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FINANCIAL MODELING OF GEOTHERMAL POWER PROJECTS

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ABSTRACT

A financial model is an essential tool that helps to define key financial parameters of a project on the basis of which investors and financiers commit resources to a project, and governments, utilities or off-takers sign onto the project. The investors require knowing what funds they need to raise to make the project a reality and what the return is for their efforts. Financiers on their part wish to ascertain that the project will fully service the loan taken and make payment promptly when they fall is due. The approving authorities pursue value for money and therefore seek the most cost effective tariff.

Some of the information sought by the various stakeholders especially tariffs and return on investment cannot easily be determined. These parameters are derived best using financial models. The outputs of financial models typically take the format of pro forma financial statements which are prepared according to various accounting standards.

The data input into the model largely mirrors the key strategic decisions required for the project implementation. These strategic decisions relate to the resources to be committed to the project, their sources and the costs associated with them. For a geothermal project, it also reflects the assumptions made on the resource characteristics and project development costs. Putting together data that is representative for a geothermal project is the main challenge in carrying out a financial modelling exercise.

Optimizing models through computer based programing shows that the models can further help refine the implementation strategy and assist in evaluating impacts when changes occur in the assumptions made. For this reason, models are also useful tools for monitoring the project through the various development stages.

1. INTRODUCTION

A financial model is anything that is used to calculate, forecast or estimate financial numbers. Models can therefore range from simple formulae to complex computer programs that may take hours to run (Financewalk, 2014). From the inception of a project, investors who act as the project sponsors and providers of equity, want to know how much money they will need to raise to make a project a reality and what will be their benefits if they undertook the project. On the other hand, lenders who support the projects by providing debt wish to affirm that the project will generate sufficient money to fully

service the loans taken for their development in addition to promptly making payments when they fall due. Governments, utilities and off-takers only accept projects whose tariff is cost effective compared to alternative similar projects. Figure 1 shows the screening curves used to prioritize power projects using alternative sources under the least cost power studies in Kenya. From this figure, Kenya should only implement imports as the least cost source of power. Excluding imports for strategic reasons, only projects falling on the thick line in the figure are acceptable subject to the plant utilization.

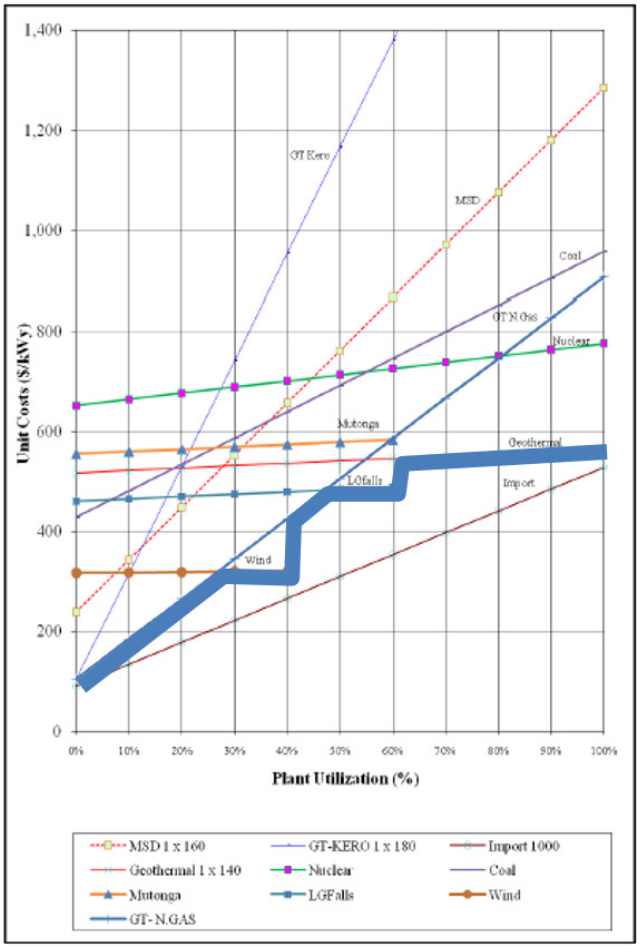

FIGURE 1: Screening curve
(KenyanMinistry of Energy, 2011)

A mostly representative set of financial performance data for a geothermal project cannot be easily derived. This arises from the fact that almost all geothermal resources are different and one cannot relate geothermal projects to one another to make accurate decisions. In addition, different project sponsors have different opportunities. Some have rigs and personnel within their organizations while others will hire. Further, the information sought by the various stakeholders is intricately related to the various costs and cost drivers. The cost drivers also behave differently under different conditions. Some of the cost and cost drivers include geothermal resource temperature and pressure, permeability and well output, enthalpy, level of non-condensable gases, adopted technology, required infrastructure, cost of financing as well as the underlying terms, cost of equipment, government policies and also macro-economic factors. At the inception of a project, it is therefore confounding to accurately determine the value of the bulk tariff, return on investment and pattern of cash flows and how they are affected by the various cost drivers without employing a financial model.

Three types of financial models are prepared in the life of a geothermal power project. The project inception model is prepared to demonstrate that the project financial prospects are attractive. It is normally a high level generic model prepared by the project team mainly based on assumptions made from general experience. The feasibility study financial model is more definitive. It is prepared by a third party. It is constructed mainly from extrapolated real data especially data relating to the resource. It is prepared after exploration and appraisal drilling. These two models are prepared for decision making points and are targeted at top management and financiers. A third and detailed model is prepared for the project development and execution team. It reflects much more details on the assumptions made, projected cost and budgets, strategy adopted and technology chosen. The model is a working document that is updated often as real data is obtained and decisions are arrived at. Its life continues from the strongly assumption based project inception financial model to the plant commissioning where real historical data is reflected. Optimizing models through computer based programing shows that the models can further help in refining implementation strategy and help to evaluate impacts of changes in the assumptions made. For this reason they are useful tools for monitoring the project through the various development stages.

A valuable financial geothermal model is one which integrates accurately all the costs throughout all phases of development and presents the resulting information in a manner to help various users make the appropriate decision. It should resolve the need for a competitive priced tariff, while indicating adequate cash flow to meet the project's, lenders' and investors' financial requirements.

2. FORMAT OF FINANCIAL MODEL

The output of the financial models typically takes the format of proforma financial statements. The statements, prepared annually in most cases, present the result and financial position of a company by a certain date. Four statements, namely income statement, statement of financial position (balance sheet), cash flow statement and statement of owners' equity are commonly prepared. However, for the purpose of analysis, the statement of the owner's equity is normally disregarded. The statements are adopted from the accounting profession and have been developed over a long period of time. In general, financial statements are designed to meet the information needs of investors. The investors have to make a decision whether a certain investment is viable and therefore worthy of committing personal financial resources to the investment. To afford comparability between entities, the statements are prepared in accordance with various standards including the General Agreed Accounting Principles (GAAP), International Financial Reporting Standard (IFRS) and other standards adopted by various countries (Investopedia, 2014).

2.1 Income statement

2.1.1 Template

The objective of the income statement is to establish the profitability of a business venture. It is founded on the matching principle. The principle requires that a company relates expenses incurred within a specific period to the revenue accruing over the same period in order to report the company's profitability during the specified period. Figure 2 presents the most typical template of an income statement. The main elements of a financial statement are revenue, expenses, depreciation, interest and tax. The gross profit, operating profit alternatively called earnings before interest and tax (EBIT) and net profit or Profit after tax (PAT) are some of the information obtained from the income statement.

PKN COMPANY
INCOME STATEMENT FOR THE PERIOD ENDING XX

		20X2	20X1
	REVENUE	82.29	82.29
	EXPENSES		
	O&M	5.35	5.35
	STEAM FIELD MANAGEMENT	0.68	0.68
	TOTAL EXPENDITURE	6.04	6.04
EBDIT	OPERATIONAL PROFITS	6.26	76.26
	DEPRECIATION	13.24	13.24
EBIT	EARNING BEFORE INTEREST & TAX	63.02	63.02
	INTEREST	1.96	2.27
EBT	EARNINGS BEFORE TAX	61.06	60.75
	TAX	18.32	18.23
PAT	PROFIT AFTER TAX	42.74	42.53

FIGURE 2: Sample income statement

2.1.2 Revenue

Revenue is the sales arising from the activities of a business venture. For a power project, it is a product of the net exported power and the agreed tariff.

2.1.3 Operating expenses

The operating expenses encompass all cost directly and indirectly associated with the generation of the sold energy. These include staff cost, spares, oils, cooling water where applicable, security and other administrative costs.

The cost also includes reservoir maintenance costs such as undertaking a steam status report, scaling management measures, well interference testing using tracers and pressure monitoring as well as maintenance of road and steam gathering systems. Often, costs of drilling and connection of make up wells are included as an expenses rather than capital. This is not standard as these costs may be appropriately described as capital costs. However, including them as expenses reduces the tax payment and improves cash flow.

2.1.4 Depreciation expense

Depreciation expense is that portion of the capital assets allocated to a specific period and used in the generation of revenue based on the matching accounting principle. There are various methods of determining depreciation. The two most common include a straight line depreciation and fixed percentage deduction. Computation of the capital cost includes interest during the construction period.

2.1.5 Interest

Interest expense is the cost of debt allocated to the period in consideration. The interest computation are determined by the amount of the principle loan, grace period provide and the loan tenure.

2.1.6 Tax

Tax is a compulsory contribution to state revenue, levied by the government on business profits or added to the cost of some goods, services, and transactions. For the purpose of the income statement, the business profit tax applies. The tax is computed on fixed tax rate. However, where tax based incentives are provided, the incentives may be deducted from the computed tax.

2.1.7 Computation

The net profit is computed as shown in the formula below:

$$Net\ profit = Revenue - total\ expenses - depreciation - interest - taxes \quad (1)$$

2.2 Cash flow statement

2.2.1 Template

The cash flow statement mainly accounts for the “physical” cash available to the organization whether at hand or in the bank. The amount of cash within an organization defines how much it can meet its financial obligation. An organization could register book profits but may become bankrupt if it runs out of funds to carry on day to day business. On the other hand, cash exceeding the organization’s day to day needs represent a lost opportunity to invest the same and have a better return. The GAAP is founded on an accrual principle. The accrual principle recognizes income or expenditure upon a sale or purchase transaction regardless of whether the transaction was on a credit basis. Therefore a cash flow statement tracks transactions involving cash and provides a cash balance in the possession of an entity at a given

time. Figure 3 shows the typical structure of a cash flow statement. The statement is divided into three major segments, the cash flow from operations, from investment activities and from financing activities.

ABC COMPANY
CASH FLOW STATEMENT FOR THE PERIOD ENDING XX

	20X2	20X1
A: Cash flow from operating activities		
Net profit	113	76
Adjustment for		
Depreciation	68	63
Other adjustments	-	-
Operating profit before working capital changes	181	139
Adjustment for		
Trade and other receivables	8	(45)
Inventories	(17)	(27)
Trade payables	42	(32)
Net cash flow from operating activities	395	174
B: Cash flow from investing activities		
Investment in assets		
Purchase of fixed assets	(146)	(168)
Sale of fixed assets	-	-
Net cash flow from investing activities	(146)	(168)
C: Cash flow from financing activities		
Proceeds		
Long term borrowing	192	139
Overdraft	-	-
Short term borrowing	-	154
Payments		
Long term borrowing	(88)	(100)
Short term borrowing	(128)	-
Dividend paid	(38)	(39)
Other	(101)	(94)
Net cash flow from investing activities	(163)	60
Cash flow summary		
Cash and cash equivalent at beginning of year	72	6
Net cash flow from operating activities	395	174
Net cash flow from investing activities	(146)	(168)
Net cash flow from investing activities	(163)	60
Net cash	86	66
Cash and cash in hand at end of year	158	72

FIGURE 3: Sample cash flow statement

2.2.2 Cash flow from operating activities

Net profit, depreciation, other non-cash deductions, and changes in working capital are elements that are included in the cash flow from operational activities. The first item in the cash flow from operating activities is the net profit obtained from the income statement. The net profit is based on the matching and accrual principles. This means that some non-cash items are included in the determination of the net profit. These include depreciation as well as production tax credit where such incentives are granted. They are added to determine the cash arising from operations.

Working capital is that portion of the financing that is locked in the business and is used to support the business by paying bills that become due such as salaries, spares and consumables, stationary and other

administrative and office expense. Some of the spares and consumables may be provided at credit and energy sales may also be on credit. Creditors and financiers evaluate the working capital of an organization as it serves to tell whether the company will pay its debts. The working capital therefore stands for several very important concepts; it serves as a measure of the ability of the firm to meet its most immediate financial obligations, it reflects the company's policy on credit and debt servicing, it reflects capital inherently retained by the business that will require financing and it also serves as a measure of financial efficiency by management during the operations and maintenance phase (Pandey, I.M., 2005).

Not all the net profit declared is therefore cash. Sales or revenue may have been sold on credit and some of the materials may have been bought on debt while some of the cash generated may have been investment in spares and consumables held in the stores. Thus an analysis is undertaken to correct that portion declared as net profit that is not physical cash (credit) or costs financed through debt or cash spent to stock items.

An estimation of working capital needs is complex requiring a wide range of considerations. Assuming a percentage of either total project cost or annual revenue is common practice.

2.2.3 Cash flow from investing activities

Initial capital expenditure, plant overhaul and make-up wells' cost and salvage value entail cash flow from investing activities (Pandey, I.M., 2005). Capital expenditure consumes cash and are the key aspects under this category. Proper accounting takes overhaul and makeup wells as capital expenditure. However, some analysts factor in these cost expenses and include them in the income statement. Tax reduction is the main motivation for such modelling. Salvage value is the residual cost after the plant is decommissioned. The sale of the decommissioned plant generates revenue to its owners. The difference in the cash inflows and outflows make the net cash flow from investing activities.

2.2.4 Cash flow from financing activities

The owners' financial contribution (equity), all kinds of debts that may include overdraft, long term loans, grants and other forms of cash incentives such as carbon credit contribute cash to the project while dividend payments takes away cash from the project. The difference of the cash inflows and outflows make the net cash flow from financing activities.

2.2.4 Computation

The net cash at end of a period is generally computed as shown in the formula below:

$$Net\ cash\ = PAT + Dep. - \Delta\ NWC + E + D - \ CAPEX - Rep. - Div + B/F \qquad (2)$$

where PAT = Profit after tax;
$Dep.$ = Depreciation;
$\Delta\ NWC$ = Change in net working capital;
E = Equity;
D = Debt;
Rep = Debt repayments;
$Div.$ = Dividend paid; and
B/F = Cash balance brought forward from previous period.

2.2.5 Free cash flow

Free cash flow may be viewed as the surplus funds that is available for distribution to equity and debt providers (Wikipedia, 2014). It is the most useful concept in calculating the project's and investor's internal rate of return. It is given by the following equitation:

$$FCF = EBIT\ (1 - T) + Dep. - \Delta\ NWC - CAPEX \quad (3)$$

where T = tax rate.

2.3 Statement of financial position (balance sheet)

2.3.1 Template

The statement of financial position reveals the sources of financing for the project and their total value and matches the same with the value of the various classes of assets held by the organization. Figure 4 shows a typical balance sheet template. The elements are categorized into two major groupings, the assets and the equity and liability.

XYZ COMPANY
STATEMENT OF FINANCIAL POSITION FOR THE PERIOD ENDING XX

	20X2	20X1
Current Assets		
Cash	126	114
Short term investment	42	20
Trade receivables	60	50
Inventory	38	28
	266	212
Fixed Assets		
Long term investments	28	44
Machinery	200	140
Buildings	240	80
Land	14	14
	482	278
Total Assets	748	490
Current Liabilities		
Creditors	40	30
Bills payable	20	10
Short term loans	60	30
	120	70
Long term Liability		
Long term loans	250	130
Equity		
Paid share capital	220	160
Premiums	24	0
Reserves and Surplus	134	130
	378	290
Total Equity and Liability	748	490

FIGURE 4: Sample of a statement of financial status

2.3.2 Assets

Assets are properties both tangible and intangible that an entity acquires using funds provided by the owners and creditors. The assets are further classified as current assets which are those assets that can be turned to money within one year and fixed assets which are assets procured for the purpose of carrying out the business.

The current assets include cash at hand and in the bank, accounts receivables or debt owed to the entity, inventory which includes consumables and spares used in the carrying on of the business, and any short term investments.

Fixed assets include land, buildings, equipment and machinery, vehicles and all other items used in the carrying out of business. Intellectual properties as well as copyrights fall within this category.

2.3.3 Equity and liability

Equity and credits/debts represent capital provided to the entity to conduct it business. Equity comprise owners' capital and where the firm is a limited public or limited company, equity may be in the form of paid up shares, premiums, surplus and reserves.

Liability may be further classified as current liability which is debt that will fall due within a year or long term liability. Liability may be in the form of supplier credit, overdraft/short term loans or long term loans.

The total value of assets is always equal to the total value of equity and liability. The main computation is given by the equation:

$$ASSETS = LIABILITY + EQUITY \tag{4}$$

3. INPUT DATA

Putting together representative data for inputting into the model is the main challenge in carrying out a financial modelling exercise. The data largely mirrors the key strategic decisions required for the project to be implemented. These strategic decisions relate to the resources to be committed to the project, their sources and the costs associated with them for the entire project's economic life. The costs to the project can be grouped into two major categories, capital and expenses. Capital cost in general are costs that accumulate during the project formulation and construction while expenses are direct and indirect costs incurred and accruing annually charged against revenue generated each year after the plant is commissioned. The expenses are directly dispensed off annually through the income statement. However, the capital expenditure is dispensed by depreciating them over time (Pandey, I.M., 2005).

The factors that drive costs of geothermal development comprise of infrastructure, plants and equipment, raw materials and consumables, nature of the resources, opportunities and other factors of production. The cost drivers can generally be categorized into eleven groups namely investment policy, project site specific costs, level of investment, plant design, construction and installation, operation and maintenance, financing and risk, taxes, investment incentives, macro-economic factors and assumptions made about the resource.

4. INFORMATION OUTPUT

Various groups of people take interest in a geothermal project. Governments, municipalities and utilities see an opportunity for serving their constituencies, investors realize business opportunities in order to make money, financiers seize the opportunity to issue loans, project management teams see employment and consumers seek cost effective services. All these groups seek different information from a project. Therefore a financial model is generally designed to provide information to serve the various groups. Collectively, the stakeholder wishes to know the tariff, capital requirement, internal rate of return, profitability, debt levels, liquidity levels, operating performance, cash flows, and projected financial performance.

4.1 Required capital and cash flow

The project cost is of interest to the investors, financiers and the project management team. The value is used to assess investors ability to provide equity, is a reference for setting debt ratio and for establishing testing of the viability of a business venture. Where the cost is spread over a number of periods, it is used to plan financier disbursement schedules.

4.2 Bulk tariff (Levelized Cost of Energy)

The cost of generating geothermal electricity is normally expressed on a kWh basis otherwise referred to as the levelized unit cost of electricity. Levelized Cost of Energy (LCOE) is the constant unit cost (per kWh or MWh) of a payment stream that has the same present value as the total cost of building and operating a generating plant over its life (Black and Veatch). It is an economic assessment of the cost of the energy-generating system including all the costs over its lifetime: initial investment, operations and maintenance, cost of fuel and cost of capital. It is a very useful industrial tool for comparing technologies with different operating characteristics. It is on this cost basis that the geothermal projects are evaluated for investment, approval and financing by prospective investors, governments, consumers or regulators and bankers or credit providers.

The LCOE is determined through an iterative process during modelling.

4.3 Financial performance

The project's financial performance is a key concern to all stakeholders. Capital budgeting tools are used to evaluate financial performance of a project vis-à-vis alternative projects. The capital budgeting tools include break even analysis, payback period, net present value analysis and the internal rate of return.

Further to the capital budget tools, ratios are used to interrogate the model. The most commonly used ratios are profitability, debt service, leverage, and liquidity ratios.

5. COMPUTER MODELING

A spreadsheet software such as Microsoft Excel or similar software is most frequently used as the platform for financial modelling. A proper understanding of geothermal cost factors, skill in MS-Excel and basic financial and accounting knowledge will enable the development of a geothermal financial model with an adequate level of accuracy. Incorporating an iterative computer program helps greatly in understanding the behaviour of the key parameters and their effect on the tariff, total capital requirement and internal rate of return.

6. MODEL OPTIMIZATION

The primary target of a financial modelling exercise is to determine the lowest tariff, lowest capital requirement and the highest profit possible with stable cash flows. Ngugi (2012) has shown that the various geothermal project cost factors impact the tariff and capital cost in different ways. Some have a direct relation while others an inverse relation. Table 1summarizes the effect of the various cost drivers on the tariff and total capital expenditure. For this reason, Ngugi has postulated that for a set of financial model input data there is an optimal point where certain values for each of the drivers give the lowest tariff.

7. MODEL ACCURACY

There is an inherent risk associated with data obtained from a financial model. This is because the various cost factors are intricately interlinked and the fact that certain key factors are assumed. It is recommended that a sensitivity analysis be performed to evaluate the impact of changes in any of the assumed factors.

TABLE 1: Relationship between cost drivers, tariff and capital expenditure

Cost drivers	**Relationship tariff**	**Relationship to capital expenditure**
	Relationship	Relationship
Well output (1.5-21 MW)	inverse	inverse
Debt interest (0-12%)	direct	direct
Payback period (5-12 years)	inverse	None
Drilling cost (US$ 3.5 -9.5 million at 1.5 MW)	direct	direct
Project size/fix costs (20-400 MW)	inverse	inverse
Leverage (40-80%)	inverse	direct
Return on equity (12% - 22%)	direct	none
Plant capital cost (US$ 1.5 -3 million)	direct	direct
Loan term (7 -25 years)	inverse	none
Early generation (wellhead, 0-60% of designated plant size)	inverse	inverse
Operation & Maintenance cost (US$ 0.005 – 0.009)	direct	none
Steam decline (0-3%)	direct	none

8. CONCLUSIONS

A financial model is an essential tool that helps stakeholders evaluate the attractiveness of a project. The model provides them with information that they need to make decisions. The stakeholders wish to know the tariff, capital requirement, internal rate of return, profitability, debt levels, liquidity levels, operating performance, cash flows and projected financial performance. The information sought by the various stakeholders is intricately interlinked with the various costs and cost drivers. It is therefore difficult without a model to adequately derive that information.

The models typically take the format of proforma financial statements. Three statements, namely income statement, statement of financial position (balance sheet), and cash flow are commonly prepared when modelling. The primary target of a financial modelling exercise is to determine the lowest tariff, lowest capital requirement and the highest profit possible with stable cash flows. A valuable financial geothermal model is one which integrates all the costs through all the phases of development and presents the resulting information in a manner to help various users make appropriate decisions. For every set of data used in modelling, an optimal point can be obtained where certain values for each of the cost/cost drivers give the lowest tariff.

There is an inherent risk associated with data obtained from a financial model and it is recommended that a sensitivity analysis be performed on the effects of possible changes to the input data.

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