

Gas and Associated Liquids Exploration Economic Model Manual

Version 1.00

Introduction

This model is designed to provide screening economics for the evaluation of gas exploration prospects and discoveries on the Nova Scotian shelf in the shallow waters around Sable Island, either as tie-ins to existing infrastructure or as stand-alone developments, and in deep water with potential as subsea tie-ins to existing infrastructure.

The model can be operated at different levels dependent on the maturity of the prospect / discovery. At the simplest user level, the user may enter the key parameters for the discovery / prospect and the model will automatically calculate schedules, costs and production and determine cash flows and risked values, the schedule and costs are based on a default set of cost and schedule assumptions. Users may modify the existing set of cost and schedule assumptions or may create their own sets of assumptions; similarly users may create their own economic scenarios for price, exchange rate, inflation and interest rates. As a prospect or discovery matures, companies may do more detail work and wish to override aspects of the model derived costs and production. The model provides full calculations for Nova Scotia offshore royalty and provincial and federal corporate income taxes and these are incorporated into the cash flow and economic indicator calculations.

In addition to evaluating gas prospects and discoveries, the model can also be utilised to evaluate the economics of small oil prospects, but in this mode the user must use the manual override facility for the development and operating costs and production profiles, however exploration and appraisal costs maybe calculated by the model and the royalty and tax calculations are valid for oil.

Inputting Data in the Model

All cells in the model designed for user input in the model are unprotected, all other cells are protected. Input cells are shown with blue text against a white background. Dependent on their purpose, input cells enable the user to input numerical data, dates or select from a list of text inputs and are restricted to the appropriate date type. For text input and some numerical cells a note assisting the user is available, this normally appears to the right of the selected cell but can be dragged to an alternative place on the screen if the user desires.

Model Structure and Operations

The model is designed to require the minimum amount of input from users to enable quick screening analysis, all the required input for screening analysis is contained in the second sheet **Input**. The first four sheets after **Introduction** summarise the analysis and enable threshold and sensitivity analysis and have a tab colour Red; the next Dark Blue sheet is the Override sheet used to override aspects of the model calculations; the next twelve sheets are the calculation modules and have a tab colour Light Blue; the next three sheets are shown with a Tab colour Orange and enable the user to Override the model calculated results and to override or provide new scenarios for the basic model assumptions; the last five sheets are blank sheets for user notes and model extensions and are shown with a tab colour Green.

The Sheets

Introduction provides a brief overview of the model

Input This is the main sheet for input of prospect specific data by the user, input is in the cells in the second column and the model results are summarised to the right of these inputs. The required inputs are:

<i>Evaluation Parameters</i>	The parameters specifying the discounting and economic assumptions for the evaluation
Discount Rate	This is the discount rate to be used for the calculation of discounted values and should be input as a percentage greater than zero
Discount Date	Three values can be selected: Decision Date all values will be discounted to the date of the appropriate decision. First stage decisions are discounted to the start date of the current operation and future decisions are discounted to the date of that decision. In this mode all values shown in the Decision Flow diagram show the values that the decision-maker will perceive at the time of the decision. Current Month all values are discounted to the first day of the current month (if the date is 15 April 2007, the discount date will be set to 1 April 2007). In this mode values shown in the Decision Flow chart are discounted to this date, and are not the values the decision-maker will perceive at the time of the decision.

Current Year all values are discounted to the first day of the current year (if the date is 15 April 2007, the discount date will be set to 1 January 2007). In this mode values shown in the Decision Flow chart are discounted to this date, and are not the values the decision-maker will perceive at the time of the decision.

Economic Scenario The user can select from a list of Economic Scenarios defined in the sheet **Economic Assumptions**

Cost Set The user can select from a list of Costs Sets, which define the model cost assumptions and are defined in the sheet **Cost Assumptions**

Development Parameters The parameters specifying the development method assumed if the field is developed

Prospect Name The user should enter the name of the Prospect

Current Project Stage The user should select the stage of the project that is currently being evaluated, the available stages are:

Seismic the evaluation is to decide whether to run exploratory seismic analysis to identify potential prospects

Wildcat the evaluation is to decide whether to run wildcat analysis of an identified prospect

Appraisal the evaluation is to decide whether to appraise a discovery or partially evaluated prospect

Development Planning the evaluation is to decide whether to proceed with development planning of an appraised gas field

Development the evaluation is to decide whether to proceed with development of an appraised gas field where all planning and regulatory procedures have been completed

Start Date The start date of the current project stage

Development Method The proposed method of development for the gas field, the three method of development are:

Subsea The field is to be developed using subsea wells and a subsea manifold with processing on an existing platform (Infrastructure Type must be set to Satellite)

Fixed Platform The field is developed using a conventional bottom standing steel platform with a piled foundation, the extent of the topsides facilities will be determined by the setting in the next input Infrastructure Type

Jackup The field is developed using a purpose built portable jack-up platform, the extent of the topsides facilities will be determined by the setting in the next input Infrastructure Type

Infrastructure Type The infrastructure type required for the field development, the options are:

Satellite The field is developed as a satellite to an existing platform. It is assumed if the Development method is subsea all processing takes place on the existing platform, if the Development Method is Fixed Platform or Jack-up then it is assumed simple water knockout occurs on the satellite facility

Direct Pipeline Tie-in The field gas is exported by direct subsea tie-in to an existing export pipeline to shore. The development method must be Fixed Platform or Jack-up and is assumed the field facility produces export quality sweet wet gas (two phase including condensate), if the field has H₂S then it is assumed this is removed on the field facility.

Shore The field gas is exported by a new dedicated pipeline to shore. The development method must be Fixed Platform or Jack-up and is assumed the field facility produces export quality sweet dry gas; if the field has H₂S then it is assumed this is removed on the field facility. It is assumed condensate is utilised for platform fuel.

Export Distance The distance of the field from the delivery point in km, dependent on the infrastructure type – if the infrastructure is a Satellite the distance to the mother platform, if direct pipeline tie-in, the distance to the tie-in, otherwise the distance to

Risk Parameters The risk parameters specify the probability of proceeding from one project stage to another, these factors reflect that new information or

other adverse affects at each step will cause the project to be abandoned. The resultant overall chance of development is calculated and shown to the right of the inputs. While this approach is somewhat different to a conventional two-point prospect analysis it reflects the true nature of the process. If it is desired to perform a conventional two-point Wildcat analysis set the Project Stage to Wildcat, set the Wildcat percentage to the Chance of Success and set the other factors to 100%. The parameters are:

Seismic	The probability of proceeding from the seismic program to drilling a single identified structure
Wildcat	The probability of proceeding from drilling a wildcat to an appraisal program
Appraisal	The probability of proceeding from an appraisal program to development planning
Development Planning	The probability of proceeding from a development plan to field development

Technical Parameters The parameters associated with technical aspects of the field. The parameters are:

Mean Reserves	The estimated mean technical reserves in bcf in the success case – this is reserves used to generate the production profile prior to the economic limit calculation
Reservoir Depth	The reservoir depth in metres below Mean Sea Level
Reservoir Complexity	A factor that influences the number of wells required to develop the field, and has three settings Low, Medium and High, the multiplier for each can be set in the sheet Schedule & Prod Assumptions .
Areal Extent Factor	A factor that affects the average measured depth of wells and the length of subsea well flowline bundles, and has three settings Low, Medium and High, the multiplier for each can be set in the sheet Schedule & Prod Assumptions.
Reservoir Pressure	This has two settings Normally Pressured and HPHT and influences the time to drill wells and the cost of well tangibles, the multiplier for each can be set in the sheet Schedule & Prod Assumptions.

Gas Calorific Value	The energy content of the gas in British Thermal Units per standard cubic feet (Btu / scf)
Liquid Yield	The liquid yield of the gas in Barrels per thousand standard cubic feet (Bbls/mcf)
Gas Type	Whether the gas is Sweet or Sour . Pipeline and process unit costs calculated by the development module and input in the sheet Cost Assumptions are affected by this setting
Water Depth	The water depth of the development in metres (m)
Tax and Royalty Parameters	The parameters associated with the calculation of tax and royalty
Small Reserves for Royalty	Whether the field is considered Small Reserves for Royalty (Yes or No), if Yes the pre-payout Gross Royalty Tier is a minimum of 24 months and the post-payout Gross Royalty Tier a minimum of 36 months from first production.
High Risk for Royalty	Whether the field is in the area designated for royalty (Yes or No), if Yes then the Net Revenue royalty is restricted to the Tier 1 rate of 20%.
Flow-Through for Tax	Whether to assume that all Federal and Provincial Taxes are immediately relieved by income from other sources (Yes or No), if Yes the field losses are immediately relieved, if No field losses are carried forward until they can be offset against field income.

To the right of the inputs, the Input sheet displays a Decision Flow diagram that shows the decisions involved in the exploration and development of the field and, the chance of proceeding from one step to the next and the assessed go-forward value and cost at each stage. Stages that are not part of the evaluation are greyed out, the immediate stage is shown in Green and subsequent stages in Orange.

Below the Decision Flow, the risked discounted contribution of each component of cost and revenue to the prospect value (NPV) is shown in a tabular form and in the form of a Waterfall chart. Additionally the rate of return on the risk adjusted cash flow and the Discounted Return on Investment (risked NPV divided by discounted future risked investments over full life of prospect), and

the Committed Discounted Return on Investment (risky NPV divided by the committed discounted investment for proceeding with the current project stage).

Thresholds

This sheet calculates the Threshold Reserves, Reservoir Depth and Economic Scenario at which the prospect is economic for differing Current Project Stages. The user can adjust the required ranges for each of Reserves, Reservoir Depth and Economics Scenario, values with negative NPV (at the selected discount rate) are below the Threshold for proceeding are shown in Orange and those above the Threshold are shown in Green.

The example below shows that for the basic set of parameters and assuming a threshold discount rate of 15%, a mean reserves of 100 bcf is uneconomic at all Stages of exploration, from 150 to 250 bcf, it is economic to proceed with Development Planning and Development, but drilling a Wildcat or Appraising a discovery is uneconomic. From 300 to 700 bcf it is economic to appraise a discovery, and above 700bcf it is economic to drill a Wildcat, within the range of reserves specified it is not economic to run an exploratory seismic program.

Prospect X		Economic Thresholds for Different Project Maturities : NPV @ 15.0 %										
Discount Rate	15%	Reserves (bcf)										
Discount To	1-Jun-07	100	150	200	250	300	400	500	600	700	800	900
Economic Scenario	Base	-72.3	-57.3	-61.5	-50.9	-41.7	-31.3	-35.5	-27.0	-19.2	-12.1	-5.3
Cost Set	Default	-96.6	-72.6	-77.6	-60.8	-46.2	-28.6	-36.6	-22.2	-9.0	3.0	13.5
Project Parameters		-84.0	-17.5	-49.0	-2.0	38.4	85.9	82.1	118.7	154.5	188.0	205.5
Start Date	01-Jun-07	-37.4	66.7	125.5	201.1	268.0	327.4	417.7	487.0	555.0	616.4	670.5
Development Method	Subsea	-38.6	90.5	169.3	260.0	342.0	447.1	568.3	659.4	747.4	822.9	896.3
Infrastructure Type	Satellite	Reservoir Depth (metres)										
Export Distance (km)	40	3000	3500	4000	4500	5000	5500	6000				
Facility Finance	Purchase	-34.2	-41.7	-49.6	-59.4	-66.8	-74.1	-81.2				
Lease Term (years)	10	-34.0	-46.2	-58.2	-70.5	-86.0	-97.8	-109.4				
Risk Parameters		49.4	38.4	27.1	16.0	6.1	-14.8	-24.6				
Seismic	70%	263.4	268.0	270.6	273.9	276.4	279.1	281.5				
Wildcat	40%	335.8	342.0	347.1	350.9	355.2	359.4	362.4				
Appraisal	70%	Economics Scenario										
Development Planning	95%	Low Price	Base	High Price	Scenario 4	Scenario 5						
Technical Parameters		-54.1	-41.7	-30.1	-51.5	-51.5						
Mean Reserves (bcf)	300	-65.7	-46.2	-27.1	-59.5	-59.5						
Reservoir Depth (m MSL)	3500	-16.7	38.4	88.7	4.4	4.4						
Reservoir Complexity	Medium	179.4	268.0	354.0	223.1	223.1						
Reservoir Pressure	Normally Pressured	233.1	342.0	448.3	305.0	305.0						
Areal Extent Factor	Medium											
Gas Calorific Value (btu/scf)	1017											
Liquid Yield (bbl/mcf)	3											
Gas Type	Sour											
Water Depth (metres)	200											
Tax / Royalty Parameters												
Small Reserves for Royalty	No											
High Risk for Royalty	No											
Flow-through for Tax	No											

Sensitivities

This sheet enables the user to specify a range (up and down) for a number of critical parameters and see the effect on the resultant NPV and other evaluation parameters. The user may adjust the sensitivity ranges in the cells in the top left hand corner of the Sheet and see the affect on the results presented in the tornado charts.

Cash Flow

This sheet shows the detail cash flow and start dates for the success case for the current prospect under evaluation and also shows the derivation of the risked evaluation.

Overrides

This sheet allows the user to override the cost and production calculations in the standard modules. The user can elect to override for stages individually or for all stages

Exploration

This sheet is the exploration module, it calculates the number of wells, the timing and the costs of the exploration program.

Development

This sheet is the development module, the start of development planning follows the end of exploration and the sheet calculates the number, type, timing and cost of development wells and development facilities.

Production

This sheet is the production module, production commences once the field facilities are commissioned and the initial production wells are completed.

Dependent on the number of wells available at first production and the drilling program, the program calculates the number of days to plateau and the time on plateau, and thence the decline period. The parameters for plateau rate and decline rate may be adjusted in the sheet **Schedule & Prod Assumptions**.

Revenue

This sheet calculates the gas and liquids revenue

Operations

This sheet is the operations module and calculates the operating costs for the field life

Abandonment

This sheet calculates the economic limit for the field and the abandonment cost. Production and operating costs are terminated at abandonment.

Royalty

This sheet calculates the royalty for the success case. For prospects commencing after the initial seismic phase, historical costs are estimated, but can be overridden in Cell C101 of sheet **Overrides**. The royalty calculation estimates the month at which the change over between each royalty tier is made.

Federal Tax

This sheet calculates the federal income tax payable for the field. As with royalty the historical costs are estimated by the model but can be overridden by the user in cells C102 and C103 of sheet **Overrides**.

Provincial Tax

This sheet calculates the provincial income tax payable for the field. As with royalty the historical costs are estimated by the model but can be overridden by the user in cells C102 and C103 of sheet **Overrides**.

Success Cash Flow

This sheet shows the success case cash flow for the prospect

Risked Cash Flow

This sheet shows the risked cash flow for the field

Selected Economics

This sheet shows the selected, prices, exchange rate and interest rates for the evaluation

Sched & Prod Assumptions

This sheet contains the assumptions relating to production, number of wells and assumptions used in the model, the user is able to override the cells with blue text.

Cost Assumptions

This sheet shows the unit cost and unit time assumptions used in the model. The user can set up to five costs sets and select the one to use in the sheet **Inputs**

Economic Assumptions This sheet shows the assumptions for prices, exchange rates, inflation and interest rates, and allows the user to set-up five Scenarios, which can be selected in the Sheet **Inputs**.

User1 – User5 These sheets are freeform (blank) sheets where users can enter their own data, create their own sub-models and link to the Overrides or the Assumptions sheets