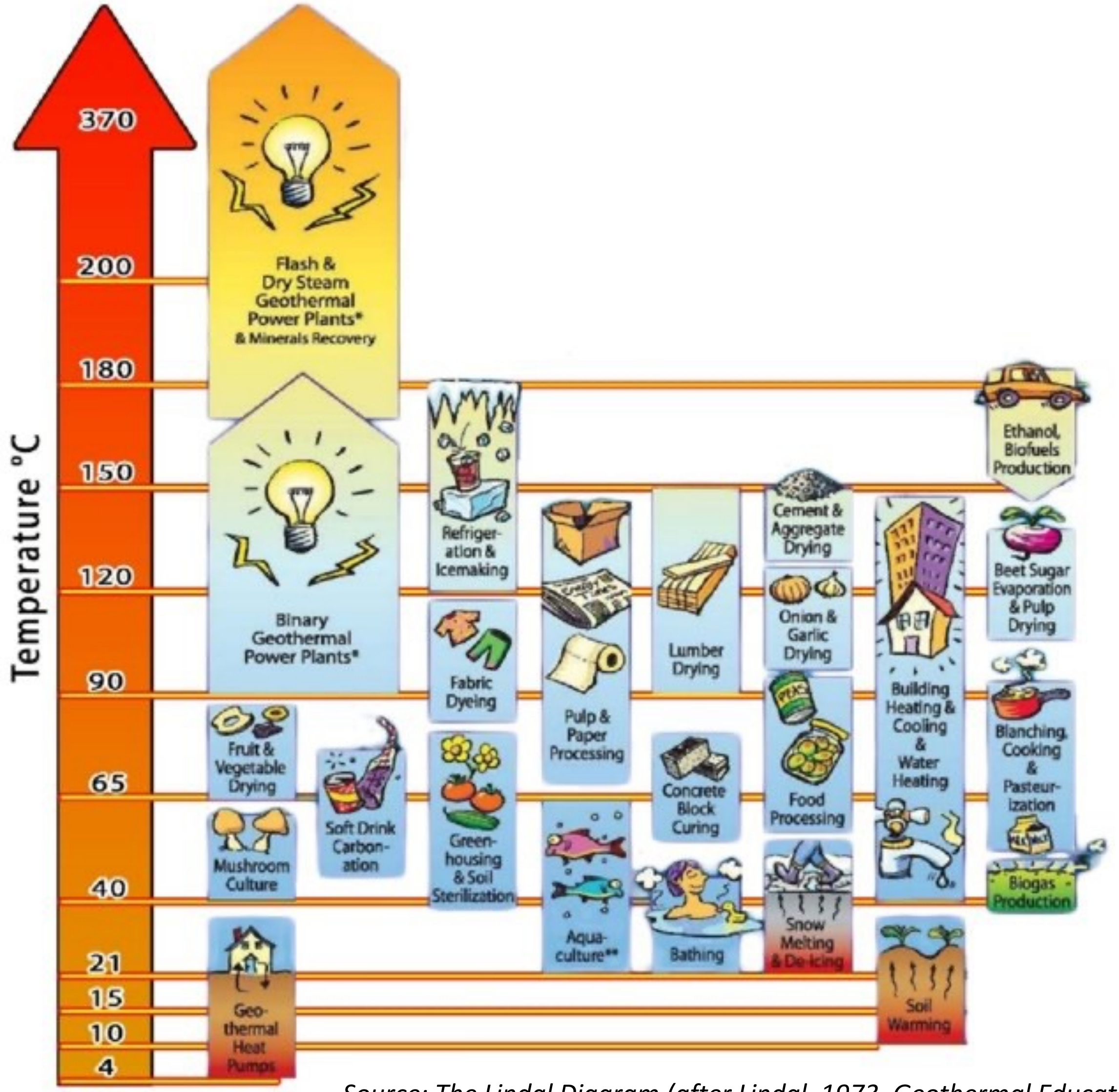
Hot spring at the Buranga Geothermal Prospect, Uganda (Source: Ministry of Energy and Mineral Development)

Geothermal Development in Africa



Source: IRENA 2020

Direct Use Applications

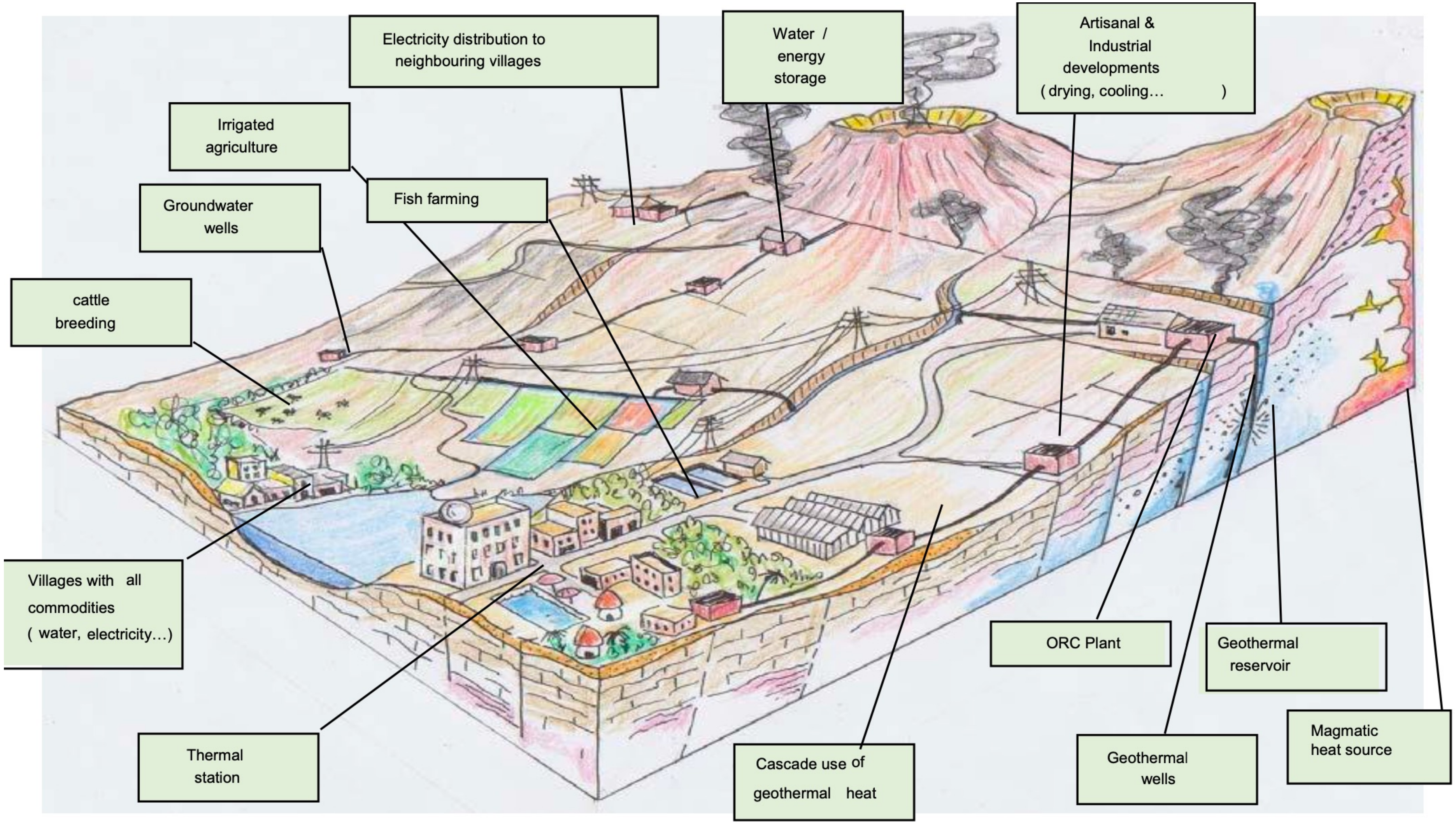


Source: The Lindal Diagram (after Lindal, 1973, Geothermal Education Office 2005)

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)

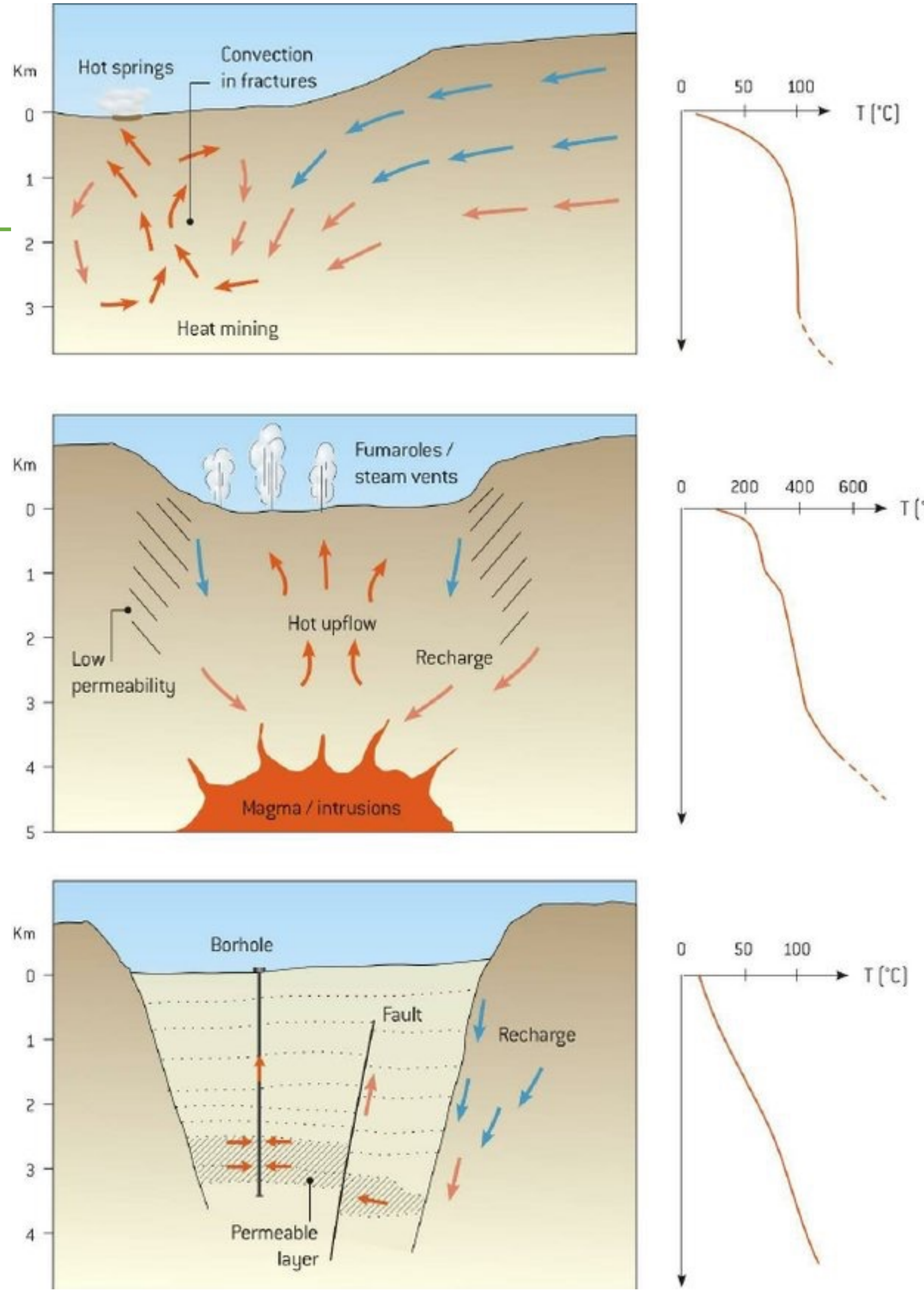
Cascaded and Integrated Use of Geothermal Resources



Source: Varet et al., 2014.

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



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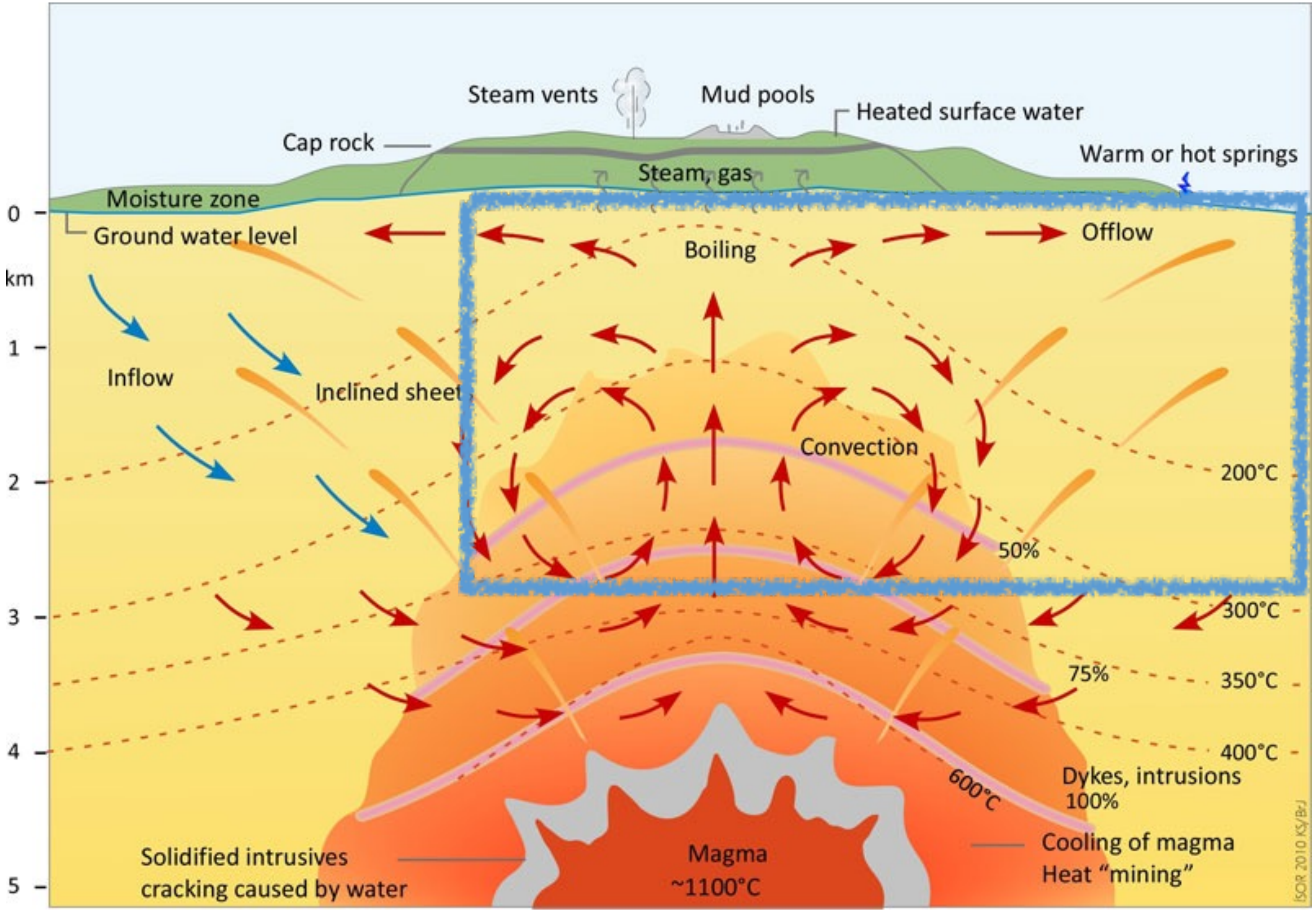
Source: Saemundsson et al., 2011; and Jóhannesson et al., 2019.

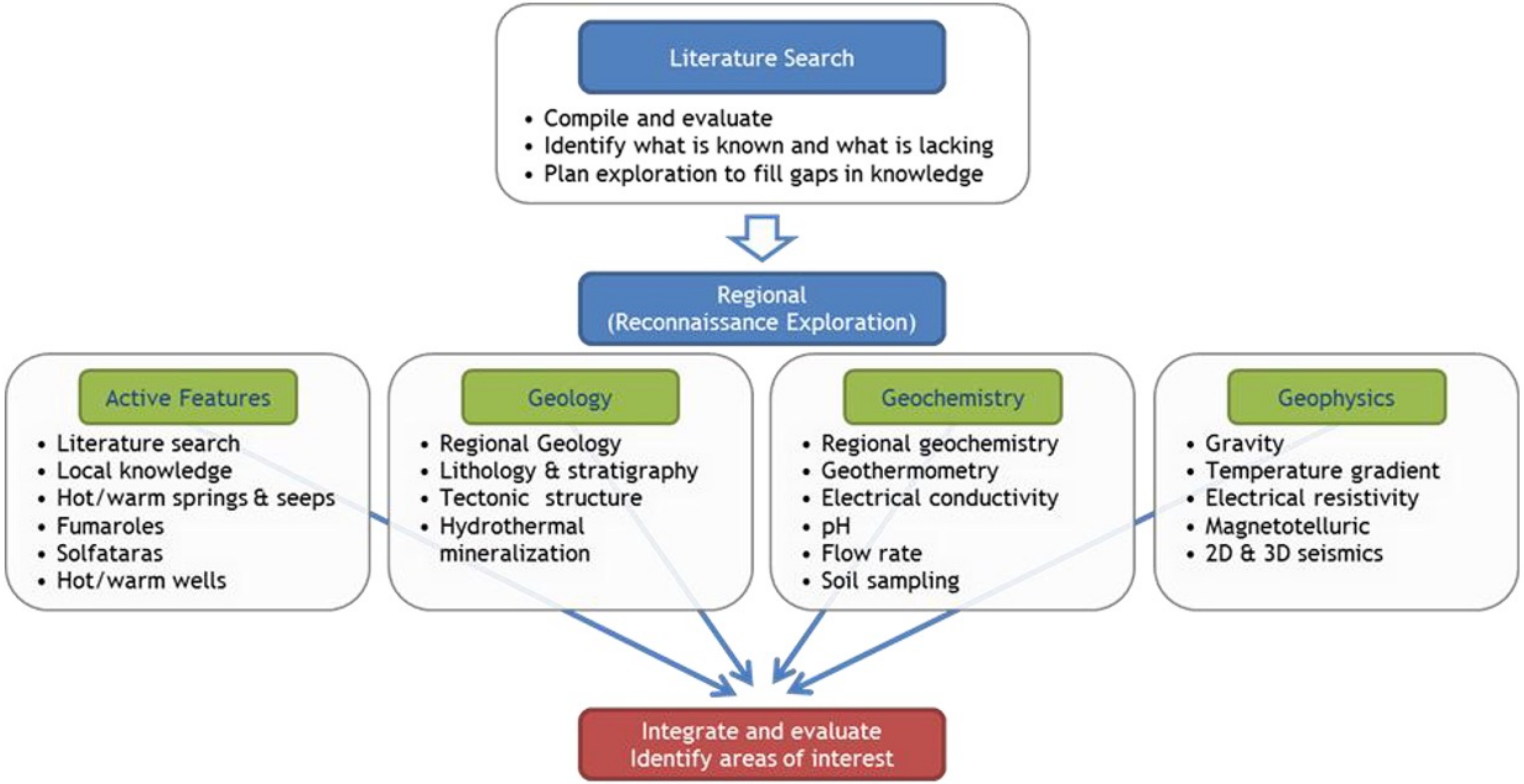
Conceptual Models



20-150°C

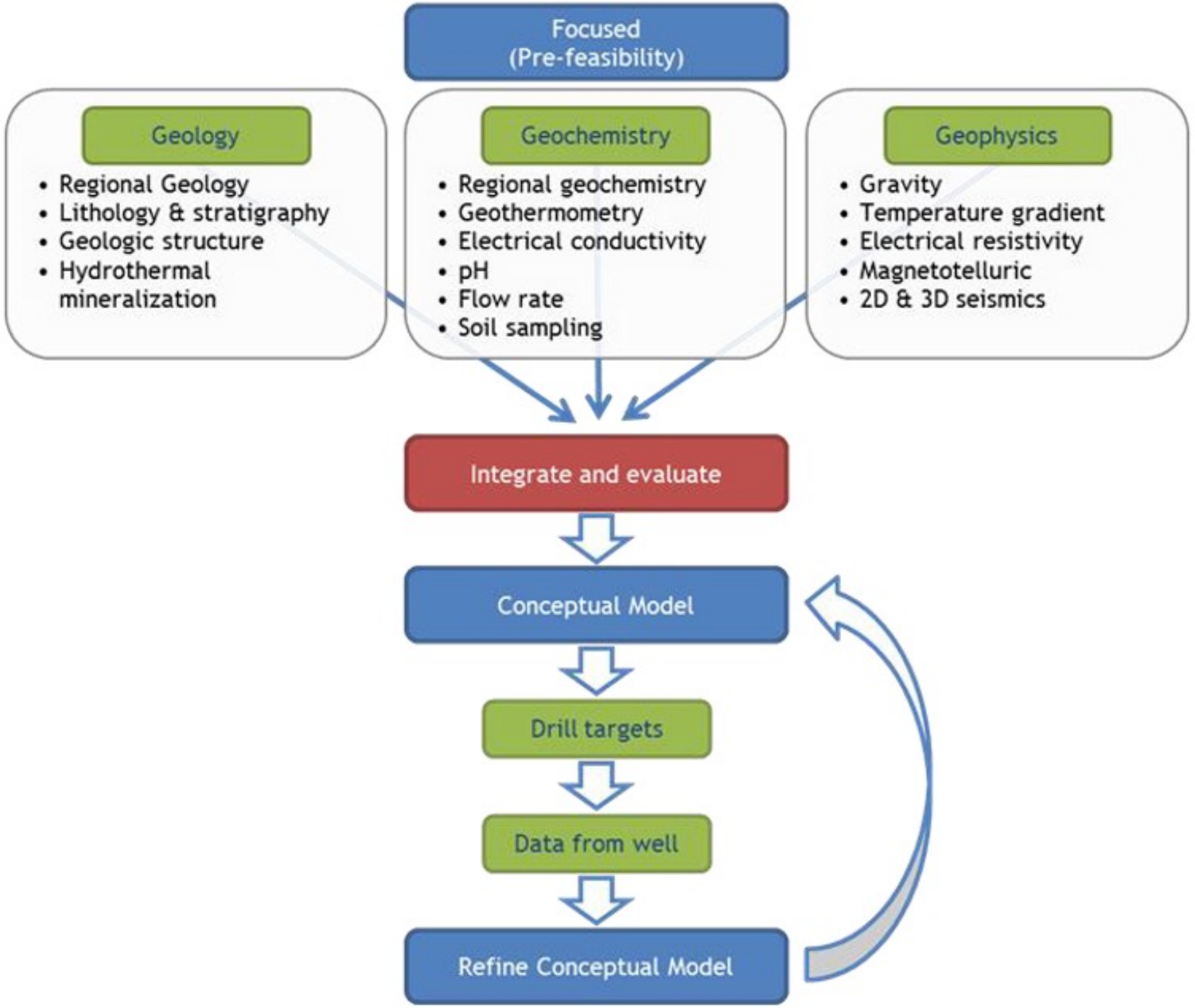
Source: simplified models of geothermal systems Jiaqi Liu, Xiaoyu Chen

Geothermal Exploration: Best Practices



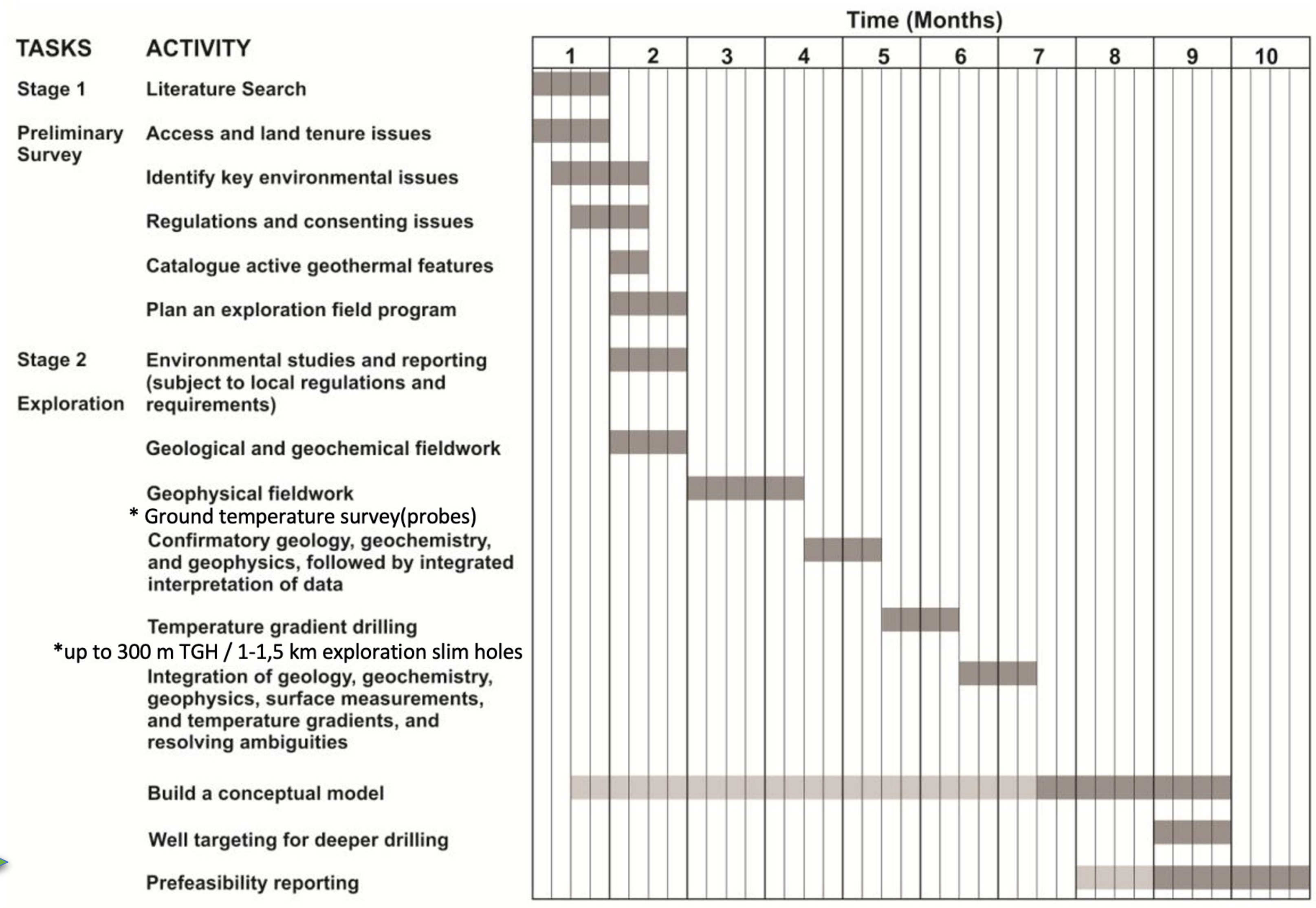
Source: Geothermal Exploration Best Practices, IGA, 2013

Geothermal Exploration: Best Practices



Source: Geothermal Exploration Best Practices, IGA, 2013

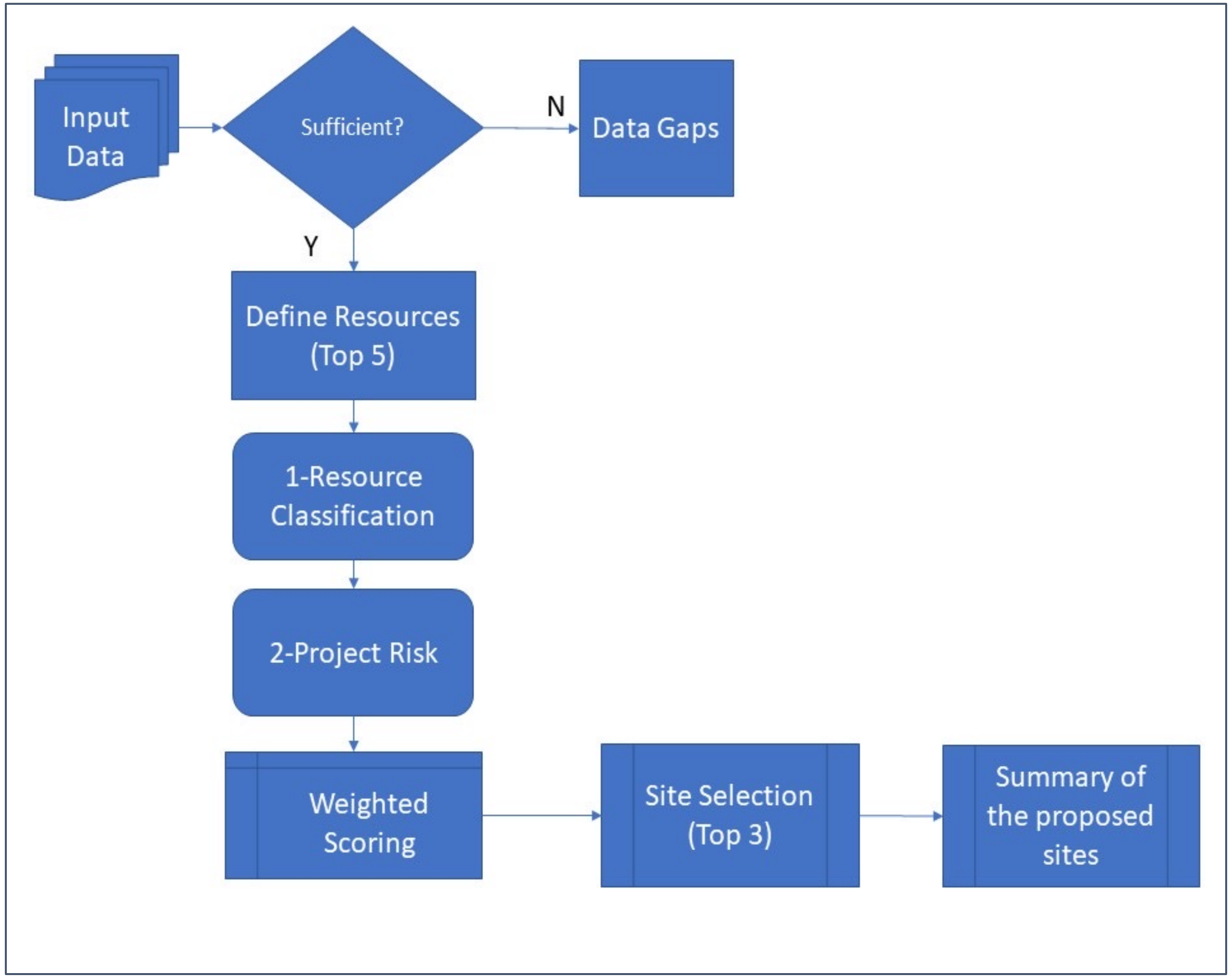
Geothermal Exploration Timeline



Source: Geothermal Exploration Best Practices, IGA, 2013

Site Selection Methodology

Data Analysis and Site Selection Approach



Source: GreenMax Capital Advisors analysis

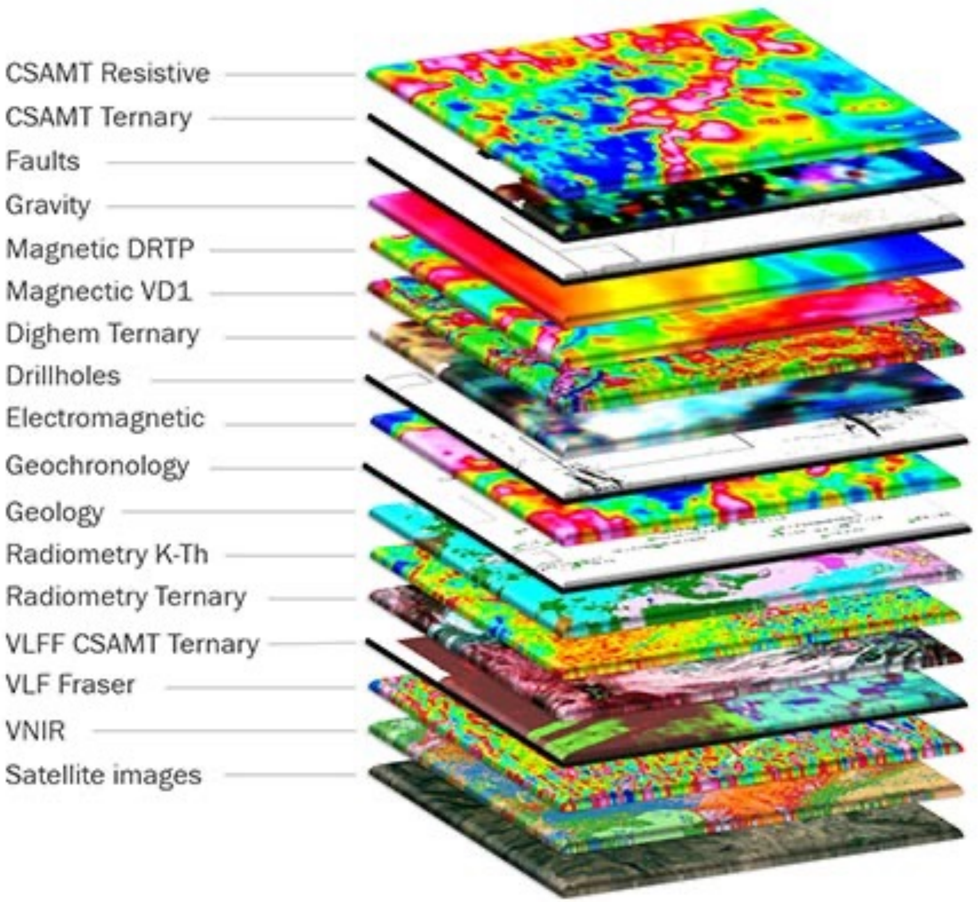
Key Components of Technical Evaluation

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 CLASSIFICTION	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

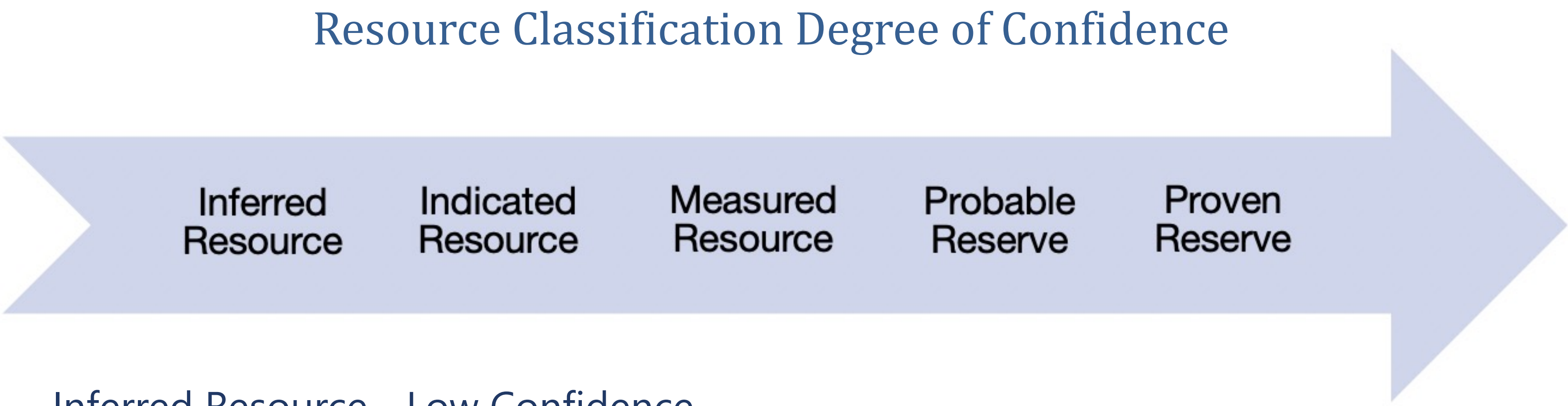
Key Components of Technical Evaluation

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



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

Source: GreenMax Capital Advisors analysis

Site Selection Methodology

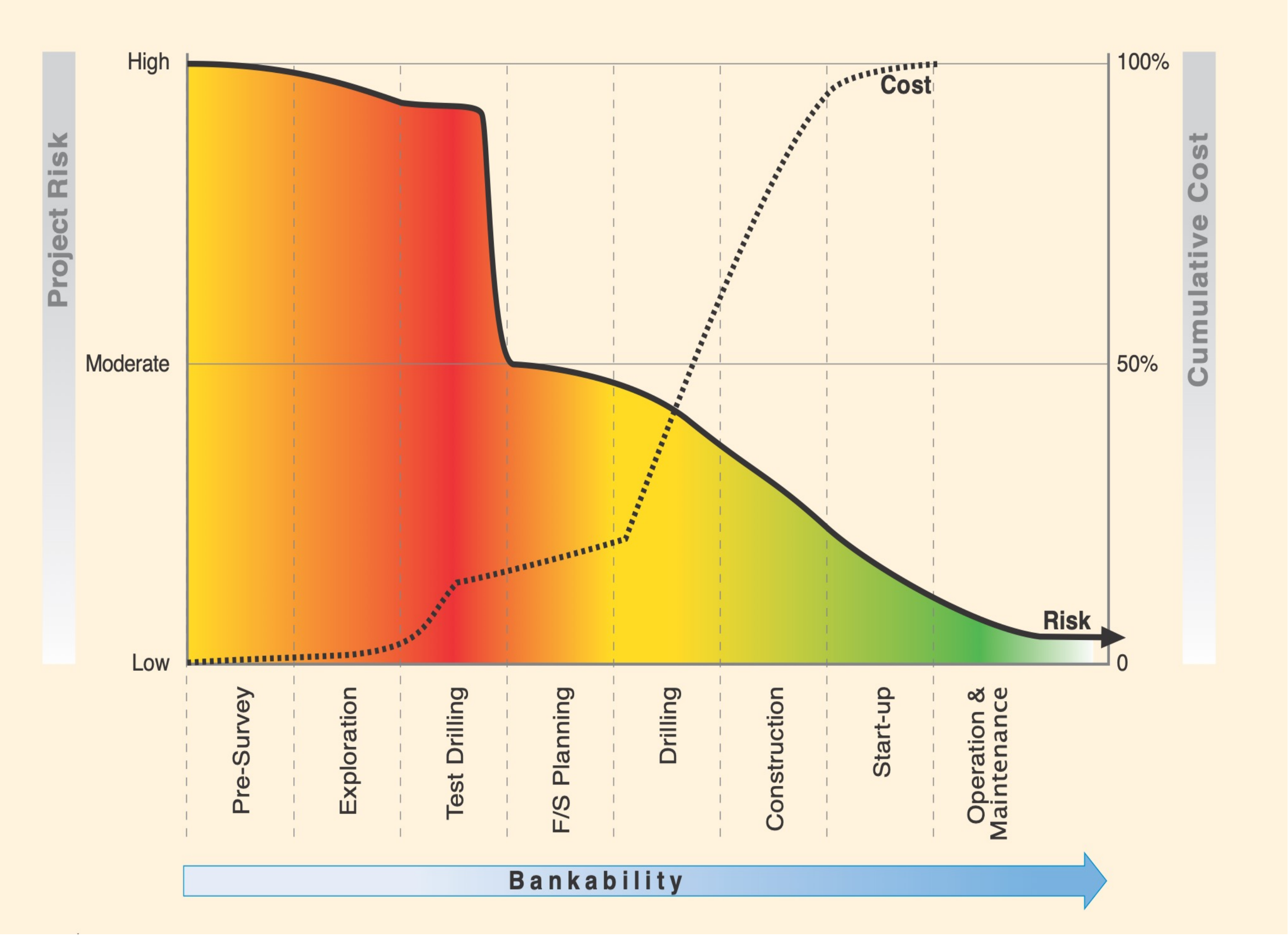
	EXAMPLE		New Defined Criteria	0/1
A) Volume	Area	1	Surface manifestations	1
		2	Geothermal Gradient	1
		3	Geological analogy	1
		4	Geophysical mapping	1
		5	Estimated resource depth	1
Deliverability	Fluid T	6	Geothermometry	1
		7	Offset Wells Data	1
Cut off T		8	Min T for commercial operation	1
Permeability and P		9	Shallow well/ spring P and T	1
		10	Fault/ Aquifer permeability	1
Chemistry		11	No fluid acidity, unontrollebale solids deposition	1
	Hydrochemistry	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
	Depth	18	Depth from geophysics / adjacent wells	1

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

Source: GreenMax Capital Advisors analysis

Site Selection Methodology

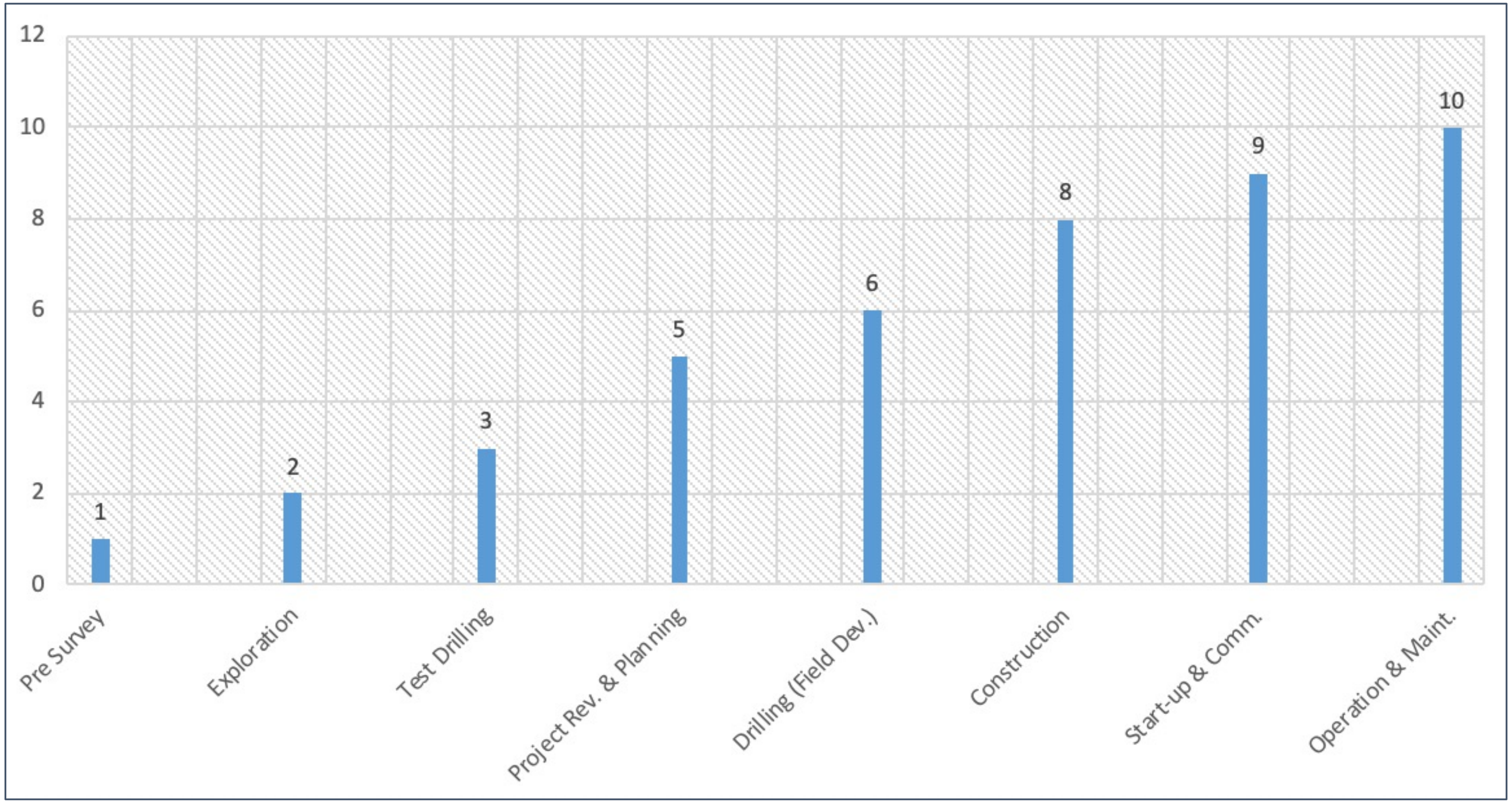
Geothermal Project Risk and Cumulative Investment Cost



Source: World Bank ESMAP

Site Selection Methodology

Geothermal Project Development Status and Associated Weighted Score



Source: World Bank ESMAP; GreenMax Capital Advisors analysis

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

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Geothermal Site Selection

Source: ARGeo Africa Geothermal Inventory Database; GreenMax Capital Advisors

No.	Geothermal Site
1	Kibiro
2	Buranga
3	Panyimur

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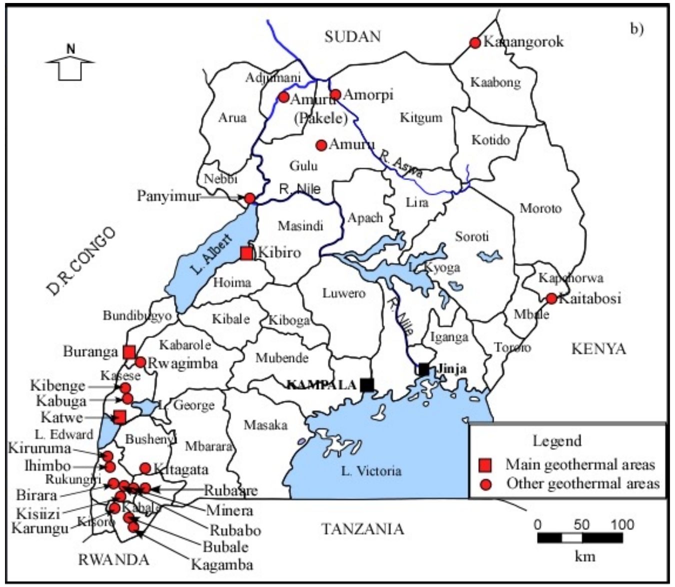
Site Selection Approach and Methodology



Geothermal Site Selection and Weighted Scoring

No.	Geothermal Resource	Classification	Classification Score	Weighted Score
1	Kibiro	Indicated Resource	11	17
2	Buranga	Indicated Resource	10	15
3	Panyimur	Inferred Resource	10	15

Source: GreenMax Capital Advisors analysis

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

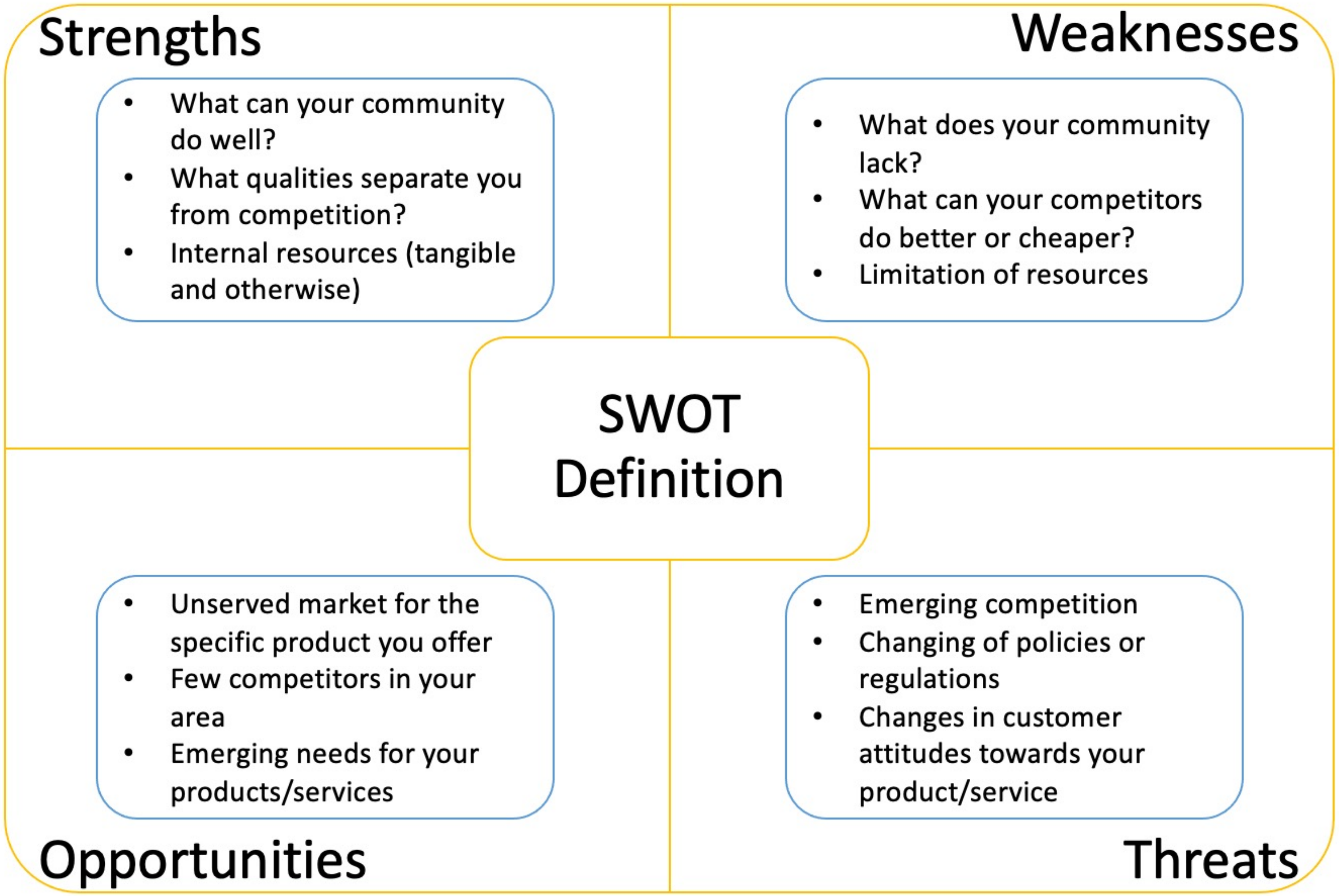
Key considerations when evaluating Direct Use geothermal projects:

- 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



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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

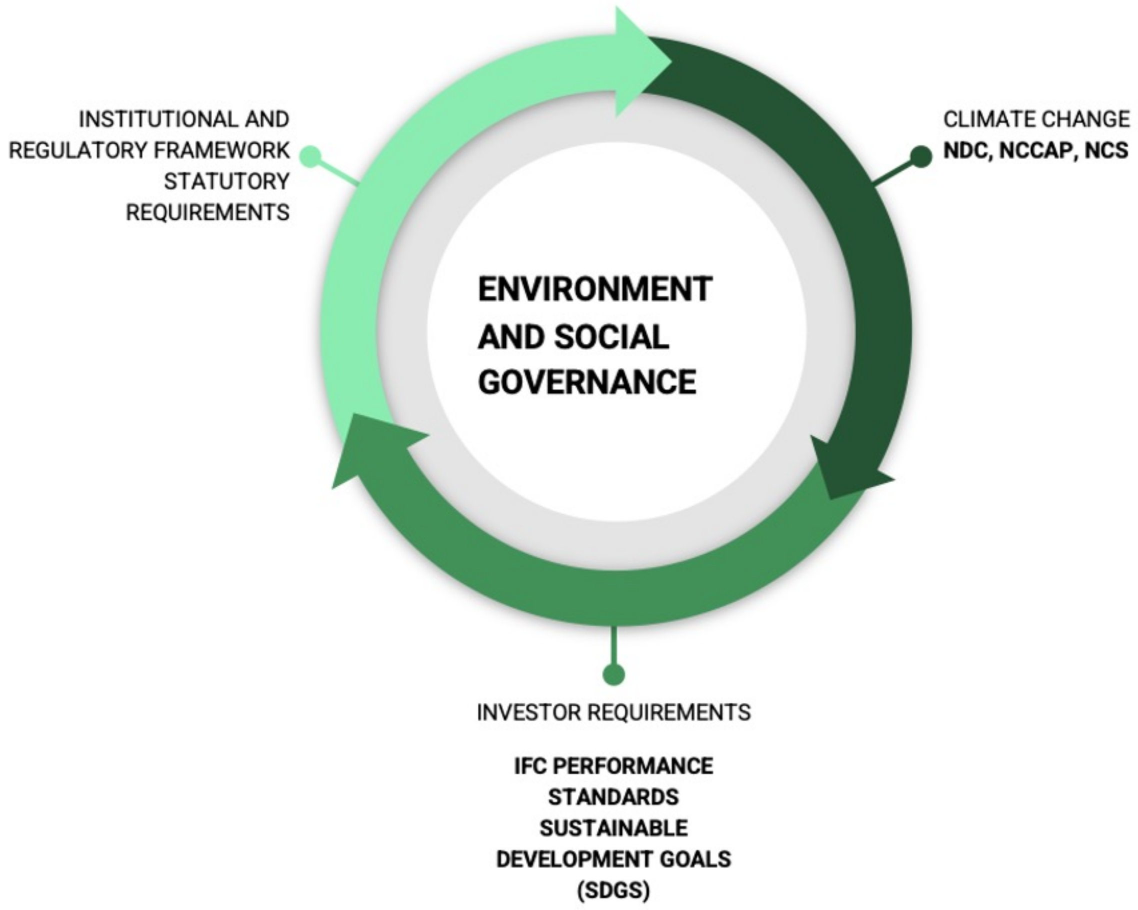
Operation

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: Fruit Drying

- The total capital cost of a newly constructed geothermal fruit drying plant with a 1-ton/batch capacity is estimated at USD 276,810 [UGX 984M]
- The operating costs for the first year of the fruit drying plant operation is estimated at USD 251,903 [UGX 895M] 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	1,339.65
Fruit peeling machine	3,500
Fruit Slicing Machine	1,500
Blanching machine	3,000
Pre-cooling machine	30,000
Packaging equipment	10,970
Total CAPEX ($ USD)	**276,810**

OPERATING EXPENSES	*Units*	Cost/Unit	1st Year (USD)
Cost of Fresh Fruit (incl. Transport)	US$/Kg	0.68	169,418
Electricity Costs	US$/kwh	0.16	7,796
Equipment O&M	% of CAPEX	10.0%	27,681
Labor (Non-payroll)	US$/hr	0.77	19,885
Payroll	US$/Yr	N/A	18,438
Insurances	US$/Yr	92	92
Equipment Leases	US$/Yr	-	-
Office and Admin Expenses	% of Rev	0.5%	1,591
Distribution/Marketing Expenses	% of Rev	0.5%	1,591
Utilities, Property Tax	US$/sqft	2.0	3,582
Packaging	US$/Kg	0.05	1,827
TOTAL OPEX			**251,903**
Opex Annual Inflator (%)		1%	

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Commercial Evaluation: Cost Comparison

- A **cost comparison analysis** was undertaken to compare the cost of geothermal fruit 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 fruit is sold at a price 50% less than the price assumed for other drying methods

Source: Van Nguyen et al., 2015.

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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 5% and 71% compared to wood-fired dryers and open-air sun drying, respectively.

	FRUIT DRYING ENERGY SYSTEMS COST COMPARISON			
	Open Air Sun Drying	Solar Drying	Wood	Geothermal
Capacity per Batch per Dryer (Kg)	10.0	1,000.0	1,000.0	1,000.0
No. of Batches per Year per Dryer	117	234	468	468
Max Annual Capacity per Dryer (Kg)	1,170.0	234,000.0	468,000.0	468,000.0
Volume of Fruit Processed per Year (Kg)	250,000	250,000	250,000	250,000
No. of Dryers Required	214.0	2.0	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)	$12,840.00	$8,828.80	$7,900.00	$9,060.00
Fuel Requirement (kg/Yr)	-	-	35,063.25	-
Fuel Costs ($/kg)	$0.00	$0.00	$0.18	$0.00
Annual Op Costs - Fuel ($/Yr)	$0.00	$0.00	$6,311.38	$0.00
Electricity Requirement (kWh/Kg)	-	-	0.2	0.2
Electricity Cost ($/kWh)	$0.00	$0.00	0.16	0.16
Annual Op Costs - Electricity ($/Yr)	$0.00	$0.00	$7,795.96	$7,795.96
Annual Op Costs - Labour ($/Yr)	$24,856.74	$19,885.39	$24,856.74	$19,885.39
Annual Maintenance Cost (% of CAPEX)	10%	10%	10%	10%
Annual Maintenance Cost ($/Yr)	$6,420.00	$17,657.60	$15,800.00	$22,650.00
Cost of Lost Revenue ($/Yr)	$159,167.94	-	-	-
Total Annualized Costs ($/Yr)	$203,284.68	$46,371.79	$62,664.08	$59,391.35
Total Annual Costs Savings ($/Yr)	$143,893.32	-$13,019.56	$3,272.73	
Total Annual Costs Savings (%)	71%	-28%	5%	

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Commercial Evaluation: Assumptions

Key Assumptions:

- Revenue: The local price of dried fruit was assumed to be USD 6.46/kg [UGX 22k/kg] based on the price of dried mango in Nairobi, while the export price of dried fruit was assumed to be USD 9.73/kg [UGX 34k/kg] based on Dutch CBI data. It was also assumed that 50% of the dried fruit 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 23.1% was assumed based on average local commercial bank rates in Uganda. It was assumed that the debt will be amortized annually over 10 years.

REVENUE	USD
Price of Dry Fruit - Local (USD/Kg)	6.46
Price of Dry Fruit - Export (USD/Kg)	9.73
% of Dry Fruit Sold Locally	50%
% of Dry Fruit Exported	50%
Price Escalation (Annual)	1%

TAXES	
Tax Rate (% pa)	30%

SOURCES	% of Total	$
Senior Debt	70%	193,767
Equity	30%	83,043
Grants/Rebate	0%	-
TOTAL	100.00%	276,810

SENIOR DEBT	
All-in Interest Rate p.a	23.1%
Term (Years)	10

Commercial Evaluation: Summary of Findings

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

- ✓ Average annual sales of 39,089kg of dried fruit
- ✓ Average annual revenue of USD 357,214 [UGX 1.27B]
- ✓ Average annual net income of USD 34,197 [UGX 121M]

The investment opportunity is attractive with:

- ✓ After-tax equity IRR of 20.52%
- ✓ After-tax project IRR of 21.88%
- ✓ Payback period of 8 years
- ✓ Net cashflow to equity investors of USD 854,919 [UGX 3B] over the 25-year life of the project

FRUIT DRYING RESULTS SUMMARY	
Avg Annual Sales (Kg)	39,089
Avg Annual Revenue	$357,214.26
Avg Annual Expenses	$284,581.31
Avg EBITDA	$72,632.95
Total CF to Equity	$937,962
Net CF to Equity	$854,919
Cash on Cash Return	10.29x
After Tax Equity IRR	20.52%
After Tax Project IRR	21.88%
Payback Year	8

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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 assumed production level of 250,000kg if:

- CAPEX increases by 40% to USD 388k [UGX 1.38B] and above
- OPEX increases by 20% to USD 302k [UGX 1.07B] and above
- Average price decreases by 20% to USD 6.5 [UGX 23K] 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 fruit processed falls below 250,000kg, underscoring the value of economies of scale.

- In conclusion, it is clear from the sensitivity analysis that a slight increase in the assumptions, particularly OPEX or decrease in prices will make the project unviable.

		CAPEX						
		$166,086	$221,448	$276,810	$332,172	$387,534	$442,895	$498,257
Quantity (Kg)	20.52%	-40%	-20%	0%	20%	40%	60%	80%
	100,000	NEG IRR	NEG IRR	NEG IRR	NEG IRR	NEG IRR	NEG IRR	NEG IRR
	150,000	5.99%	-1.66%	-6.91%	-13.90%	NEG IRR	NEG IRR	NEG IRR
	200,000	31.55%	14.89%	6.50%	1.37%	-2.37%	-5.48%	-8.55%
	250,000	67.74%	36.09%	20.52%	12.26%	6.72%	2.84%	-0.16%
	300,000	105.99%	63.44%	38.91%	24.74%	16.53%	10.97%	6.84%
	350,000	144.29%	92.07%	60.88%	40.83%	28.00%	19.87%	14.45%
	400,000	182.55%	120.80%	83.73%	59.17%	42.22%	30.56%	22.67%

		OPEX						
		$151,142	$201,522	$251,903	$302,283	$352,664	$403,044	$453,425
Quantity (Kg)	20.52%	-40%	-20%	0%	20%	40%	60%	80%
	100,000	8.02%	-5.82%	NEG IRR	NEG IRR	NEG IRR	NEG IRR	NEG IRR
	150,000	31.75%	10.88%	-6.91%	NEG IRR	NEG IRR	NEG IRR	NEG IRR
	200,000	64.86%	30.74%	6.50%	NEG IRR	NEG IRR	NEG IRR	NEG IRR
	250,000	100.04%	57.64%	20.52%	-5.07%	NEG IRR	NEG IRR	NEG IRR
	300,000	135.32%	86.57%	38.91%	4.66%	NEG IRR	NEG IRR	NEG IRR
	350,000	170.57%	115.70%	60.88%	14.65%	NEG IRR	NEG IRR	NEG IRR
	400,000	205.82%	144.82%	83.73%	25.99%	NEG IRR	NEG IRR	NEG IRR

		Price						
		$4.85	$6.47	$8.09	$9.71	$11.33	$12.95	$14.56
Quantity (Kg)	20.52%	-40%	-20%	0%	20%	40%	60%	80%
	100,000	NEG IRR	NEG IRR	NEG IRR	-8.18%	4.77%	17.39%	33.13%
	150,000	NEG IRR	NEG IRR	-6.91%	11.84%	34.54%	64.84%	96.69%
	200,000	NEG IRR	NEG IRR	6.50%	35.97%	77.08%	119.65%	162.22%
	250,000	NEG IRR	NEG IRR	20.52%	68.14%	121.32%	174.53%	227.68%
	300,000	NEG IRR	-3.91%	38.91%	101.69%	165.56%	229.36%	293.12%
	350,000	NEG IRR	3.14%	60.88%	135.31%	209.77%	284.17%	358.54%
	400,000	NEG IRR	10.17%	83.73%	168.91%	253.96%	338.97%	423.96%

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4. User Guide: Financial Model

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Financial Model: Entering Inputs

Blue Text	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.
Blue Text	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.
Black Text	Black text in grey cells denotes inputs that cannot be varied by the user. These cells should not be modified.
Black Text	Black texts in white cells are either in-built or calculated automatically. These cells should not be modified.

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 fruit to be processed annually should be entered in cell G25, while the average moisture content of fresh fruit and the desired moisture content of dried fruit should be entered in cells G26 and G27, respectively.
- The percentage of dried fruit 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 fruit 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

<u>**Plant Labor:**</u> The number of kilograms of fresh fruit 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.

<u>**Payroll:**</u>

- The list of the fruit 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 <u>commercial viability</u> and <u>attractiveness</u> 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.

Souce: Sun-Connect and Rural Electrification Agency

User Guide: Financial Model

QUESTIONS

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5. Next Steps

Kitagata Hot Springs (Source: Global Press Journal)

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 MEMD 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

GRMF
A Catalyst for Geothermal Development

GreenMax
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Thank You!

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