PRELIMINARY REPORT ON FISCAL DESIGNS FOR THE DEVELOPMENT OF ALASKA NATURAL GAS

BY
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For

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Section 4.3

Model assumptions and sensitivities

Part 4: Analysis of Alternative Upstream Fiscal Models for Alaska

4.3 Methodology for systematic sensitivity analysis of assumptions

The ten hypothetical gas and oil fields are evaluated in this study using an Excel workbook model designed to evaluate economic, fiscal and technical (reserves and production profiles) base cases that can be easily adjusted for sensitivity cases. The base-case economic assumptions are listed in Figure 4.3.1.

Economic Factors	
Analysis Start Year	1
Days / year Onstream	360
Gas Destination Price, Year 0 ($/mmbtu)	7.5
Sales Gas Calorific Value (BTU/cf)	1118
Year 0 Gas Price by Volume ($/mcf)	8.39
Gas Price Nominal Escalator (%/yr)	2.0%
Gas to boe (cf/boe)	6000
Oil (C5+) Destination Price, Year 0 ($/barrel)	80
Oil (C5+) Price Nominal Escalator (%/yr)	2.0%
LPG Destination Price, Year0 ($/ton)	860
LPG Conversion (Barrels/ ton)	11.5
Year 0 LPG Price by Volume ($/barrel)	74.8
LPG Price Nominal Escalator (%/yr)	2.0%
Costs Estimated in Money of Year	0
Cost Nominal Escalator (%/yr)	2.0%
Buying Power Inflation Deflator (%/yr)	2.0%
Producer's Discount Rate (%)	10.0%
Government Discount Rate (%)	5.0%

Figure 4.3.1 Economic assumptions for base-case models. The arrows illustrate that all economic input variables are adjusted easily in small increments (upwards and downwards) using the workbook. This can be performed manually using spreadsheet "spinners," or more systematically using VBA macros. Note that although LPG price and escalation are quoted in this table no LPG is in fact produced in the models as presented, rather the C3 and C4 components are left in the wet gas which goes into the gas pipeline.

The base-case year 0 natural gas price (US$7.5/mmbtu) and oil (C5+) price (US$80/barrel) are all high in terms of average prices for the past decade although not when compared to mid-2008 prices. A similar comment applies to LPG price, although this is not used in the analysis presented here as no LPG is extracted in Alaska in the scenarios developed. The high gas, oil and NGL price volatility in current markets requires wide ranges of values to be used to provide meaningful ranges of potential revenue streams from each model field.

The models apply nominal escalators to the year 0 input base-case prices and costs. These nominal escalations are used to calculate money of the day (MOD) cash flows which are then adjusted for inflation by applying a buying power deflator to provide cash-flow values in real terms. The models provide cash-flow analysis in both MOD and real terms. A 2.0% per year buying power deflator is applied to MOD cash flows in the analysis presented to establish real cash-flow values. In the case of real fields it could also be necessary to consider price discounts (premiums) to benchmark market prices for variable product quality (e.g. sulphur in natural gas or oil (C5+); low gravity or high wax in the oil). Such issues are not considered in the analysis undertaken.

Base-Case Natural Gas and Oil Price Forecasts

The real and nominal gas price profiles, escalated from the assumed base case year 0 starting point of US$ 7.5 per mmbtu (AECO, Alberta hub price) are illustrated in Figure 4.3.2. Price escalators applied to the year "0" price are 0% per year in real terms plus inflation of an additional 2% per year to provide MOD (nominal) prices across the lives of each field analyzed. 0% real escalation means that real values are quoted in dollars of year 0.

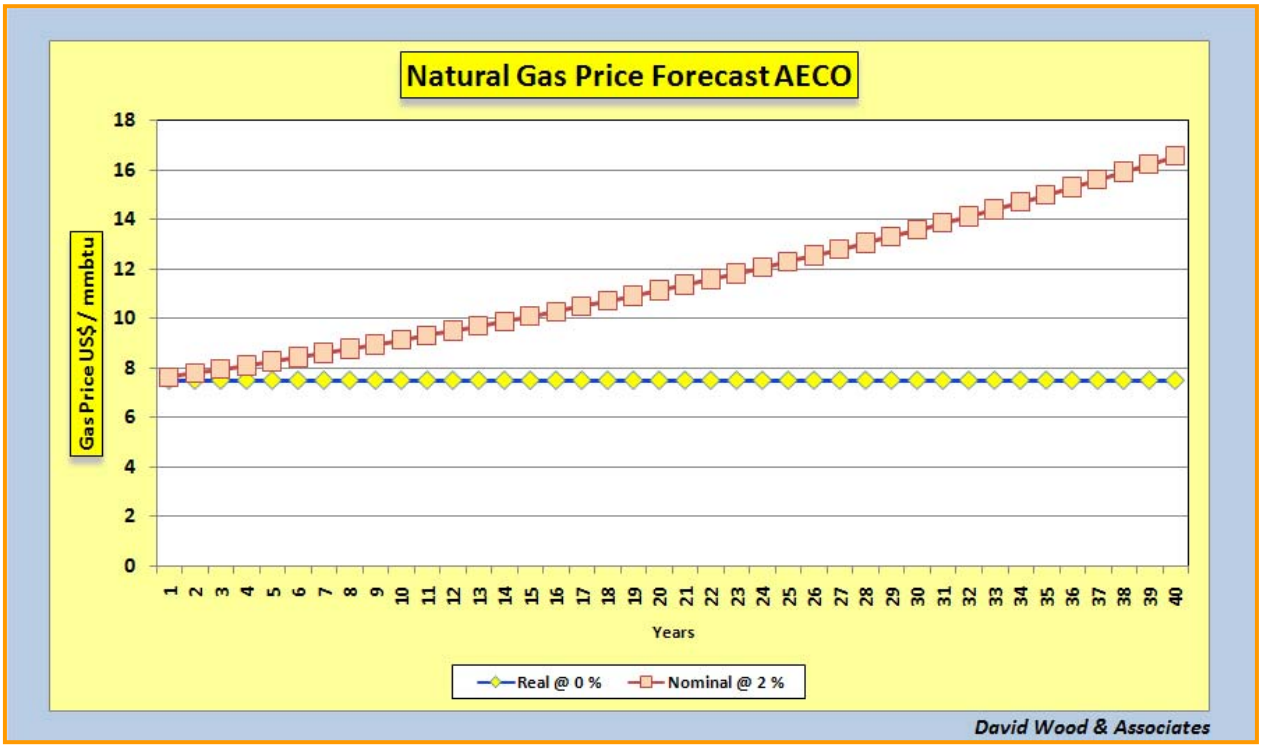

Figure 4.3.2. Base-case natural gas price forecast and assumptions for fiscal models. US$ 7.5 per mmbtu (AECO, Alberta hub price) is escalated at 0% per year real plus 2% per year for inflation.

For comparison the AECO natural gas price assumptions used by Black & Vetch (P50 case) and TransCanada in their 2008 representations to the State of Alaska are illustrated in Figure 4.3.3. These forecasts are based upon EIA Henry Hub prices through to 2030 with a US$0.75 discount for AECO relative to the Henry Hub prices. Black & Vetch (2008) escalated the 2030 prices at 1.9% per year in real terms (plus 2.5% inflation to yield their nominal forecast). TransCanada (2008) applied nominal escalation to the EIA AECO 2030 price at 2.2% per year for their nominal forecast. The nominal gas price forecast used in this study is closer to the Black & Vetch forecast, but somewhat higher in the period to 2020. The real gas price forecast used in this study is more conservative than both Black & Vetch and TransCanada.

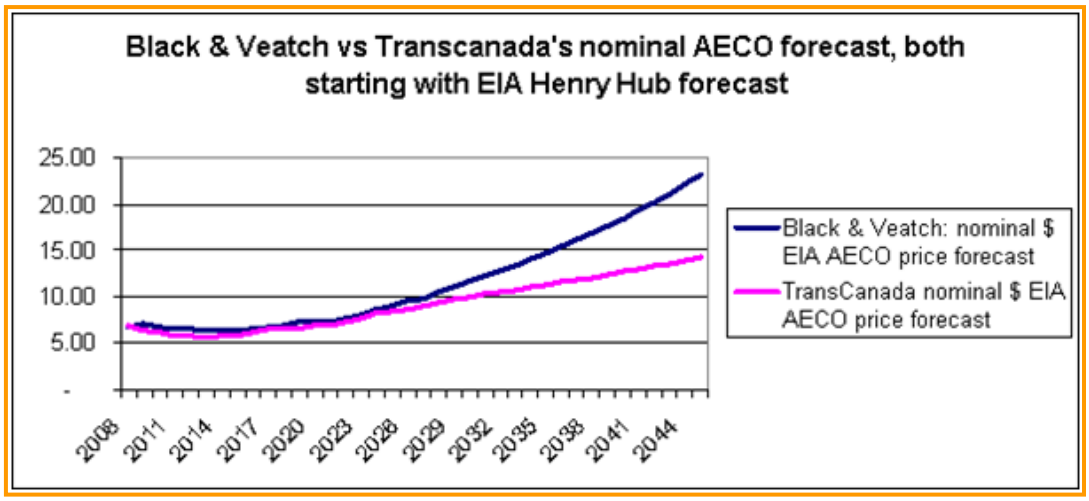

Figure 4.3.3. Other natural gas price forecasts used in 2008 for Alaska gas pipeline studies (source: D.E. Dickinson, 2008)

This study assumes a US$ 80 per barrel Alaska North Slope (ANS WC) crude oil price as a base case for year 0 and escalates that price at 0% per year in real terms and inflates it at an additional 2% per year to provide MOD (nominal) prices across the lives of each field analyzed. The real and nominal crude oil price forecasts applied to oil (C5+) are illustrated in Figure 4.3.4. 0% real escalation means that real values are quoted in dollars of year 0.

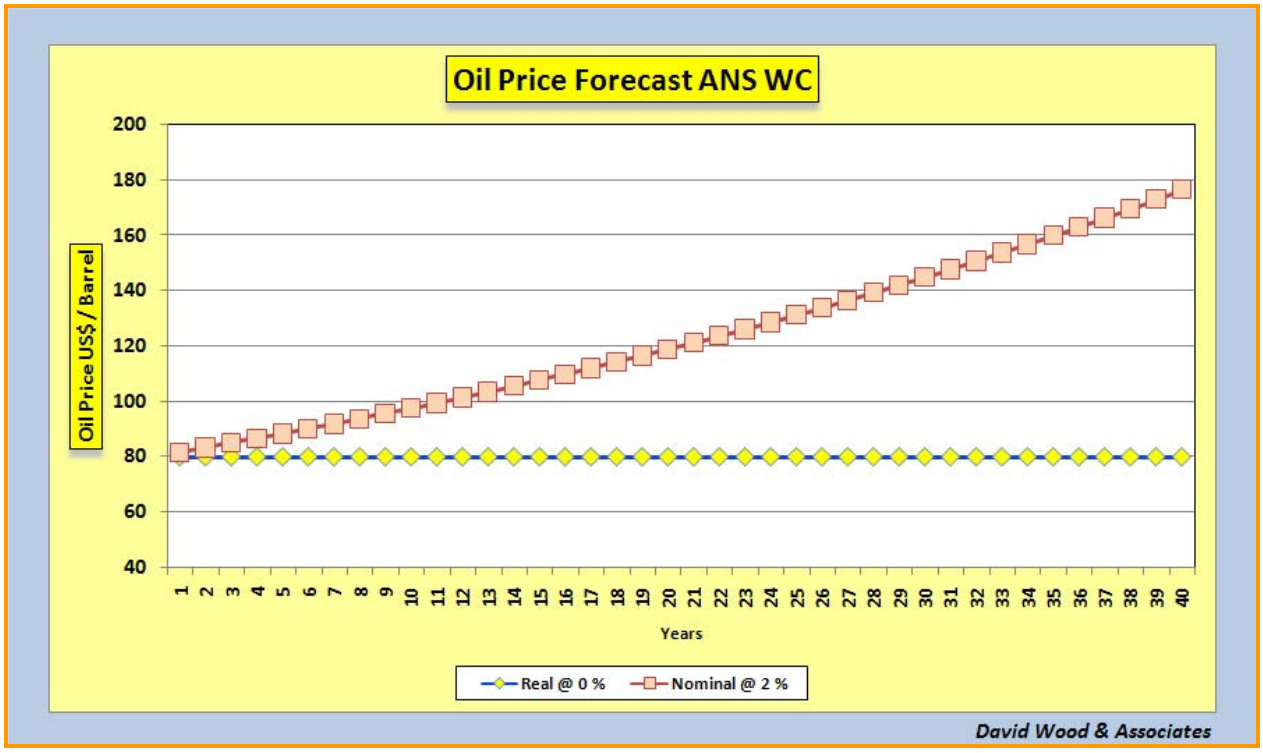

Figure 4.3.4. Base-case oil price forecast and assumptions for fiscal models. US$ 80 per barrel (ANS WC) price is escalated at 0% per year real plus 2% per year for inflation.

Production Related Sensitivity Adjustments

Sensitivities on Field Production Variables	
Gas Daily Start-up Rate (mmcf/d)	100%
Gas Daily Plateau Rate (mmcf/d)	100%
Years (+/-) to Production Start-up	0
Years (+/-) to Production Plateau	0
Gas Shut-in Rate (mmcf/d)	100%
Oil Daily Start-up Rate (bopd)	100%
Oil Daily Plateau Rate (bopd)	100%
Gas to Oil Ratio (cf/barrel)	100%
Field Decline Exponent	100%
Oil Shut-in Rate (bopd)	100%
Condensate Yield (barrels/mmcf)	100%
LPG Yield (barrel/mmcf)	100%
Years (+/-) to First Water Cut	0
Water Cut Initial Rate (%)	100%
Water Cut Growth Rate (%)	100%

Figure 4.3.5 Production adjusters for base-case models. The arrows illustrate that all production related input variables for bases cases are adjusted easily in small increments (upwards and downwards) using spreadsheet "spinners." 100% represents the base case (or zero for the timing variables).

Production rate, timing (start-up, decline, shut-in), condensate yield can all be adjusted from the base-case assumptions (Figure 4.3.5). Water-cut, its timing and growth rate can also be adjusted for each field base case.

Cost-Related Sensitivity Adjustments

All cost components input in the hypothetical field base cases can also be varied by sensitivities (Figure 4.3.6).

From project value perspectives five variables are identified as the main influences on field profitability excluding fiscal instruments:

- Product prices (gas and oil (C5+))
- Production volumes (gas and oil (C5+))
- Condensate yield
- Gas TT&T
- Costs (capital and operating)

Sensitivities on Upstream & TT&T Costs		
Capital Costs (CAPEX)		
Exploration & Appraisal ($ millions)	100%	
Gas Development Facilities ($/mcf)	100%	
Oil (C5+) Development Facilities ($/barrel	100%	
Gas / NGL Processing Plant ($millions)	100%	
Incremental/Forward Capital ($/boe)	100%	
Years (+/-) to Forward Capital Start Year	0	
Decommisioning ($ millions)	100%	
(Decommissioning / shut-down year is calculated by model)		
Operating Costs (OPEX)		
Fixed Field Operations ($ millions)	100%	
Variable Field Operations ($/boe)	100%	
Gas Treat Trans & Tariff ($/mcf)	100%	
Oil (C5+) TTransport & Tariff ($/barrel)	100%	
Fuel Gas Consumed by Operation	100%	

Figure 4.3.6 Cost adjusters for base-case models. The arrows illustrate that all production related input variables for bases cases are adjusted easily in small increments (upwards and downwards) using spreadsheet "spinners." 100% represents the base case (or zero for the timing variables).

Systematic Sensitivity Analysis

In addition to the ability to change the individual input elements using the spreadsheet spinners, VBA macros are also used to calculate and record in tabular and graphical form a series of systematic sensitivity cases. These cases are for a selection of seven key variables from each of the three (price, liquid yields and cost) main economic categories (Figure 4.3.7). Varying product rates was not included as the ten hypothetical fields studied already sample a wide range of production rates.

The particular sensitivity input data displayed in Figure 4.3.7 shows base-case values beneath the column marked "1.00" (e.g. gas price $7.5/mmbtu). The ten columns to the right of the base case show the sensitivity values applied to each of the variables listed. These numbers are in fact the base-case number multiplied by the adjusting factor above each column. For example, an oil price of $80 (under column heading 1.00) becomes $40 under column heading 0.50 (=$80 x 0.5) and $240 under column heading 3.00 (=$80 x 3.0). These values are applied to the model in sequence (i.e. individually with all other base-case values retained) and a series of selected economic performance variables are recorded for each and tabulated.

Sensitivity Analysis - changing selected input metrics by a factor to analyse field profitability														
Input Variables	Base Case =1.00	1.00	0.40	0.50	0.60	0.70	0.80	0.90	1.20	1.40	1.50	2.00	2.50	3.00
Year 1 Gas Price ($/mmbtu)	Field #4	7.5	3.0	3.8	4.5	5.3	6.0	6.8	9.0	10.5	11.3	15.0	18.8	22.5
Year 1 Oil Price ($ / Barrel)		80.0	32.0	40.0	48.0	56.0	64.0	72.0	96.0	112.0	120.0	160.0	200.0	240.0
Condensate Yield (barrels/mmcf)		20.0	8.0	10.0	12.0	14.0	16.0	18.0	24.0	28.0	30.0	40.0	50.0	60.0
Gas TT&T ($/ mcf)		4.5	1.8	2.3	2.7	3.2	3.6	4.1	5.4	6.3	6.8	9.0	11.3	13.5
Total Capex ($/boe)		4.37	1.75	2.18	2.62	3.06	3.49	3.93	5.24	6.12	6.55	8.74	10.92	13.11
Total Opex ($/boe)		3.05	1.22	1.52	1.83	2.13	2.44	2.74	3.66	4.27	4.57	6.10	7.62	9.14
Production Startup Accelerated (-) or Delayed (+) by Years		6					-2.0	-1.0	1.0	2.0	3.0			

Figure 4.3.7 Systematic sensitivity cases run from base-case starting assumptions (values shown are for gas field #4). For the first four items (prices, condensate yield and gas TT&T) the same range of values is applied to all ten fields. The ranges for the last three items (opex, capex and timing of production start-up) are specific to each field.

The results of several systematic sensitivity analysis cases run in batches by VBA macros are presented in subsequent sections of this report. One such table for the company real post-federal income tax NPV discounted at 10% for field #4 is shown in Figure 4.3.8 to illustrate just one of the variables recorded.

Impacts on Producer NPV (Real) @	10.0%	1.00	0.40	0.50	0.60	0.70	0.80	0.90	1.20	1.40	1.50	2.00	2.50	3.00
Gas Price	Producer NPV $ millions:	1508	-92	-1157	-465	79	586	1077	2242	2850	3111	4031	5146	6171
Oil Price	Producer NPV $ millions:	1508	959	1059	1156	1250	1339	1424	1672	1828	1904	2267	2594	2891
Condensate Yield	Producer NPV $ millions:	1508	1009	1096	1181	1264	1346	1427	1669	1825	1903	2284	2657	3020
Gas TT&T	Producer NPV $ millions:	1508	2626	2463	2291	2108	1917	1718	1042	513	242	-121	-89	-89
Capex	Producer NPV $ millions:	1508	2261	2140	2019	1894	1767	1640	1244	975	839	139	-594	-1363
Opex	Producer NPV $ millions:	1508	2759	2579	2389	2186	1971	1746	972	367	54	-116	-101	-105
Production Startup Accelerated (-) or Delayed (+) by Years		1508 Producer NPV $ millions:					2535	2001	1056	642	268			

Figure 4.3.8 Systematic sensitivity case output example from base-case starting assumptions (values shown are for gas field #4). NPV real discounted at 10% in the base case is US$1.508 billion (shown under column headed 1.00). Note for the spectrum of gas prices evaluated the NPV real discounted at 10% varies from US$1.157 billion for a model starting with a 2008 gas price of $3.0/mmbtu (=0.4 x 7.5 from Figure 4.3.7) to US$6.171 billion for a model starting with a 2008 gas price of $22.5/mmbtu (=3.0 x 7.5 from Figure 4.3.7).

It is the trends revealed by each variable value in the rows of Figure 4.3.8 that is revealing about the fiscal and project performance. This is reviewed in some detail in graphical form in Section 4.5.