Pricing Domestic Energy Resources: A Model-Based Approach

Project Inception Report

East-West Center
Program on Resources: Energy and Minerals
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PRICING DOMESTIC ENERGY RESOURCES: A MODEL-BASED APPROACH

Project Inception Report

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Pricing Domestic Energy Resources: A Model-Based Approach

Project Inception Report

(Statement of Work)

1. Purpose of Project

The primary goal of the project is to provide Philippine government analysts with tools and training to assist in pricing various energy sources—especially the indigenous energy supplies that compete in the baseload power sector Not only are these often difficult to price because of the lack of direct comparison with any international market, but these resources also offer a wide range of environmental costs and constraints that must be accounted for in determining a reasonable value for the resources in comparison with other available energy options

A secondary goal of the project is to make recommendations on pricing strategies, given the information and insights garnered in developing the pricing tools It should be kept in mind, however, that the overriding purpose of the project is the transfer of skills and technologies to government counterparts

More specifically, the project is intended

- To provide the Government with a set of basic principles which can be used to guide energy pricing policies,
- To recommend methodologies which can be used to translate these principles into a set of recommended energy prices,
- To examine the economic and financial impacts of the particular energy pricing alternatives of current interest to the Government,
- To assist in the establishment of an analytical capability within the Government to develop short to medium-term pricing policies for natural gas, coal, geothermal and hydropower, and

- To examine the fiscal implications associated with proposed alternative pricing options and strategies

It should be noted at the outset that there is no "correct" way of setting prices analytically, if there were, then there would be a single tool or approach that could be used in every country Even the ideal free market or open bidding situation may not adequately address environmental costs and benefits, or differences in benefits to the national economy in terms of government revenues, balance of payments, or other macroeconomic issues Thus, what will be provided are tools that assist in "bounding" the appropriate prices for fuels, based on concepts ranging from production cost to alternative fuel prices to environmental premiums/penalties to fuel netbacks in given end-uses The pricing tools will not produce a single recommended price, but rather a range of prices that all have a legitimate grounding The tools will simultaneously provide quantitative implications of choosing one fuel over another, including environmental impacts and broader macroeconomic effects Selecting an appropriate price is ultimately a matter of informed judgment and policy decision within the framework of economically determined parameters

The tools and the training go hand-in-hand Too often, models end up sitting on the shelf because they are not matched to the needs, skills, and experience of the intended users The intention here is to produce user-friendly, comprehensible modeling systems that are at a level of complexity that can be fully grasped within the scope of the project time frame Although team members have much experience in automatic, algorithm-driven optimization (where the model determines the full range of decisions, including fuel mix, construction schedules, and marginal prices), such an approach is not considered desirable for this project Instead, the emphasis here is on understanding pricing dynamics, and employing "what if" scenarios analysis to determine the implications of different pricing strategies This means that an optimization or a non-optimization framework may be used, but if an optimization framework is employed, it must be optimization within a highly constrained system (The final choice of modeling technique in the power sector will be selected based on the availability of needed data, and the

backgrounds of the counterpart team, the most important consideration will be in producing a model that is usable and maintainable by the counterpart team)

At present, Philippine indigenous energy resources are dominated by coal, geothermal, hydropower, and, most recently, natural gas Coal, like oil, has a well-developed and competitive international market, pricing coal is a relatively straightforward matter Markets for natural gas, on the other hand, are more complex, there are many local markets, with widely differing prices There is also an international LNG market, but the costs and economies of scale in moving LNG are so large that LNG can provide no more than a single benchmark in deciding appropriate prices for domestic gas production Finally, geothermal and hydropower are not typically traded at all (except for limited trade in electricity in some special areas around the world), there is no "international market reference" for these resources

Although natural gas has more uses than merely power generation, the forum for competition between indigenous fuels in the Philippines and external energy sources (such as refined oil products, coal imports, and LNG) is the power sector Thus, the focus of this project is on the pricing of indigenous fuels with limited trade opportunities (domestic gas, geothermal, and hydropower) through their competition in the power sector with fuels that have international prices This competition is not limited to pure prices per unit output, however, but also includes competition between the fuels in terms of environmental impacts and other traditionally non-price costs or benefits

2. Methodology

A pricing policy must be based on the base costs, which include the long-run marginal cost, depletion premium for non-renewable energies and externality costs and the highest price that the consumer is willing to pay, netback value The price interval between the base costs and netback value is the optimal economic price range for a unit of energy

The long-run marginal cost (LRMC) is identical to the planning curve In practice, LRMC is approximated by average incremental cost (AIC) AIC is a forward-looking

value calculated using the average basic costs that will be incurred over a specific period in order to provide a given level of output

The depletion premium measures the additional costs of using depletable energy resources today versus using them at some future time when, having been depleted, they will have to be replaced by another resource that is generally higher in cost This is applicable to oil, natural gas and coal resources The depletion premium is often referred to as the user cost

The externality costs reflect costs to society which arise indirectly from energy production and consumption These costs could include new infrastructure and environmental degradation which may occur In developing countries, data on such costs are rarely available Thus, it is necessary to rely on international experience

The sum of these three economic costs is the minimum economic price which will fully account for the costs of supplying a resource This is a key parameter on the supply side

On the demand side, netback value reflects the value of an energy resource to the end user This allows the end user to buy energy at the lowest cost possible on a comparative basis Netback values generally differ according to the specific conditions governing their use and location This value is an approximation of consumer behavior, and is considered to be a maximum economic price For example, in electricity economics, many power utility companies use a least generating cost method to select fuels for the electricity generation On the basis of the lowest generation cost, netback value for a particular energy can be determined

Estimation of the range between the economic supply cost and the netback value is an important foundation of an effective energy pricing policy This range represents the producer and consumer surpluses The producer surplus is known as economic rent The economic rent plus the consumer's surplus can be distributed among producers, consumers and the government

An equilibrium price represents the economic optimum for all of the parties—producer, consumer and the government In reality, market barriers and government policy make such equilibrium impossible For this reason, it is necessary to derive a pricing structure, such as a financial price, that will incorporate these distortions Next we must adjust these optimal economic prices to cover the cost of energy in the financial price This is the price that the producer has to receive to allow for the exploration, development, operation, and delivery of the energy to the consumer, including a normal profit to compensate for risks, income taxes, depreciation and royalties or shares of production paid to government

One of the major elements of the project is its development of analytical tools for use by the officials of the Philippine Department of Energy To a large extent, these tools and concepts are embodied in a set of computer models

An economic model is designed to determine base costs and a netback value The AIC is the summation of discounted of incremental production costs divided by the summation of discounted incremental production

The depletion premium for energy commodities is based on the value of the next economically available alternative energy (backstop fuel) The depletion premium can be calculated as the difference between the present value of the backstop fuel price in the future year in which it is needed due to economic depletion of the first fuel and the cost of the fuel under analysis

In the countries where environmental impact is a concern, the additional costs of necessary mitigation measures must be considered to reduce the negative impacts to a certain acceptable level In general, these types of costs are included in the capital and O&M costs

The netback value is calculated by taking into account the different capital equipment required to use different fuels, and the different operating costs and efficiencies that characterize each fuel, and the economic supply cost of the next best alternative fuel

A financial model is designed to calculate the financial price of energy resources This model is commonly used in connection with the production sharing contract to split net operating income For the purpose of calculating the financial price, a trial and error approach is used to define a price structure that will provide a certain rate of return for the investor in each project

Energy supply and demand forecasts must be made before any economic, financial or optimization calculations are done The supply and demand forecasts are an important input to the calculation of economic and financial prices

3. Modeling Activities

3.1. Resource Costing Tools

Understanding the production costs, or long-run marginal costs, for resources is an ongoing effort, since the understanding of the resource base, the costs of development, and the potential market demands are constantly evolving For this reason, models of this type must be constantly updated and expanded as new information becomes available One of the key considerations in designing these tools will be ensuring that updating with better or expanded information is an easy process

In many cases, if development costs per unit output differ significantly between different sources of the same type of resource (for example, hydropower projects with very different costs and very different distances from the market), it may make more sense to treat them as separate kinds of resources, rather than combining them in the calculation of a single marginal cost

A. Natural Gas Tools

One of the most soundly based approaches to determining a production cost for natural gas resources for the purpose of policy analysis is determining the average incremental cost (AIC) of gas production resulting from following a specified production curve, and then adding on necessary transport and depletion value, needed to deliver the resource to the demand centers This approach determines an effective production cost for the resource given the needed investments in production and transportation to meet a given delivery schedule As such, using this for pricing can be iterative, if the costs determined are such that the initial demand and/or production profile would change, then the AIC and other factors need to be recalculated against the new demand and/or production profile

The specific modules provided from this effort will include

- A spreadsheet database of potential natural gas demand,
- A spreadsheet database structure for natural gas production and investment costs vis-a-vis deliverabilities, with baseline estimates for known resources,
- A spreadsheet database for natural gas transportation and distribution costs, vis-a-vis scenarios of the volume transported,
- A modeling tool that combines the first three modules to determine the AIC and economic price path of gas,
- A spreadsheet application for the calculation of natural gas netback values,
- A spreadsheet application for the calculation of the costs related to LNG imports in the Philippines

B. Geothermal and Hydropower Tools

Geothermal and hydropower resources are highly site-specific, and therefore are less appropriate, in most cases, for compiling into price-supply curves of the type used for gas or oil resources What will be provided here instead is a spreadsheet model of a

hydropower resource and a geothermal resource, with the key input variables needed to determine the production cost of the resource given resource quality, resource size, investment costs, and returns on investment These are designed to act as templates for analysis of additional projects, as information becomes available on the resource, and to estimate likely production costs given the basic input parameters These could form, in the longer term, a resource database that would allow price-supply curves to be built up if deemed appropriate

C. Coal Tools

Coal is the dominant fuel used for electricity generation in Asia, and remains highly competitive for base-load electricity generation in the majority of Asian economies The prices of thermal coal traded in the region are trending downward over time, and the specifications pertaining to sulfur content are becoming more stringent The Philippines has moderate coal reserves that have yet to play a substantial role in electricity generation Government projections indicate rapid growth in coal consumption for electricity generation, with imported coal accounting for most of the growth in consumption A series of policy issues are related to coal development and use in the Philippines, including (i) the competitive position of domestic coal production compared with the cost of imported coal, and (ii) coal qualities and power plant pollution control technology requirements to meet present and projected tighter environmental constraints For example, the impact of different emission limits on fuel choices and technology choices can be compared These key policy issues can be addressed using the models and data provided in this study

The specific modules on the coal sector will include

- A spreadsheet calculation comparing the plausible costs of coal from domestic supplies and the long term prices of coal CIF Philippines from Indonesia and Australia
- A spreadsheet calculation of levelized costs of electricity, from domestic and imported coal and from natural gas, at plausible supply costs

The above will be accompanied by a discussion of the commercial technology options for coal use in power plants, including their costs and efficiencies in reducing various pollutants There will also be a discussion of coal pricing issues for internationally traded coal, including spot and contract prices and trends

3.2. Power Sector Model

This model will compare the economics of power expansions, given the costs of different fuels and different technologies, including the options of adding environmental controls such as scrubbers The user specifies the demand mix in the power sector (totaling to a checksum for the needed MW output for the year in question) The model then gives several results simultaneously

- The price of each of the indigenous resources based on (i) the power sector netbacks from the key technologies and (ii) traded resources in key technologies (for example, the value of gas in the power sector given the price of fuel oil steam turbine costs, the value of gas given the price of low-sulfur coal in conventional power generation and in advanced clean-coal power generation, the value of gas given the price of medium-sulfur coal in modern or conventional power generation with and without flue gas scrubbing, etc)
- The price of each indigenous resource as above, but adjusted by the relevant charges for environmental emissions (SO_2, NO_x, CO_2) based on international standards and the pollution output from each technology,
- The total change in the pollution load by pollutant relative to several baselines,
- The average price of power production cost given the fuel mix, assuming that the indigenous resources are priced at production costs as determined in the resource costing modules,
- The average price of power production cost given pricing at netback values (including environmental charges),

As noted in the introductory section, the power sector model may be a highly constrained optimization framework, or a "dispatch" framework, depending on the backgrounds of the counterpart team and the availability of forthcoming data, the final decision cannot be made at this moment Optimization models offer some additional features, but also require more complex data inputs and place greater interpretive demands on the user if reasonable results are to be achieved The model outputs listed above can be obtained by either of these modeling techniques

3.3. Macroeconomic Implications Model

The model is capable of estimating the impacts on the economy and on government revenues based on the price and fuel mix changes that result from the assumed price generated by the resource costing and power sector models discussed above The model will

- Estimate the flow of funds related to the utilization of natural gas in the Philippines, such as a production sharing contract scheme for natural gas, arrangements in natural gas transportation (i e , pipeline), and government fiscal revenues from both the resource production split and taxes,
- To trace and construct the link of changes in fuel mix and pricing to macroeconomic parameters such as balance of payments, national income and employment, output of key sectors (such as manufacturing), general prices, and inflation

3.4. Preliminary Natural Gas Costs Evaluation

Per Department of Energy request, a preliminary natural gas cost evaluation will be performed for the Malampaya-Camago fields based on the information available to the consultants at the beginning of the project In addition, a spreadsheet calculation will be carried out to calculate a pro-forma of the government's revenues from oil, natural gas, and condensate production Within this activity the consultants will submit to DOE

- A spreadsheet calculation of estimated costs related to the production of the oil, natural gas, and condensate in the field, and estimated costs related to bringing the gas (through the marine pipeline) on-shore Bantangas,
- A spreadsheet calculation of estimated government revenues based on the assumption of the oil, natural gas, and condensate production that will be absorbed by the market at a predetermined price scenario(s)

The above estimation will be carried out based on the assumptions set forth by the available information to the consultant at the time the calculation is performed

4. Training Activity

As mentioned above, the consultant team regard that the training activity is one of most important activities within the project The training activity is intended to provide DOE counterparts with a capability to perform energy pricing analyses through the use of the analytical tools specially developed in the study The project has scheduled a one month formal training for the counterpart team to be conducted in October/November 1996 The training program is designed not only to introduce the counterpart team to the modeling tools, but to provide an energy background that is of sufficient breadth and depth to use the models for policy analysis Upon completion of the project, it is expected that the counterpart team will be able to

- Provide decision makers with energy pricing policy options detailing their analysis and projections of economic and financial impacts of the options
- Perform periodic assessments of energy pricing policies with analysis of the implications of such policies under certain economic, financial, and investment conditions

In order to achieve these objectives the training activity is designed to develop the following skills

- A sound grounding in the economic and financial principles behind the methodology of energy pricing analysis,
- The ability to undertake a systematic and rational approach to performing energy resource analysis,
- The ability to determine the proper analytical tools necessary for any given analytical task and to test the sensitivity of the results to change in assumptions and parameters,
- The ability to acquire appropriate data and information needed for energy pricing analysis and to develop and maintain a computer database for the purpose of policy support, and
- The knowledge of the limitations of the various analytical tools and methods in actual practices of energy pricing policy adoptions

Preliminary Training Syllabus

Week 1

A Fundamental Concepts

- Economic Price Theory, in the context of Energy Resources
- Financial Analysis of Energy Resources Development and Utilization
- Energy Supply and Demand Analysis
- Energy and Environment Link
- Energy Pricing Methodology
- Computer Application in Energy Modeling

Week 2

A Fundamental Concepts (Continued)

- Optimization Theory in Energy Resource Allocation

- Macroeconomic Linkage to Energy Utilization

B Energy Market Issues

- Energy Policy Issues and Regional Trends
- Global and Regional Oil Market
- Global and Regional Coal Market
- International and Domestic Gas Market
- Power Sector Analysis
- Introduction to Resource Negotiation

Week 3

C Analytical Tools in Energy Pricing Analysis

- Resource Costing Models Adopted in the Project
- Power Sector Models Adopted in the Project

Week 4

D Energy Pricing Policy Analysis

- Issues in Energy Pricing Policy
- Application of Analytical Tools for Energy Pricing Policy Recommendation

In addition to the consultant team, other researchers of the EWC Program on Resources will take part in the training program, both as lecturer and resource person They are

Dr Fereidun Fesharaki, EWC-PREM Director

Dr Allen Clark, Deputy Director

Dr Ujjayant Chakravorty, Adjunct Fellow

Dr Cary Bloyd Adjunct Fellow

Dr Jim Dorian, Fellow

Dr Kang Wu, Fellow

Mr Ron Hagen, Fellow

Dr Frank Tang, Consultant

5. Issues Addressed in the Final Report

- Energy Policy Issues and Trends

- Trends in energy policies in Asian countries, issues of deregulation, free market pricing, and the roles of governments and the private sector

- The formulation of energy pricing policy in the context of national energy policy

- Elements in energy pricing

- Multiple objectives in energy pricing policy

- Indigenous energy prices in selected other Asian countries

- Formulation of indigenous energy prices in the Philippines

- Examples of the use of the models in policy making

- International Energy Price Trends

- Trends in the international oil market, especially pertaining to the East-Asian market, and the likely impact on Philippine domestic energy prices

- Trends in the Asian coal market, including the export availability from major coal producers and the likely imported prices CIF Philippines

- Price Band Summary for the Philippines Indigenous Energy Resources

- Based on the results from all the resource costing and power sector modules, a summary of the price band for the indigenous resources will be constructed, showing each possible benchmark price in graphical form

- Government Revenue Analysis from Indigenous Resources

- Assessment of government revenues from the production of indigenous energy resources based on the split arrangement (e g , in the service contract)

- Macroeconomic Impacts Assessment

- Assessment on the linkage of domestic energy prices to the Philippine macroeconomy such as outputs of key sectors, especially manufactures, national income, balance of payments, and inflation effects

- Reports on the Training Activities

- Transfer of the models to the Department of Energy

- Documentation of the models and model manuals

6. Project Schedule

(See the attached chart)

Project Schedule
Pricing Domestic Energy Resources of The Philippines

Consultant	Position / General Task	PROJECT PERIOD (1996) July	August	Sept	Oct	Nov	Dec	EFFECTIVE PERSON-MONTHS Phil	U S	Total
M Montes	Senior Economist/Project Advisor	□□□□□	□□□□□	□□□□□	□□□□□	□□□□□		0 25	0 25	0 50
C Johnson	National Policy/Coal & Power Economics							0 75	1 25	2 00
W Prawiraatmadja	Resource Assessment/Modeling/Training							0 75	2 25	3 00
David Isaak	Resource Assessment/Modeling/Training							0 66	1 34	2 00
Aniceto Orbeta	Macro Economic Impact/National Policy							1 25	0 75	2 00
Nicholas Biederman	Natural Gas Specialist							0 30	0 70	1 00

Reports / Deliverables	PROJECT PERIOD (1996) July	August	Sept	Oct	Nov	Dec
Inception Report		X				
Preliminary Gas Costs Evaluation		X				
Resources Data Analysis & Assumptions for Modeling			X			
Natural Gas Model and Manual				X		
Coal Geothermal and Hydro Modules and Manuals					X	
Power Sector Model and Manual					X	
Macroeconomic Impact Models and Manuals					X	
Training of DOE Personnel						
Transfer Models to DOE Office						
Draft Final Report					X	
Final Report Presentation						X
Final Report						X

Note

□□□□□ Project Monitoring

Project Activity

x Report Submission

7. Tasks of Consultants

(See the attached detail tasks for each consultant)

Name of Consultant Widhyawan Prawiraatmadja

Position Energy Economist / Project Manager

Tasks

- Overall project coordination
- To provide coordination and facilitation the development of models in natural gas and other indigenous energy resources, and the electric power sectors, and for financial and macroeconomic impacts from the energy resource utilization
- To provide expertise on the comparative analysis of energy resource utilization, especially the comparison between natural gas and oil in the power sector
- To assess the trends in the international oil market, especially pertaining to the East-Asian market, and its likely impact on Philippine domestic energy prices
- To coordinate and facilitate training activity for Department of Energy officials
- To coordinate and facilitate report writing, including model manuals

Name of Consultant Manuel Montes

Position Senior Economist

Task

To provide general advice on carrying out the project—in particular, on the analysis of financial and macro economic impacts from the utilization of indigenous energy resources in the Philippines and on the national energy pricing policy recommendations

Name of Consultant Charles Johnson

Position Senior Energy Economist

Tasks

- To construct a spreadsheet model in the power sector that covers comparisons of electric power generation costs at various types of power plants using different types of fuels based on scenarios of domestic primary energy prices
- To estimate fuel netback values in the power sector and to perform sensitivity analysis of changing operational or financial parameters used
- To perform economic price assessment on coal, geothermal, and hydro in the power sector
- To assess the trends in the Asian coal market, including the export availability from major coal producers and the likely imported prices CIF Philippines
- To formulate and to provide the recommendation of the national energy pricing policy
- To provide a write up on the above tasks for inclusion in the project Inception Report, Model Manuals, and Final Report

Name of Consultant Aniceto Orbeta

Position Economist

Tasks

- To trace and construct the flow of funds related to the utilization of natural gas in the Philippines (a) production sharing contract scheme for natural gas (i e , companies revenues and income, government royalties etc), (b) arrangements in natural gas transportation (i e , pipeline), and (c) government fiscal revenues
- To trace and construct the link of indigenous energy resources to macroeconomic parameters such as balance of payments, production costs of commodities especially manufactures, national income and employment, general prices and inflation
- To develop a user friendly spreadsheet applications for the calculation and simulation of financial and macroeconomic impacts from the utilization of energy resources in the Philippines
- To provide a write up on the above task for inclusion in the project Inception Report, Model Manuals, and Final Report
- To provide training for the Philippine Department of Energy officials

Name of Consultant Nicholas Biederman

Position Natural Gas Specialist

Tasks

- To construct a spreadsheet database on natural gas supply and demand
- To construct a spreadsheet database on costs related to natural gas development and utilization, i e , production, transportation (pipeline), distribution, and utilization by sector, for both economic and financial costs
- To construct a spreadsheet application for the calculation of natural gas netback values
- To construct a spreadsheet application for the calculation of the costs related to LNG use in the Philippines
- To provide a write-up on the above tasks for inclusion in the project reports, i e , Inception Report, Model Manuals, and Final Report

Name of Consultant David Isaak

Position Resource Assessment Specialist / Energy Modeling

Tasks

- To construct a user-friendly spreadsheet model for the natural gas sector of the Philippines
- To construct a spreadsheet (or optimization) model for the utilization of energy resources in the Philippines, particularly in the power sector
- To perform economic comparisons in the utilization of energy resources in the Philippines
- To provide a write up on the above tasks for inclusion in the project Inception Report, Model Manuals, and Final Report
- To provide a write-up on the comparative analysis of energy utilization in the Philippines for inclusion in the Final Report
- To provide training for the Philippine Department of Energy officials

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Gas Sector Analysis Model (Preliminary)

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Gas Sector Analysis Model (preliminary)

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GAS SECTOR ANALYSIS MODEL

(Preliminary)

INTRODUCTION

The Philippine Gas Sector Analytical Model is a computerized technique that can be used to determine the economic and financial costs for developing and utilizing Philippine natural gas resources The model is designed to be used by a trained analyst in the interactive mode The analyst defines the supply/demand conditions applicable for each analysis (run) made by the spreadsheets The spreadsheets then utilize the information in the supply and demand data files, and the economic and financial parameters built into the spreadsheets, to compute economic costs of gas supplies and netback values for gas at various points in the production-transportation-utilization system

This documentation section of the Gas Sector report includes two sections relating to the design and use of the spreadsheets

1 The methodology on which the spreadsheets are based is described basically, the economic evaluation methods used by the World Bank and other development organizations to determine the economic costs of each supply/demand case

2 The spreadsheet architecture and operations are described They are designed for use on a desktop or laptop computer (PC) using widely available spreadsheet software, so that an analyst competent in using the spreadsheet software can be trained to operate the spreadsheets in minimum time

The objective of this analytical model is to provide a consistent means for assessing various gas supply/demand strategies for the Philippine government For a given set of assumptions, the spreadsheets produce economic costs and netback values for gas

METHODOLOGY

A ECONOMIC COSTS AND NETBACK VALUE CALCULATIONS

Economic Price Path Calculation

The economic price path of gas calculation is used to determine the minimum value of gas at the selected discount rate and cost of production The economic price path is the weighted average incremental cost (AIC) of gas delivered to the demand area plus either the scarcity rent or the depletion value The AIC is calculated in the Field Cost spreadsheet and transferred to the EPP spreadsheets to determine the weighted AIC The AIC is calculated based on the cost of production and the volumes of gas produced from the field under analysis and transported to the demand region When gas supply exceeds demand, the economic price path is equal to the sum of the AIC plus the depletion value When gas supply is less than demand, the economic price path is equal to the sum of the AIC plus the scarcity rent In order to calculate the economic price path, the analyst must specify the year of economic depletion for natural gas This can be determined from the graphs of natural gas supply/demand (spreadsheet charts 12 through 15) for the specific supply and demand regions being assessed The equations used in calculating the economic price path are given in Table 1 Note that coal is the default fuel for calculating the depletion value

Table 1 EQUATIONS USED TO CALCULATE ECONOMIC PRICE PATH FOR NATURAL GAS

When supply exceeds demand

EPP = Weighted AIC in year n + Depletion Value in year n

When supply is less than demand

EPP = Weighted AIC in year n + Scarcity Rent in year n

Depletion Value in year n =

$$\frac{\text{(Economic Price Path of Coal in year of Economic Depletion)}}{(1 + \text{Discount Rate})^{(\text{Year of Economic Depletion} - \text{Year n})}}$$

Scarcity Rent in year n = Economic Price Path of Coal in yr n - Weighted AIC in yr n

Netback Value Calculations

The concept of netback value is that the value of gas in a particular end-use application is determined by the next lowest cost fuel and the difference in end-use efficiencies between other fuels and gas The netback value of gas then becomes the maximum value of gas for that particular end-use application A weighted average mix of all end-use applications being considered for natural gas theoretically sets the maximum value of gas in that demand area Netback values for gas are calculated for each sector based on the default fuel and the relative efficiencies between the default (backstop) fuel and gas

The netback value calculation in spreadsheet 21 consists of a number of data matrices for each end-use application, where the economic price path of alternative fuels IS adjusted for efficiency, and the unit costs of delivery are added For specific industrial applications, plant netback values are calculated based on the investment costs for gas and alternative fuels, operating cost, and fuel use efficiencies These files calculate the value of gas for these industrial and electric power generation applications that balance the overall cost of producing a unit of product output

B FINANCIAL COST CALCULATION

The Financial Calculation spreadsheet (No 6) has been structured in accordance with standard accounting practices and based on the guidelines

established by the Philippine's government production sharing agreement with petroleum producers The key elements in the production sharing agreement utilized in the financial spreadsheet include a 5-year straight-line depreciation schedule (this is calculated in spreadsheet 7, Depreciation), a cap on the recovery of expenses of 70% of the gross revenues with an indefinite carry-forward provision, and a 60/40 government/producer revenue sharing split

The financial spreadsheet can be used to determine several parameters summarized on the IRR & NPV spreadsheet (No 2)

1 Project IRRs
2 Company IRRs
3 Project NPV
4 Company NPV
5 Government NPV
6 Total Government Income
7 Effective Gas Price (with and without government revenue)

These parameters are generated based on the assumptions for gas, condensate and oil prices input by the analyst in the Financial Inputs spreadsheet (No 1) For example, based on an economic cost of gas of in 2002 of $3 18/1000 CF and a netback value of gas for coal-fired, steam-thermal power generation equals $2 71/1000 CF If the price of gas is assumed to be the economic cost of gas in 2002 (i e , $3 18/1000 CF), the company IRR (exploration start) is 20% and nominal government income over the production life is $7 6 billion Changing the gas price to $2 66/1000 CF (the netback value of gas vs coal-fired, steam-thermal electricity generation less a local transport charge of $0 05/1000 CF), the company IRR changes to 18% and the government income drops to $6 4 billion over a 25-year project life These values all assume that the price of condensate and oil produced are equal to $19/barrel

Thus the analyst can test the impact of changing gas price on the company and project IRRs, the NPVs generated, and the government revenues recovered

FIELD COST SPREADSHEETS

The Field Cost spreadsheet (No 3) uses inputs on field exploration and development costs, O&M costs and the production profile resulting from the investments to calculate the average incremental cost (AIC) of producing gas from the specific field In the current spreadsheet, the costs and production profile are for the Camago-Malampaya gas fields operated by Shell International and Occidental Petroleum Co Since no official cost estimates tied to a specific production schedule have yet been provided, an estimate of these values based on discussion with Shell and information from the literature has been made

Baseline values assumed are

- Sunk Cost of Exploration equals $175 million
- Total Development Cost equals $1500 million
- Offshore Transmission equals $425 million
- Production Schedule
  - 2002 210 Million CF/Day
  - 2003 330 Million CF/Day
  - 2004 400 Million CF/Day
- Total Recoverable Reserves of 2 5 Billion CF
- Overall O&M Costs equal 5% of Total Investment

Discussions with Shell indicated that approximately 90% of the development costs would be invested in the beginning of the project On this basis the assumption was made to distribute 100% of the estimated investments over a 5-year development period The distribution of the total assumed investment by component (e g , wells, platform, gathering system and offshore transmission line) was based on standard industry practice assuming no unusual problems are encountered during construction of the facilities

DESCRIPTION OF THE SPREADSHEETS

Below is a list of spreadsheets as they appear in the Gas Sector Model workbook (Excel 5 for Windows, GASCOST2 XLS)

- Supply/Demand Financial/Economic Analyses
  - 1 Financial Inputs
  - 2 IRR & NPV
  - 3 Field Costs
  - 4 Production Investment
  - 5 Adjusted Prices
  - 6 Financial Calculation
  - 7 Depreciation
  - 8 Area Supplies
  - 9 Area Demands
  - 10 Supply Allocation
  - 11 Supply-Demand Summary
  - 12 S-D Balance -- Bataan [Chart]
  - 13 S-D Balance -- Batangas [Chart]
  - 14 S-D Balance -- MetroManila [Chart]
  - 15 S-D Balance -- Other [Chart]
- Economic Price/Netback Analysis
  - 16 Default Fuels
  - 17 EPP Fuels & Commodities
  - 18 EPP Calculation
  - 19 Transport AIC
  - 20 Netback Value Summary
  - 21 Netback Calculations
- Pipeline Sizing and Costing
  - 22 Pipeline Summary
  - 23 Pipeline Investment
  - 24 P-L Node Data
  - 25 P-L Flow Diagram
  - 26 P-L Flow Model
  - 27 Pipeline Costing Model
- LNG Receiving Facility Costing
  - 28 LNG Receiving Investment
  - 29 LNG AIC Calculation
- Reference Data
  - 30 Conversion Factors
  - 31 Nelson-Farrar Refinery Indices

Note that the spreadsheets have been grouped into five categories dealing with the principal purpose of each group Overall the first group -- Supply/Demand Financial/Economic Analyses -- deals with the production and utilization of natural gas from indigenous natural gas fields in the Philippines The costs associated with the development, production and delivery onshore of these supplies are used to determine various financial and economic values assuming an onshore gas price The second group -- Economic Price/Netback Analysis -- deals with determining the economic price path of natural gas as delivered to potential end-users based on the data and analyses performed in the first group of spreadsheets The Netback Value of gas for various

end-uses is also calculated in this group of spreadsheets The third group of spreadsheets -- Pipeline Sizing and Costing -- allows the analyst to determine the diameter and compression requirements, and the subsequent investment and economic cost of delivering natural gas once onshore The fourth group of two spreadsheets -- LNG Receiving and Costing -- allows the analyst to estimate the cost of an LNG receiving facility of various capacities, and calculates the average incremental cost (AIC) of vaporized LNG delivered into a pipeline at the facility boundary Finally, the fifth group provides some reference information for converting various fuels and commodities to equivalent heating value and natural gas volumes, and the Nelsen-Farrar refinery indices for updating historical costs Each of the spreadsheets in these groups is discussed in more detail below

Group 1 Supply/Demand Financial/Economic Analyses

The first spreadsheet -- Financial Inputs -- consolidates the financial/economic parameters used throughout the workbook The second -- IRR & NPV -- provides the results of the internal rate-of-return (IRR) and net present value (NPV) analyses The second spreadsheet also presents the sensitivity of the IRR and NPV to assumed project start dates, the effective price of gas with government revenue subtracted, and the total government income resulting from the selected onshore gas price

The third spreadsheet -- Field Costs -- contains volumetric, gas quality and cost data for indigenous natural gas supply This spreadsheet is divided into several areas to allow for the addition of information for more than one field As discussed previously, the supply area for which information has been added is the Camago-Malampaya field The fourth spreadsheet -- Production Investment -- summarizes the investment schedule for natural gas field development

The fifth spreadsheet -- Adjusted Prices -- summarizes by year the adjusted (i e , price less government revenue share) onshore price of natural gas The spreadsheet shows this information for Camago-Malampaya resulting from the price assumption used in the financial model

The sixth spreadsheet presents the Financial Calculations This model uses the specific conditions specified in the production sharing agreement between the producer and the Philippine government Using the investments, O&M costs, and production assumptions for natural gas, condensate, and oil, the analyst can test the sensitivity of the various financial indicators assuming a gas price (input in spreadsheet 1) as, in this case, delivered to land-fall in Batangas for the Camago-Malampaya fields By changing these assumptions, other field scenarios can be tested The financial indicators that are produced by this spreadsheet model are shown in spreadsheets 2 and 5, as discussed above Spreadsheet 7 -- Depreciation -- calculates the allowed depreciation for the field development and production investments used in spreadsheet 6

Spreadsheet 8 -- Area Supplies -- summarizes the production schedule for the natural gas fields in spreadsheet 3, and provides a proposed LNG delivery schedule The LNG delivery schedule corresponds to the proposed LNG receiving facility at Batangas being discussed by First Holdings There is also an open option -- Other -- to insert any other proposed sources of natural gas

Spreadsheet 9 -- Area Demands -- presents the demand assumptions by sector for the major consuming areas around Manila These areas are Bataan-Lamay, MetroManila and Batangas The natural gas requirement estimates supplied in the demand area spreadsheet focus on the proposed Batangas and Bataan-Lamay combined-cycle power plants

Spreadsheet 10 is used to allocate natural gas supplies from each of the sources identified (plus an Other category) to each of the demand areas (plus an Other category) For example, supplies of gas from Camago-Malampaya could go to both the Bataan and Batangas areas The allocation spreadsheet allows the analyst to balance supply from the fields to these demand areas

The results of spreadsheets 8 to 10 are presented in spreadsheet 11 -- Supply-Demand Summary -- and the charts showing the supply/demand balances for each of the demand areas in spreadsheets 12 to 15

This raw data and partially processed data is used in this group of spreadsheets to calculate the required set of data for input to the economic cost of gas calculations and subsequently to the netback values calculations

The group of spreadsheets is designed to handle each the demand sector individually Gas supply can be designated for each demand area from any of the supply areas In this way case studies of gas supply and demand can be run for each of the demand areas The demand scenario is determined by the analyst, as well as the mix of gas supplies from the various areas The available maximum gas supply from each area is fixed, however (The analyst while working with a fixed set of gas supply figures could choose to add a speculative field or other source of natural gas with its development costs and quality assumptions to determine the impact of such an addition or discovery on the overall economics of gas utilization) The spreadsheets then calculate, with these supply and demand assumptions in the second set of spreadsheets, a set of economic gas costs and netback values for each demand area

The analyst then can determine which set of supply and demand assumptions produces an economically viable combination for the Philippines and in the case of multiple viable cases which are the most economic

Group 2 Economic Price/Netback Analysis

The first spreadsheet in the group, spreadsheet 16 -- Default Fuels -- sets the choice of fuel for the netback calculations in spreadsheet 21 These fuel choices represent the next preferred fuel over natural gas in the end-use applications listed These uses include electric power generation (steam thermal, simple cycle turbine and combined-cycle turbine), and specific industries (e g , urea fertilizer, cement, ammonia, steel, methanol and refinery fuel) The analyst sets the fuel of choice for the netback calculations in this spreadsheet

Spreadsheet 17 -- EPP Fuels & Commodities -- lists the fuels and commodities used for both the economic price path and netback calculations This spreadsheet is a

database of fuel and commodity price forecasts over the analysis period in constant 1996 dollars

Spreadsheet 18 -- EPP Calculation -- calculates and presents the economic price path (EPP) for natural gas produced from the selected field The default field used in the spreadsheet is the Camago-Malampaya field This calculation includes the AIC for the natural gas from the selected field and the AIC for transportation of the landed gas to the demand area The AIC for the transportation of the gas is calculated in spreadsheet 19 -- Transport AIC -- and takes its investment and O&M costs from the next group of spreadsheets -- Pipeline Sizing & Costing -- discussed later in this write-up

Spreadsheets 20 and 21 -- Netback Value Summary and Netback Calculations -- present and develop the netback values of natural gas in various industrial and electric power generation end-use applications Based on the selected Default Fuels (spreadsheet 16), the algorithms in spreadsheet 21 calculate the value of natural gas in these applications These values are summarized in spreadsheet 20

Group 3 Pipeline Sizing & Costing

This group of spreadsheets allows the analyst to determine the transmission pipeline diameter and compression requirements for pipelines of varying capacities and lengths located onshore and offshore The diameter, length and compression parameters are then used to calculate the investment costs and O&M costs for this pipeline

Spreadsheet 22 -- Pipeline Summary -- summarizes the parameters for the pipeline case assessed The values in blue in the spreadsheet represent the parameters input by the analyst in spreadsheet 24 -- P-L Node Data -- and the values in black those calculated by the pipeline algorithm in spreadsheet 26 -- P-L Flow Model The active spreadsheet in this group is spreadsheet 24 In the P-L Node Data spreadsheet the analyst enters the parameters for pipeline capacity (million of cubic feet of natural gas per day), the initial pressure into the pipeline (in psig), pipeline

length (in miles) for the different onshore and offshore segments of the pipeline and the pipeline diameters (in inches inside diameter) These values show in blue in the spreadsheet The value in red under Pressure, PSIG, on the line for pipe in the Input Node Data matrix, represents the maximum compression outlet pressure By setting this pressure high (up to a maximum of 1200 psig) or low (a value of zero eliminates compression) the analyst can "optimize" the compression horsepower based on pipeline diameter and capacity against the delivery pressure The delivery pressure is shown in green under the PRESSURE, PSIG, TOTAL line in the Output Node Data matrix For large industrial applications and electric power generation the delivery pressure should not be less than 100 psig Spreadsheet 26 -- P-L Flow Model -- contains the algorithms for calculating pressures Spreadsheet 25 -- P-L Flow Diagram -- summarizes the pipeline lengths, diameters and pressures for each of the segments, and the compression requirements

Spreadsheet 23 -- Pipeline Investment -- summarizes the onshore and offshore line pipe installed costs and the compression investment costs These are generated by the algorithms in spreadsheet 27 -- Pipeline Costing Model

As mentioned above, the investment and O&M costs are used in spreadsheet 19 -- Transport AIC -- to generate the transportation AIC cost used in the EPP calculations

Group 4 LNG Receiving Facility Costing

This set of two spreadsheets estimates the investment requirement for an LNG import receiving terminal based on a daily capacity selected by the analyst This total investment is used in the second spreadsheet to calculate the average incremental cost of the vaporized LNG at the outlet from the facility

Spreadsheet 28 -- LNG Receiving Investment -- shows the LNG terminal investment cost buildup By entering a plant throughput in millions of cubic feet per day (shown in blue on the spreadsheet), the analyst can have a total investment cost generated based on the "built-in" assumptions For more specific estimates, the

analyst can change the default values used in the spreadsheet to more accurately set such parameters as land purchases & site preparation, building, roads & fences, utility connections or marine facilities, for example, based on the particular conditions at a site in the Philippines The overall assumption used to develop the investment costs in this spreadsheet is that the total capacity of the facility will be from 1 billion cubic meters per year up to 5 bcma (100 to 500 million CF/Day) Above this range, a different set of assumptions is necessary For example, in larger capacity receiving facilities the use of seawater vaporizers for primary vaporization of the LNG (with fuel-fired vaporizers as backup) has cost advantages over the use of fuel-fired vaporizers only In the smaller capacity facilities, the added investment costs of seawater vaporizers is not considered cost effective The investment costs from this spreadsheet are used in spreadsheet 29 -- LNG AIC Calculation -- to calculate the AIC of the vaporized LNG at the plant outlet

Group 5 Reference Data

This set of spreadsheets consists of a table of conversion factors for use in the netback calculations for determining the natural gas heating value or volume equivalent in various industrial or electric power processes and for different fuel types The conversion table is in spreadsheet 30, Conversion Factors Spreadsheet 31 shows the Nelson-Farrar refinery inflation indices used to update historical investment figures to late 1995 values