ETM

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Title: A Multi-Objective Economic Model to Assess and Evaluate Capital Expenditures Associated with a Foreign Utility

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Abstract: The privatization of the global energy market has presented unique problems and issues to domestic firms investing in foreign utilities. With these new problems and issues, the need arises for unique and creative solutions. This need has been the driver for the development of this multi-objective economic model developed herein. The overall goal of this model is the maximization of the incremental cash flow from the investment and ultimately the net operating cash flow for the company.

A Multi-Objective Economic Model to Assess and Evaluate Capital Expenditures Associated with a Foreign Utility

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Introduction

The privatization of the global energy market has presented unique problems and issues to domestic firms investing in foreign utilities. These problems and issues range from poorly maintained facilities, to theft in the distribution system, to foreign currency exposure. With these new problems and issues, the need arises for unique and creative solutions. This need has been the driver for the development of this multi-objective economic model developed herein.

One problem area that requires a complete solution is related to the meter and invoicing function. The purpose of this project is the development of a model that will assist utilities in evaluating the most effective strategy to replace defective meters. The magnitude of the required meter replacement with foreign utilities is enormous-with some utilities requiring up to a 30 percent meter replacement. This can lead to an enormous financial burden on a company [1].

The overall goal of this model is the maximization of the incremental cash flow from the investment and ultimately the net operating cash flow for the company.

Problem Statement

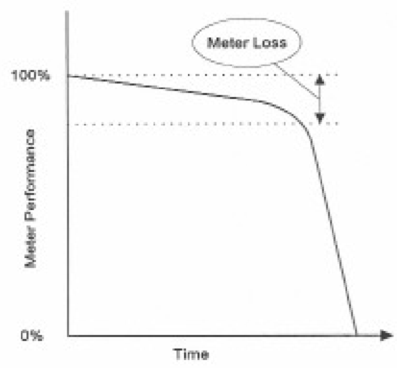
The model that is presented herein is developed to model the financial constraints associated with the issue of meter replacement. Financial constraints within a company limit the funds available for a project. The model will assist the decision-maker in determining an investment alternative that will add value and a higher rate of return to the company and ultimately the shareholders.

Presented in the following is a discussion of the issues addressed by this model.

Meter Function

Meters are the cash registers of the utility. They bring in revenue for delivered energy every month. However, meters become inaccurate due to weather, time usage and damage. This inaccuracy causes the meter to run slower than it should, therefore reading lesser than the actual amount of the energy provided. This difference is revenue loss to the company. The performance of these meters is illustrated on Figure 1.

Figure 1: Meter Performance



In addition, not all meters age equally. Some may last many more years than others, but generally specific brands, design, and year can be isolated. Oftentimes a utility does not have an inventory of when and where specific meters were installed. When a foreign utility company is purchased, the purchaser must determine the optimum strategy of replacing the defective meters. This strategy will impact the financial strength of the company.

Technology has improved in meters over the last several years. One improvement has been a decrease in cost of digital meters. Digital meters can directly replace a mechanical meter, affording no advantage, or they can be linked together with other enabling technologies to increase billing cycle.

Invoicing Function

In order to invoice a customer the meter must first be read. This reading activity historically has been labor intensive and has followed a monthly cycle. Recently, technology has been applied to this activity increasing the rate of meter readings with reduced errors.

Once the electrical usage is determined, a fee must be calculated. This task is usually completed by downloading into a processor to develop an invoice. In the most basic view, a customer pays for energy consumed as measured in kilowatt-hours (kWh). However, not all customers pay the same rate for each kWh of energy. A typical schedule of energy tariffs is presented in Table 1.

Table 1
Energy Tariffs

Customer Types	Price per kilowatt-hour in USD
Residential: Under 200 kWh per Month	0.02
Residential: Between 200 And 300 kWh per Month	0.04
Residential: Between 300 And 600 kWh per Month	0.09
Residential: More Than 600 kWh per Month	0.12
Commercial	0.08
Industrial	0.06

Normally, among the different types of customers, commercial and industrial customers effect the largest portion of the total energy used and make up very few accounts, usually less than 50%. Therefore, when meter replacement is required the decision-maker can prioritize meter upgrades to these types of customers by installing digital meters. The model that is developed herein will model the meter upgrades to three of the four customer types, residential, commercial, and industrial. It is assumed that the low-end energy user under the heading of other will not have meters installed. The decision-maker will have the option to install digital or mechanical meters for the three customer types.

Digital meters, in conjunction with enabling technologies have seen the invoicing cycle reduced to a daily occurrence with readings done every hour, invoice calculation based upon the hour the electricity was needed and ultimately payment each day.

Increasing the invoicing cycle can improve revenue, especially in an inflationary environment commonly found in developing nations. This can be done by reading the meters more often and invoicing sooner. For the purpose of this model, we are assuming that invoicing and payment is in sequence. The model assumes monthly or bi-monthly invoicing.

Model Development

Technical

Investment decisions require the analysis of the incremental project cash flows and the impact of these cash flows on the financial health of the company [2].

The company cash flows are developed with and without investment in new meters. Free cash flows are developed from the company baseline conditions plus a growth factor and/or inflation factor.

The project cash flows are developed from decision-maker defined investment scenarios. These scenarios will be discussed in detail below.

The company cash flows are divided in to various streams; including the revenue from customers, cost of energy, taxes, etc. as shown in Figure 2. The cash flows can be affected by inflation and growth. Growth is defined as an increase in customers and is considered uniform over the customer types. The cash flows represent the company. They are modeled to evaluate performance with and without the incremental cash flow increase from the project.

The customer revenue is segmented into four cash flows, residential, commercial, industrial, and others. The other category consists of un-metered customers that pay at a flat rate. These cash flows are illustrated in Figure 3.

The information required for developing the company cash flow is:

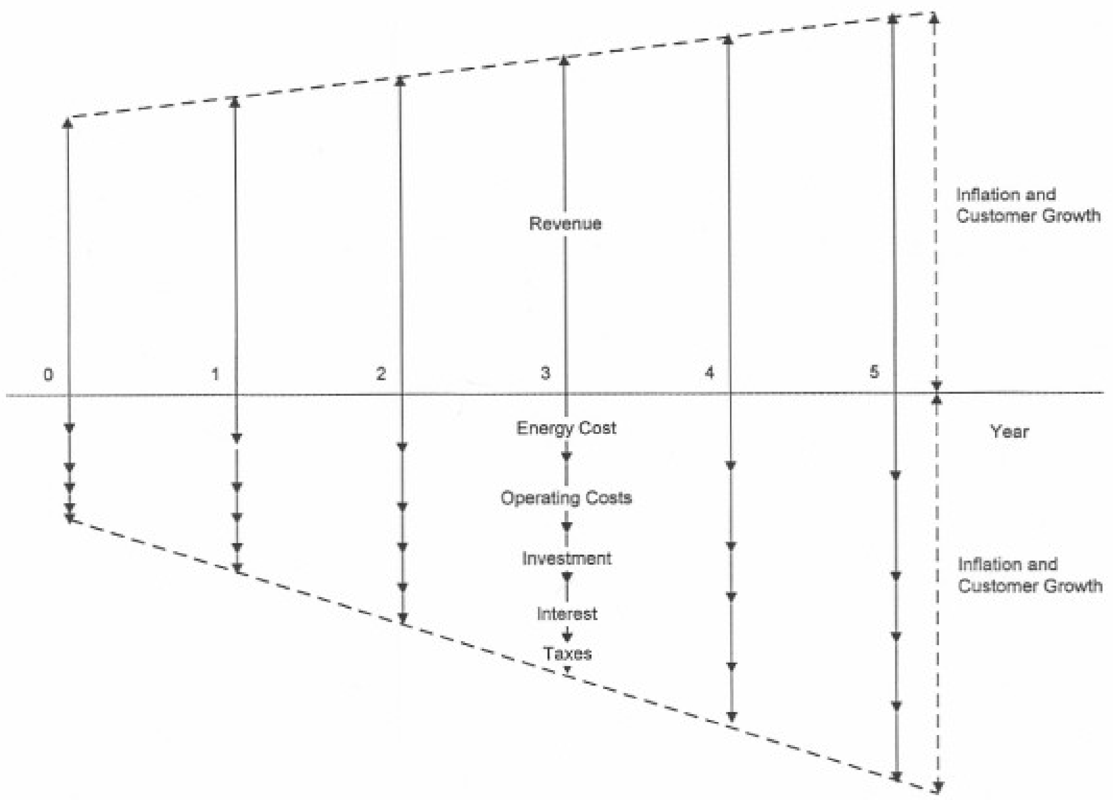
Revenues:

- Electricity tariff schedule
- Customer growth rate

Expenses:

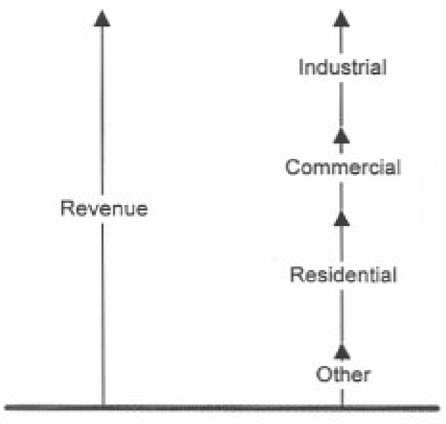
- Energy cost
- Operating costs
- Taxes

Figure 2: Company with Project Cash Flow



There are various tariff rates for residential customer type. To simplify the problems, the average fee payment per customer is developed in the model from the customer profile developed by the decision-maker. The average fee schedule per customer is obtained by dividing the total predicted revenue for year n by the number of customers in year n. Average fee calculations are also used for commercial and industrial customers. The average fee is affected by inflation as discussed below.

Figure 3: Incremental Cash Flow



The cash flow for the company is developed as an annual cash flow. The evaluation period for this analysis is 5 years.

Project Cash Flow

As stated above, the revenue cash flows for both the company and the project are segmented into four cash flows. Each cash flow simulates the investment and revenue (and other associated cash flows) from replacing defective meters within each customer type. The cash flows are also segmented as needed to simulate technology benefits, as applicable.

The cash inflows and outflows affected by meter replacement are:

- The revenue stream from customers whose meters have been replaced.

- A decrease in operating costs due to technology.
- The investment for each meter including equipment and installation.

The decrease from operating costs related to the replacement of defective meters is associated with meter reading and invoicing.

The new meter installation cost includes the cost of the new meter and labor cost associated with the installation.

The revenue stream from the customers includes the gain from the meter loss savings and the time value of money from the increased billing cycle. They both vary with each type of meter.

determined, and combined in to a total monthly cash flow. The combined cash flows are illustrated in Figure 4.

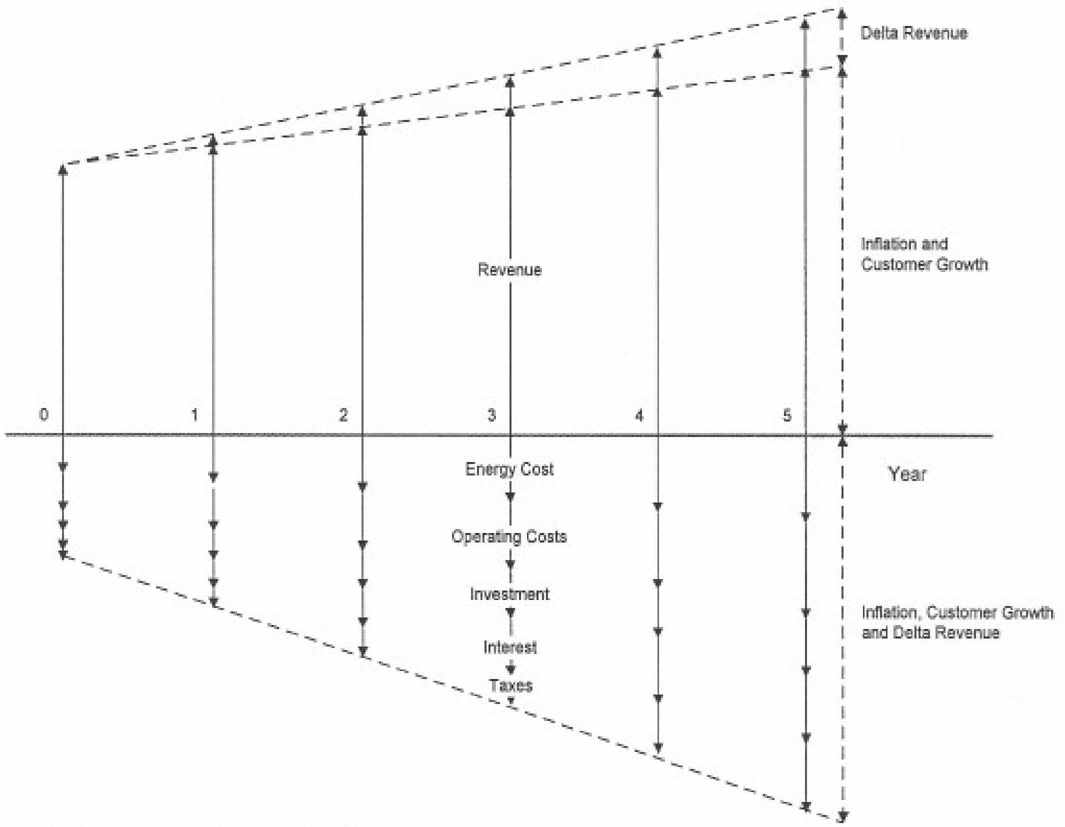
In addition, the average energy rate as effected by inflation for the year is required. The effect of inflation in the model is discussed in more detail below.

The incremental cash streams per period are represented in Figure 5 and modeled as:

Value of Revenue = $R_n / 2 \times [1 + (i / (n \times 12))] + R_n / 2$

Where:
R_n = Revenue of period n
i = Interest rate per year
n = Number of periods per month-equal to 1 (monthly) or 2 (semi-monthly)

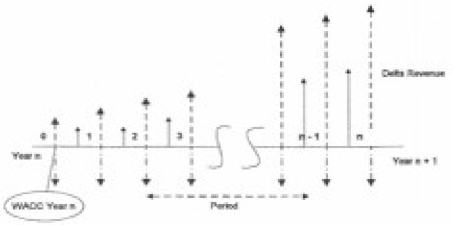
Figure 4: Company with Project Cash Flow



The billing cycles for digital meters are reduced as compared to mechanical meters. The cash flows for mechanical meters and digital meters are separated in the model. To represent the impact to revenue from the change in the billing cycle, the future value for each segmented cash flow is

Cash flows associated with revenue and costs associated with the project cash flow are outlined in equations 1 to 4.

Figure 5: Annual Cash Flow Represented by n Periods of Revenue



Equation 1:

$$\text{Meter Loss} = \text{Meter Loss Percent} \times \text{Number of Meters Replaced} \times \text{Average Payment per Customer}$$

Equation 2:

$$\text{Operating Cost Savings} = \text{Operating Cost Savings per Unit} \times \text{Number of Meters Replaced}$$

Equation 3:

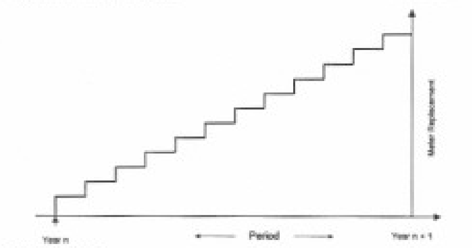
$$\text{Installation Cost} = (\text{Meter} + \text{Labor Cost}) \times \text{Number of Meters Replaced}$$

Equation 4:

$$\text{Billing Cycle Value} = [\text{Revenue per Month}/2 + \text{Revenue per Month}/2 \times (1 + i/(n \times 12))] - \text{Revenue per Month}$$

The decision-maker will determine the number and types of meters to be replaced on a yearly basis constrained by financial limitations. The meter replacement schedule is modeled as a step function as illustrated in Figure 6. The decision-maker will input the number and type of defective meters replaced per year.

Figure 6: Meter Replacement



Assumptions

The assumptions used in technical model are:

1. The growth rate per customer and customer type is uniform over the 5-year period.
2. The initial revenue includes the loss from defective meters. The revenue for years one to five includes the loss from defective meters for customers that have not been upgraded. New customers are treated as existing customers.
3. The costs associated with the new customers are not included in the project investment.
4. The revenue for each customer is averaged per customer type.
5. Meter replacement is completed in equal number of replacements per period.
6. Meter loss savings, operation cost savings, and installation costs only impact customers whose meters are replaced as part of the project.

Financial

The impact of the capital investment project on the financial performance of the company is evaluated under three scenarios. The scenarios will allow the decision-maker flexibility in minimizing the expenditure profile while allowing the decision-maker to use subjective in-country constraints. These constraints limit the investment alternatives. The three scenarios are:

- Base case (status quo) - where the system is allowed to function under the initial conditions with no new capital investment.
- Conditions of no external funding – retained earnings are used to finance capital investments.
- A condition of external debt financing – retained earnings and debt are used to finance sustainable growth.

All three methods have an assumed growth rate and inflation as part of the standard inputs.

The three alternatives are essential to evaluating the financial improvement from the capital investments. The base case is the "yard stick" to measure the financial performance of the capital investments. The internal growth rate (IGR) is a function of the companies ability to finance its growth with retained earnings with no additional debt. The internal growth rate that is achievable is dependent on the financial strength of the company. Sustainable growth rate (SGR) is also a function of the financial strength of the company and combines retained earnings with debt to finance growth. The debt to equity ratio is held constant during this analysis. To increase the SGR a firm must either use its assets more efficiently or modify its financial structure. The efficient use of assets includes increasing the profit margin or reducing its assets. Modifying its financial structure includes changes in the dividend retention rate and/or assets such as accounts receivable.

Financial Growth

The impact of the capital investment on the financial performance of the company is evaluated by determining the additional funds needed (AFN) that corresponds to the increase in financial performance [3]. AFN is related to performance by equation 5.

Equation 5:

$$AFN = \text{Required Increase in Assets} - \text{Spontaneous Increase in Liabilities} - \text{Increase in Retained Earnings}$$

$$AFN = (A^*/R_n)\Delta R - (L^*/R_n)\Delta R - MR_{n+1}(1-d)$$

Where:

A^* = assets that must increase if revenue increases
R_n = revenue at time n
R_{n+1} = revenue at time n + 1
L^* = liabilities that must increase with the change in revenue
M = profit margin (net income/revenue)
d = dividend payout ratio

The rate of growth that is funded by retained earnings is known as the internal growth rate (IGR). The premise around the IGR is that growth is funded internally from within the project [4]. The growth is not funded by debt or new equity. The IGR is given by equation 6.

Equation 6:

$$IGR = [ROA \times b] / [1-(ROA \times b)] = [NI/Assets \times b] / [1-(NI/Assets) \times b]$$

Where:
ROA = return on assets
b = retained earnings ratio
NI = net income

The rate of growth that is funded by retained earnings plus debt is known as the sustainable growth rate (SGR). The premise around the SGR is that growth is funded by retained earnings plus debt. The growth is not funded by additional new equity. The SGR assumes an optimal debt to equity ratio. The SGR is given by equation 7.

Equation 7:

$$SGR = [ROE \times b] / [1-(ROE \times b)] = [NI/Equity \times b] / [1-(NI/Equity) \times b)]$$

Where:
ROE = return on equity

Financial Cost

The weighted average cost of capital (WACC) is an estimate of the required expected rate of return for the capital of the firm [3]. A firm's cost of capital reflects the overall cost of capital to the firm and the differential risk between the firm's existing projects and the project being evaluated. Risk is a major concern with investment in foreign environments [5]. Th risks include political, financial, economic, and others. A risk adjustment for foreign currency is included in the WACC. The risk adjustment for foreign exchange exposure is discussed in Appendix A.

The WACC is dependent on the capital structure of the firm and as such changes as the capital structure of the firm changes. The model uses both a Year 0 WACC and a Year n WACC for the determination of the optimal financial strength of the company. The WACC is estimated by equation 8.

Equation 8:

$$WACC = [k_d \times (1 - t) \times w_d] + (k_e \times w_e) + k_r$$

Where:
k_d = pretax cost of debt
t = marginal tax rate
w_d = proportion of debt in a market-value capital structure
k_e = cost of equity
w_e = proportion of equity in a market-value capital structure
k_r = cost of risk

The cost of equity is determined by the dividend valuation model. The model gives the expected return on the equity based on the current dividend and the expected growth of the firm [3]. The cost of equity is determined from equation 9.

Equation 9:

$$k_e = [D_o \times (1 + g)/P_o] + g$$

Where:

D_o = the dividend in the given year

P_o = the current price of common stock
g = the expected growth rate

Inflation/Escalation Rates

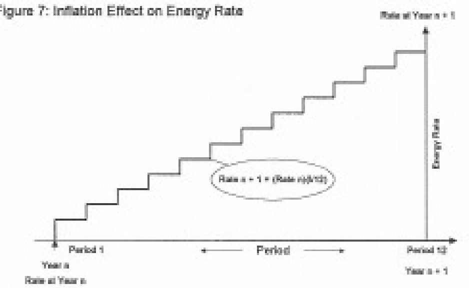
Inflation is incorporated into the project as appropriate. The areas that are affected include:

- Energy Billing Rates
- Operation Costs
- Operating Costs
- Others

Energy costs are handled by including an inflation/escalation rate. This approach allows the decision-maker to increase/decrease the price of energy as the national economics dictates. Long-term contractual agreements can effect the price differently than market factors.

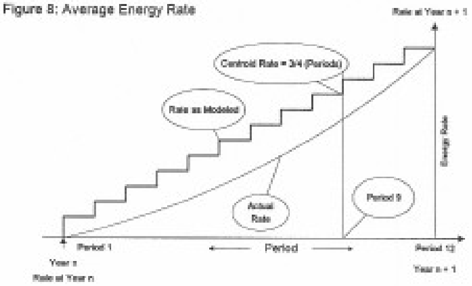
The determination of revenue impacted by the effects of inflation on the energy rate is developed as shown on Figure 7.

Figure 7: Inflation Effect on Energy Rate



The inflation is modeled as a step function and is compounded by period. The average energy rate increase from inflation effects is determined as the centroid of the area as shown in Figure 8.

Figure 8: Average Energy Rate

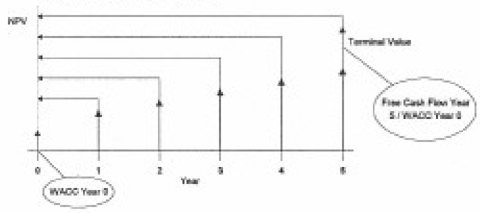


Financial Performance

In order to determine the investment schedule, given the subjective limitations imposed by the decision-maker, net present value (NPV) and adjusted present value (APV) for the project are determined. In addition, the APV and NPV for the company are determined to aid the decision-maker in comparing the base condition to the investment alternatives.

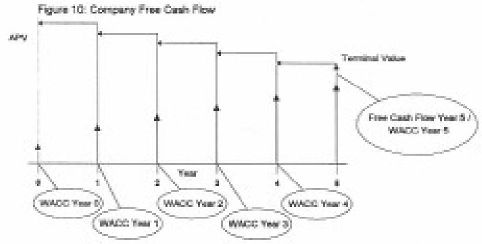
The NPV is determined by discounting the cash flows from the project and company, by the company's cost of capital at Year 0 as shown on Figure 9.

Figure 9: Company Free Cash Flow



The company's APV is determined by discounting the cash flows from the project and company by the cost of capital, with the cost of capital as determined by equation 8. This allows accounting for the change in the capital structure and therefore the cost of capital for the firm. The adjusted present value is the discount values of the project cash flows at time zero as shown in Figure 10.

Figure 10: Company Free Cash Flow



In order to evaluate the financial performance of the investment on the company, a number of macro economic and capital structure functions must be determined. This required information includes macro economic functions, growth rate, initial capital structure, and others as listed below.

Assumptions

The financial assumptions used in the model are:

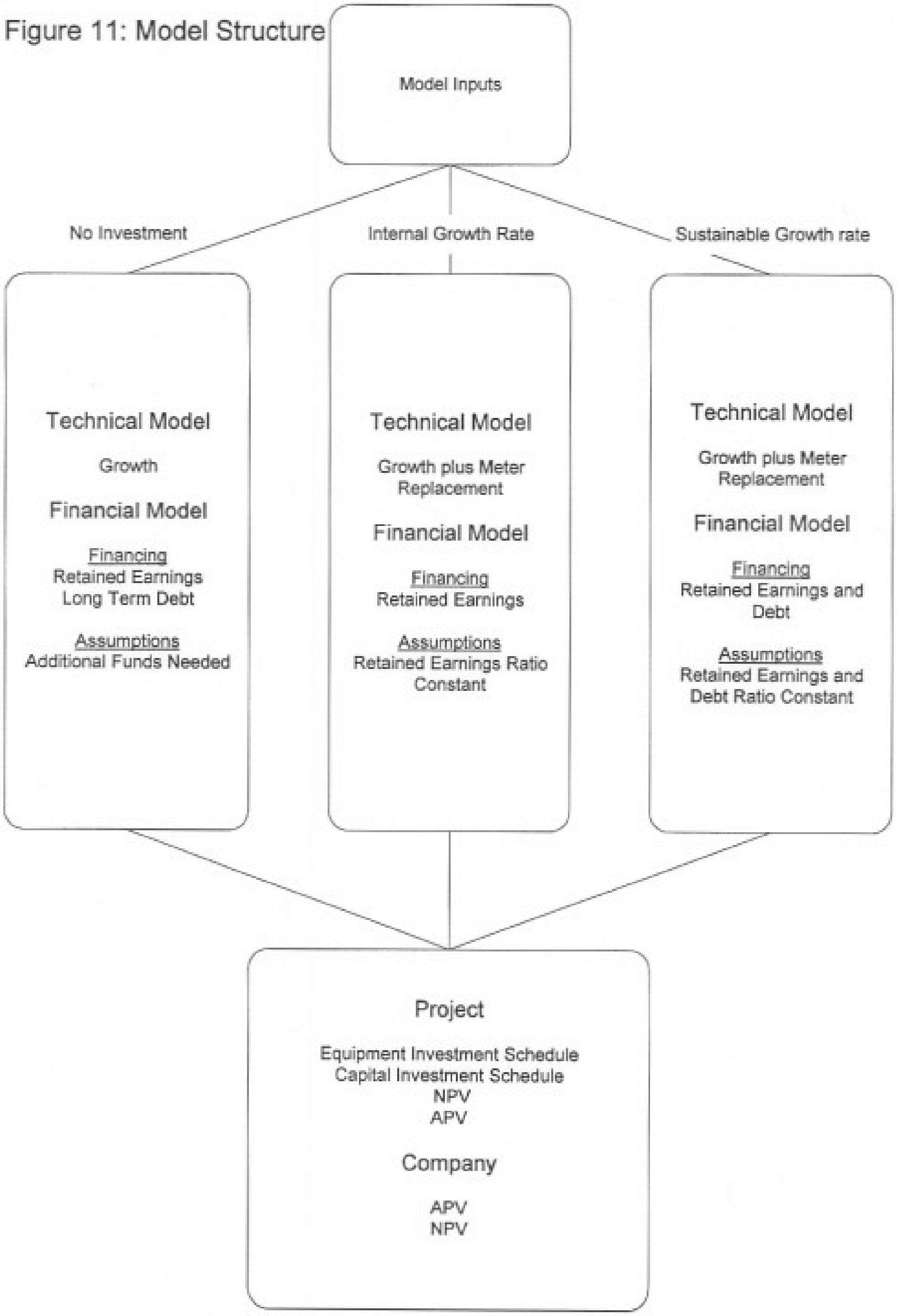
1. The retained earnings ratio remains constant.
2. The impact from the upgrades is assumed linear during the period.
3. Current book and market values are the same.

These assumptions are used to place boundaries on the model.

Model

The model will give the decision-maker a tool to evaluate the potential for increasing the company value associated with the three scenarios described above and expanded below. The model structure is shown on Figure 11.

Figure 11: Model Structure



The figure illustrates how the model is structured into four inter-linked files. The Company Main file is the master file where the base line conditions are entered and the results are tabulated. The other three files, Company, Company IGR and Company SGR are used to develop the scenarios.

The model files/work sheets are presented in Appendix B.

Base Conditions

The base condition scenario will allow the evaluation and comparison of the growth without investment, except to meet growth needs. As stated previously, growth is defined as new customers and is independent of the meter replacement project.

Following the initial setup of the model the two step process in the evaluation is:

Step 1 – Determine the additional funding needs as determined by the model.
Step 2 – Increase long-term debt (the plug) for each year to meet the basic accounting equation. The long-term debt needs are shown in the user interface worksheet (See Appendix B).

The iterations continue up to a five-year forecast at which point the cash flow is treated as perpetuity.

Internal Growth Rate

The internal growth rate will allow the determination of the allowable growth with retained earnings. The method assumes that assets grow at the same rate as retained earnings. The steps are:

Step 1 -- Calculate the internal growth rate for year n.
Step 2 -- Determine the capital investment schedule (meter replacement) that equates the ΔA percentage to IGR.
Step 3 – Increase long-term debt for each year to meet the basic accounting equation. These long-term debt needs are shown in the user interface worksheet (See Appendix B).
Step 4 – Go to step 2.

The iterations continue up to a five-year forecast at which point the cash flow is treated as perpetuity.

Sustainable Growth Rate

The sustainable growth rate will allow the determination of the allowable growth with retained earnings and debt. In theory, the method assumes that the debt ratio is constant. However, in the model the ratio is allowed to vary with time. The steps are:

Step 1 -- Calculate the sustainable growth rate for year n.
Step 2 -- Determine the capital investment schedule that equates the ΔA percentage to SGR.
Step 3 – Increase long-term debt for each year to meet the basic accounting equation. These long-term debt needs are shown in the user interface worksheet (See Appendix B).
Step 4 – Go to step 2

The iterations continue up to a five-year forecast at which point the cash flows are treated as perpetuity.

Model Input

The required input for the model is described below. The input is presented in Appendix B.

Technical

The model inputs include the initial conditions for year 0. The required information is presented in Table 2.

Table 2
Technical Data

Input	Acceptable Format
Customer Information	
Type	
Residential	Integer[1]
Commercial	Integer
Industrial	Integer
Others	Integer
Customer Growth Rate	
Average Yearly Growth	Percentage
Meter Information	
Mechanical Meter	
Equipment Cost	Currency per unit
Installation Cost	Currency per unit
Digital Meter	

Table 2 Technical Data	
Input	**Acceptable Format**
Equipment Cost	Currency per unit
Installation Cost	Currency per unit
Technical Advantages	
Mechanical Meter	
Revenue Increase	Percentage
Meter Loss	Percentage
Digital Meter	
Technology Investment - Year 1	Currency
Revenue Increase	Percentage
Meter Loss	Percentage
Annual Operation Savings	Currency per Year
Payment period per Month	Integer (1 or 2)

1) Shaded area is required input

Energy Schedule

The model requires the energy schedule for the company energy tariffs. The required information is presented in Tables 3 and 4. The energy costs as well as the escalation factor is input under the company financial data.

Table 3 Energy Schedule Residential		
Tariff Schedule		
Residential		
Ave Kwatts	Customer Percentage	Tariff
Numerical	Percentage	Currency per Unit

Table 4 Energy Schedule Commercial/Industrial	
Input	**Acceptable Format**
Commercial	
Average Annual Energy Usage per Customer)	KWatt
Monthly Energy Usage per Customer	KWatt
Tariff	Currency per Unit
Industrial	
Average Annual Energy Usage per Customer	KWatt
Monthly Energy Usage per Customer	KWatt
Tariff	KWatt
Other	
Average Revenue Per Customer	Currency per Month

Table 5 presents the data requirements for the meters to replace. The model allows the decision-maker to input the required meters to replace by customer type.

Table 5 Meters to Replace	
Input	**Acceptable Format**
Residential	Percentage
Commercial	Percentage
Industrial	Percentage

Investment Schedule

The model allows the decision-maker to develop the schedule for meter replacement based on financial limitations presented below. The required information is presented in Table 6.

Table 6 Meter Replacement Schedule	
Input	**Acceptable Format**
Total Number of Meters to Replace	
Mechanical Meters	
Residential	Units per Year
Commercial	Units per Year
Industrial	Units per Year
Digital Meters	
Residential	Units per Year
Commercial	Units per Year
Industrial	Units per Year

Financial

The model inputs include the initial conditions for Year 0. The required information is presented in Table 7.

Table 7 Financial Data	
Input	**Acceptable Format**
Macro Economic Functions	
Foreign Inflation Rate	Percentage
Exchange Rate Risk Factor	Percentage
Marginal Tax Rate	Percentage
Beginning Capital Structure Functions	
Target Debt Ratio	Decimal
Retained Earnings Ratio	Percentage
Expected Growth rate of Dividends	Percentage
Debt Repayment	
Long Term Debt	
Principal	Currency
Interest Rate	Percentage
Term	Years
New Long Term Debt	
Interest Rate	Percentage
Term	Years
Short Term Debt	
Principal	Principal at Time 0
Interest Rate	Percentage
Energy Costs – Year 0	
Energy Cost	Currency
Escalation/Inflation per	Percentage

Table 7 Financial Data	
Input	**Acceptable Format**
Year	
Balance Sheet Data – Year 0	
Cash	Currency
Account Receivable, Net	Currency
PP&E, Net	Currency
Accounts Payable	Currency
Equity	Currency
Income Statement Data – Year 0	
Revenue	Currency
Operating Costs	Currency
Depreciation	Currency
Debt Payment	Currency
Interest Payment	Currency
Provision for Income Taxes	Currency
Retained Earnings	Currency

Model Output

The model output includes parameters that are required for the decision-maker to evaluate the value added to the company from the project. These outputs will allow the decision-maker to subjectively weight the alternatives to determine the investment schedule. The output is presented in Appendix B and includes:

- Project
  - Equipment Investment Schedule
  - Capital Investment Schedule
  - NPV
  - APV
- Company
  - NPV
  - APV
  - WACC

The output from the model includes company and project cash flow statements for years one to five. These statements include:

- Cash Flow Statement of Base Case (Company without projects)
- Cash Flow Statement of New Scenario (Combination of base case and projects)

In addition, other more details of working statements include:

- Billing payment from initial information
- Annual project cash flow
  - Residential Customers
  - Commercial Customers
  - Industrial Customers

The output from the model includes Pro Forma financial statements for years one to five. The statements include:

- Balance Sheet
- Income Statement
- Cash Flow Statement

In addition, other working statements include:

- Other Financial Ratios
  - Current Ratio – Current Liabilities to Current assets
  - Debt Ratio – Total Long-Term Debt to Equity
  - Times Interest Earned – Earnings Before Income Taxes to Interest Expense
  - Return on Assets
  - Return on Revenue
  - Return on Equity
- Debt Schedule
- WACC Schedule including Risk Factor

These results will allow the decision-maker to weigh the alternatives to make the most optimal subjective

Limitations

As with all models, the output needs to be evaluated and compared to the input scenarios. The limitations and variability of the input can have a compounding effect on the output.

Scenario

The scenario presented is for a large utility in India. The utility is fictitious with only local risk factors such as foreign exchange and inflation taken into account. The model input and output is presented in Appendix C. The results are shown in Appendix C-1 Company Main – Financial Results.

Conclusion

The "Multi-Objective Economic Model to Assess and Evaluate Capital Expenditures Associated with a Foreign Utility" is a useful *tool* in evaluating investment decisions on the impact to utilities in foreign countries. As with all models, there are assumptions that impact the accuracy of the model. There are both limitations in the results from these assumptions. In addition, there are areas for further development and improvement.

Further Development

There are a number of further developments that can be added to the model. They would/could enhance the usability of the information and analysis. An initial survey of the possible items include:

- Add an optimizing routine to the capital investment routine.
- Development the capability to conduct sensitivity analysis on the optimal investment schedule.
- A more robust method of analyzing the results, both financial and technical.

Many more possible development scenarios can be explored as time allows.

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