Oil and Gas Exploration Economic Model Manual

Version 2.00

Introduction

This model is designed to provide screening economics for the evaluation of oil and gas exploration prospects and discoveries on the Nova Scotian shelf, either as tie-ins to existing infrastructure or as stand-alone developments.

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.

Inputting Data in the Model

All cells in the model designed for user input 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 data 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

five 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 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 blue text against a white background cells in the second column and the model results are summarised to the right of these inputs. If a cell appears with a red background then it has an invalid value. The required inputs are:

Evaluation Parameters 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 Cost 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
Product Type	The type of main product, either Oil or Gas
Mean Reserves	The estimated mean technical reserves in bcf if gas, mmbbl if oil, in the success case – this is reserves used to generate the production profile prior to the economic limit calculation
Water Depth	The water depth of the development in metres (m)

Development Method The proposed method of development for the field, for gas fields there are four methods of development:

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 to be 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. This option is only available to 110 metres water depth.

Jackup The field is to be 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. This option is only available to 200 metres water depth.

Tethered Structure / Semi The field is to be developed using a floating structure tethered to the seabed. This option is only available for water depths over 200 metres

For oil fields there are two methods of development:

FPSU The field is to be developed using a purchased floating production and storage unit with export by shuttle tanker.

Rented FPSU The field is to be developed using a rented floating production and storage unit with export by shuttle tanker.

Infrastructure Type **For a gas field development, the options for infrastructure type are:**

Satellite The field is to be 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 H_2S 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 it is assumed the field facility produces export quality sweet dry gas; if the field has H_2S then it is assumed this is removed on the field facility. It is assumed condensate is utilised for platform fuel.

For oil fields there is one export option, via **Shuttle Tankers**

Export Distance The distance from the field to 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 shore

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:

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 **High Pressured High Temperature (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 / GOR	The liquid yield of the gas in Barrels per thousand standard cubic feet (Bbls/mcf) for a gas field. The Gas Oil Ratio of the oil in standard cubic feet per barrel (scf/bbl).
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

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 (risked NPV divided by the committed discounted investment for proceeding with the current project stage) are shown.

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 by inputting in cells with the blue text against a white background. 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 reserve 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

Discount Rate	15%
Discount To	1-Jun-07
Economic Scenario	Base
Cost Set	Default
Project Parameters	
Start Date	01-Jun-07
Development Method	Subsea
Infrastructure Type	Satellite
Export Distance (km)	40
Facility Finance	Purchase
Lease Term (years)	10
Risk Parameters	
Seismic	70%
Wildcat	40%
Appraisal	70%
Development Planning	95%
Technical Parameters	
Mean Reserves (bcf)	300
Reservoir Depth (m MSL)	3500
Reservoir Complexity	Medium
Areal Extent Factor	Medium
Reservoir Pressure	Normally Pressured
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

Economic Thresholds for Different Project Maturities : NPV @ 15.0 %

	Reserves (bcf)										
	100	150	200	250	300	400	500	600	700	800	900
Seismic	-72.3	-57.3	-61.5	-50.9	-41.7	-31.3	-35.5	-27.0	-19.2	-12.1	-5.3
Wildcat	-96.6	-72.6	-77.6	-60.8	-46.2	-28.6	-36.6	-22.2	-9.0	3.0	13.5
Appraisal	-84.0	-17.5	-49.0	-2.0	38.4	85.9	82.1	118.7	154.5	188.0	205.5
Development Planning	-37.4	66.7	125.5	201.1	268.0	327.4	417.7	487.0	555.0	616.4	670.5
Development Start	-38.6	90.5	169.3	260.0	342.0	447.1	568.3	659.4	747.4	822.9	896.3

	Reservoir Depth (metres)						
	3000	3500	4000	4500	5000	5500	6000
Seismic	-34.2	-41.7	-49.6	-59.4	-66.8	-74.1	-81.2
Wildcat	-34.0	-46.2	-58.2	-70.5	-86.0	-97.8	-109.4
Appraisal	49.4	38.4	27.1	16.0	6.1	-14.8	-24.6
Development Planning	263.4	268.0	270.6	273.9	276.4	279.1	281.5
Development Start	335.8	342.0	347.1	350.9	355.2	359.4	362.4

	Economics Scenario				
	Low Price	Base	High Price	Scenario 4	Scenario 5
Seismic	-54.1	-41.7	-30.1	-51.5	-51.5
Wildcat	-65.7	-46.2	-27.1	-59.5	-59.5
Appraisal	-16.7	38.4	88.7	4.4	4.4
Development Planning	179.4	268.0	354.0	223.1	223.1
Development Start	233.1	342.0	448.3	305.0	305.0

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 evaulation parameters. The user may adjust the senstivity 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.

Prospect X

Discount Rate	15%
Discount To	1-Jun-07
Economic Scenario	Base
Cost Set	Default
Project Parameters	
Start Date	01-Jun-07
Development Method	Subsea
Infrastructure Type	Satellite
Export Distance (km)	40
Facility Finance	Purchase
Lease Term (years)	10
Risk Parameters	
Seismic	70%
Wildcat	40%
Appraisal	70%
Development Planning	95%
Technical Parameters	
Mean Reserves (bcf)	300
Reservoir Depth (m MSL)	3500
Reservoir Complexity	Medium
Areal Extent Factor	Medium
Reservoir Pressure	Normally Pressured
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

Economic Thresholds for Different Project Maturities : NPV @ 15.0 %

Reserves (bcf)

	100	150	200	250	300	400	500	600	700	800	900
Seismic	-72.3	-57.3	-61.5	-50.9	-41.7	-31.3	-35.5	-27.0	-19.2	-12.1	-5.3
Wildcat	-96.6	-72.6	-77.6	-60.8	-46.2	-28.6	-36.6	-22.2	-9.0	3.0	13.5
Appraisal	-84.0	-17.5	-49.0	-2.0	38.4	85.9	82.1	118.7	154.5	188.0	205.5
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Reservoir Depth (metres)

	3000	3500	4000	4500	5000	5500	6000
Seismic	-34.2	-41.7	-49.6	-59.4	-66.8	-74.1	-81.2
Wildcat	-34.0	-46.2	-58.2	-70.5	-86.0	-97.8	-109.4
Appraisal	49.4	38.4	27.1	16.0	6.1	-14.8	-24.6
Development Planning	263.4	268.0	270.6	273.9	276.4	279.1	281.5
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Economics Scenario

	Low Price	Base	High Price	Scenario 4	Scenario 5
Seismic	-54.1	-41.7	-30.1	-51.5	-51.5
Wildcat	-65.7	-46.2	-27.1	-59.5	-59.5
Appraisal	-16.7	38.4	88.7	4.4	4.4
Development Planning	179.4	268.0	354.0	223.1	223.1
Development Start	233.1	342.0	448.3	305.0	305.0

Government Take This sheet displays the percentage royalty and tax takes for different economic and reserves cases.

Cash Flow This sheet shows the detailed 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 by entering data in cells with a white background.

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 and white background.

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.** The user is able to input data in the cells with blue text and/or white background.

Economic Assumptions This sheet shows the assumptions for prices, exchange rates, inflation and interest rates, and allows the user to set-up five Scenarios by inputting data in

the cell with the blue text and white and/or blue background, 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