

Outer Continental Shelf Petroleum Assessment, 2000

Introduction

This report presents the results of a multiyear effort by the Department of the Interior's Minerals Management Service (MMS) to assess the undiscovered crude oil and natural gas resources of the Nation's Outer Continental Shelf (OCS) areas. The OCS comprises the submerged offshore Federal lands of the United States. The results presented in this 2000 assessment reflect information and data available to the MMS as of January 1, 1999. They are listed in table format on pages 5 and 6 and graphical format on pages 9, 10 and 11.

This current assessment estimates the undiscovered, conventionally recoverable oil and natural gas resources located outside of known oil and gas fields on the OCS. The assessment considers recent geophysical, geological, technological, and economic information and uses a geologic play analysis approach for resource appraisal. Information on reserves is also provided.

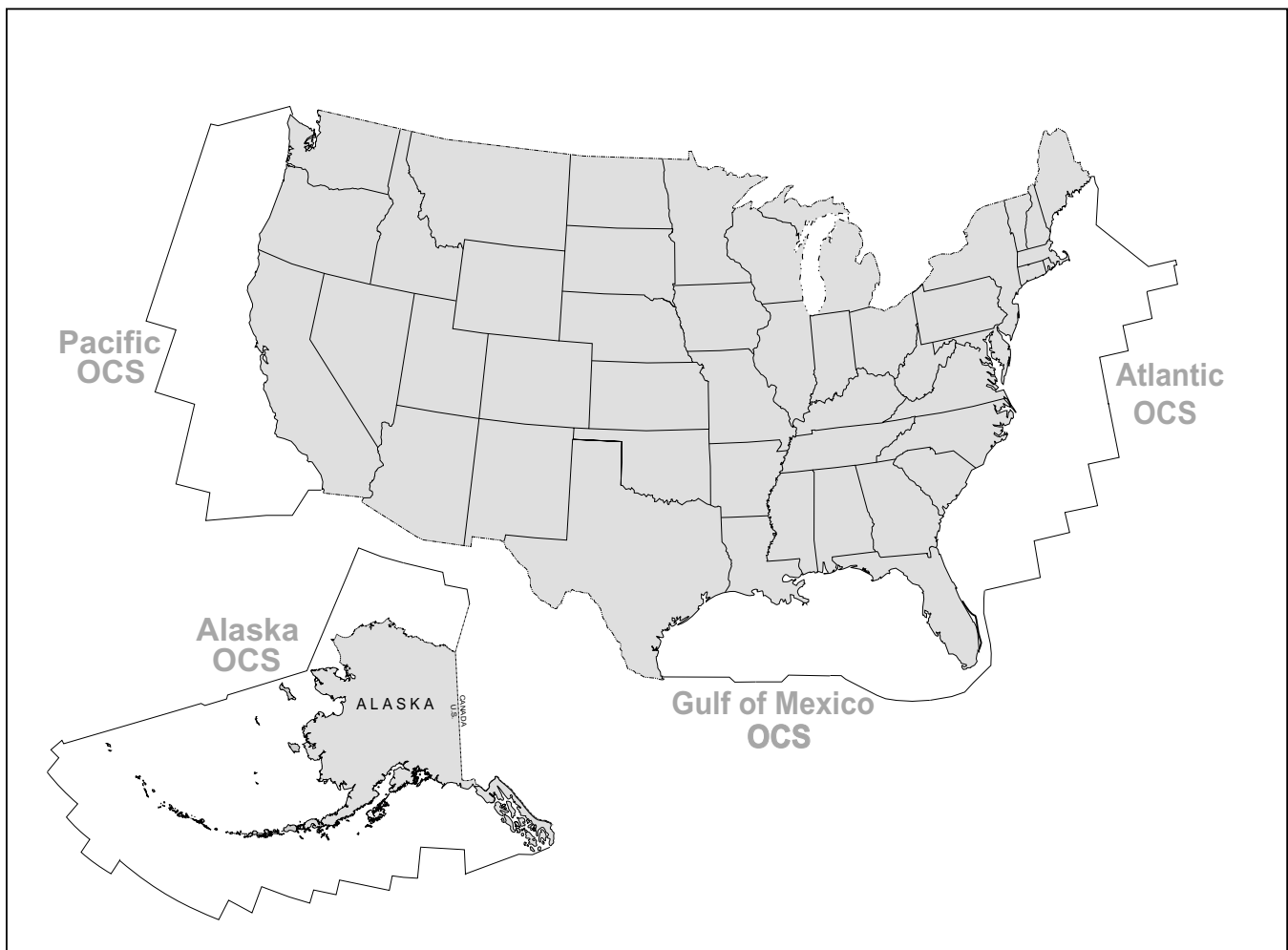


Figure 1. United States Outer Continental Shelf Regions.

This report, therefore, presents the updated assessment results since the 1995 assessment for the Alaska, Atlantic and Gulf of Mexico (GOM) OCS Regions (fig. 1). In the Alaska Region only the Beaufort, Chukchi, Hope, and Cook Inlet areas were updated as other planning areas lacked new data and changes since the last assessment. The Pacific OCS Region was not updated for the same reasons. The Atlantic OCS Region was reevaluated to reflect recent exploration results offshore Nova Scotia, current exploration and production technologies, and to make the water depth divisions compatible with the ones now being used in the GOM. More detailed information about the geology, assessment methodology, and economics will be published in separate regional assessment reports for the Gulf of Mexico and selected areas offshore Alaska.

Commodities Assessed

The assessed commodities for the OCS include crude oil and natural gas present in conventional reservoirs; unconventional resources (such as clathrates) were not assessed. In this assessment, natural gas present as natural gas caps associated with oil reservoirs, dissolved natural gas present in solution in crude oil, and nonassociated natural gas are reported collectively as natural gas. Condensate, which is the liquid resource recovered from produced natural gas, is combined with crude oil in reporting the results.

Estimates of undiscovered resources are presented in two categories:

- ◆ Undiscovered, conventionally recoverable resources
- ◆ Undiscovered, economically recoverable resources

Undiscovered Conventionally Recoverable Resources: *The portion of the hydrocarbon potential that is producible, using present or reasonably foreseeable technology, without any consideration of economic feasibility.*

Undiscovered Economically Recoverable Resources: *The portion of the undiscovered conventionally recoverable resources that is economically recoverable under imposed economic scenarios.*

Methodology

The methodology used in this assessment is the same as that used in the 1995 assessment. For a description of that methodology, see OCS Report MMS 96-0034.

Pool: *A discovered or undiscovered accumulation of hydrocarbons, typically within a single stratigraphic interval.*

The assessment methodology is based on the analysis of geologic plays. For plays in frontier areas with sparse data, analogs are developed using subjective probabilities to cover the range of uncertainties. Most plays in the Alaska OCS, Atlantic and some in the Pacific OCS were assessed this way. For mature areas with significant amounts of data, such as the Gulf of Mexico and southern California, plays were analyzed using a method based on statistical parameters of discovered pools and historical trends.

Play: *A group of pools that share a common history of hydrocarbon generation, migration, reservoir development, and entrapment.*

The current estimates of undiscovered, economically recoverable OCS oil and natural gas resources were developed using the following criteria:

- ◆ 12.5-percent or 16.7-percent royalty rate
- ◆ 35-percent Federal tax rate
- ◆ 3-percent inflation rate
- ◆ Cost of exploration, development, and transportation with their associated development scheduling scenarios for each OCS region and portions of regions when conditions warrant
- ◆ Natural gas prices related to oil prices at 66 percent of the oil-energy equivalent

Reserves Assessment

Reserves were not estimated specifically as a part of this assessment. The MMS estimates for proved oil and natural gas reserves for the OCS are revised annually and are reported for individual fields in MMS publications, most recently *Estimated Proved Oil and Natural Gas Reserves, Gulf of Mexico, December 31, 1998*, OCS Report MMS 2000-069, and *Estimated Oil and Natural Gas Reserves, Pacific Outer Continental Shelf (as of December 31, 1998)* OCS Report MMS 2000-063.

Reserves: Hydrocarbon resources that have already been discovered and may be commercially recoverable under reasonably foreseeable economic scenarios.

Reserves Appreciation: A term synonymous with reserves growth and inferred reserves/indicated reserves. Reserves appreciation refers to the expected increase in estimates of proved reserves as a consequence of extension of known pools or discovery of new pools within existing fields or through the application of improved recovery techniques.

Estimates of unproved reserves in the Gulf of Mexico are published as aggregate estimates in the report 2000-069. Estimates of unproved reserves for the Pacific OCS Region can be found in report 2000-063. The reserve estimates in this assessment are obtained from these reports.

Proved Reserves: Reserves that can be estimated with reasonable expectation to be recoverable with existing technology under current economic conditions, such as prices and costs prevailing at the time of the estimate.

Unproved Reserves: Reserves based upon geologic or engineering information similar to that used in estimates of proved reserves, but technical, contractual, economic, or regulatory uncertainties preclude them being classified as proved.

The process for determining reserves appreciation in the Gulf of Mexico Region is described in Appendix A of OCS Report MMS-96-0047 *Summary of the 1995 Assessment of Conventionally Recoverable Hydrocarbon Resources of the Gulf of Mexico and Atlantic Outer Continental Shelf*.

Because of the limited number of fields and the lack of systematic reserves growth in the Pacific OCS Region, reserves appreciation was not estimated for Pacific OCS fields (OCS Report MMS 97-0019, Appendix A). See Table 3, page 6 for reserve estimates.

Assessment Results

The 2000 estimates of the undiscovered, conventionally recoverable oil and natural gas resources for the OCS are presented in Table 1 for the four OCS regions and total OCS. The estimates reflect the geologic data and information available to MMS as of January 1, 1999.

Table 2 presents estimates of the undiscovered, economically recoverable oil and natural gas resources for the four OCS regions based upon the mean resource estimate at prices of \$18 and \$30 per barrel for oil and \$2.11 and \$3.52 per thousand cubic feet (Mcf) of natural gas.

Estimates of these resources for each OCS region as well as an S curve and a price-supply (p-s) curve for each region are presented on pages 9, 10 and 11. Results for individual plays and basins will be presented in regional reports to be released separately. The regional reports will include detail on the regional-level estimates. The Alaska Region will also include a sensitivity study showing what could be available to a local Beaufort processing plant at a given price.

The total oil and natural gas endowment, less cumulative production, for the Nation's OCS as of January 1, 1999 comprising estimates (mean) of undiscovered resources, remaining proved reserves, unproved reserves, and reserves appreciation is presented in Table 3. Although summarized in this table, the estimates for each category should be viewed independently because of the relative uncertainties pertaining to (1) the existence and the estimated quantities of undiscovered, conventionally recoverable oil and natural gas resources in the lightly explored OCS areas and (2) the amounts that may eventually become economically viable under future economic realities. The estimates of unproved reserves and reserves appreciation also have a degree of uncertainty incorporated. Even proved reserves

Oil and Natural Gas Endowment: Resources that include undiscovered conventionally recoverable resources, proven and unproven remaining reserves, cumulative production, and reserves appreciation.

have some uncertainties associated with the estimation process.

Technological advances in hydrocarbon exploration and development are sure to occur in the future, yet the nature of advancement is extremely hard to predict and its impact difficult to estimate. However, past experience indicates most technological breakthroughs occur during high-cost scenarios and impact exploration and development by lowering the cost and sometimes by improving the chance of success.

For the purpose of this assessment, recent technological advances in gathering, processing, and interpreting seismic data contributed to the identification and mapping of geological plays and development of geologic parameters used to model the plays. Similarly, recent technological advances in offshore drilling and development operations were incorporated through the assumptions associated with the costs of these activities. However, no attempt was made to determine an empirical relationship between the future technological advancements and the estimated undiscovered resources. MMS believes however, that any technological advances in the future will significantly affect the resource portion represented by undiscovered, conventionally recoverable resources, resulting in an increased percentage of them being classified as economically recoverable resources. If these lower costs can be estimated on a per barrel basis, their effect on economic resources, at any given price, may be approximated by adding the cost effect to the price and re-estimating the resource from the p-s curve.

Table 1. Estimates of Undiscovered, Conventionally Recoverable Resources for the United States OCS¹

[Tcf = trillion cubic feet; Bbbl = billion barrels; BOE = barrels of oil equivalent]

Region	Oil (Bbbl)			Natural Gas (Tcf)			BOE (Bbbl)		
	Low	High	Mean	Low	High	Mean	Low	High	Mean
Alaska	16.5	35.4	24.9	55.0	226.8	122.6	28.0	71.9	46.7
Atlantic	1.9	2.8	2.3	23.9	34.1	28.0	6.2	8.9	7.3
Gulf of Mexico	33.4	44.9	37.1	180.4	207.2	192.7	65.5	81.8	71.4
Pacific	9.0	12.6	10.7	15.2	23.2	18.9	11.8	16.6	14.1
Total OCS ²	63.7	88.3	75.0	292.1	468.6	362.2	117.8	166.9	139.5

¹ *Low and High* values refer to those estimates that occur at the 95th and 5th percentiles, respectively, on a cumulative distribution curve (see fig. 3). The *Mean* value is the arithmetic average of all values in the distribution. 5.62 MCF equates to 1.0 BOE.

² *Low and High* values are not additive to reach the *Total* values; only *Mean* values are additive.

Table 2. Mean Estimates of Undiscovered, Economically Recoverable Resources for the United States OCS (at \$18 and \$30 per barrel of oil and \$2.11 and \$3.52 per Mcf natural gas)

[Tcf = trillion cubic feet; Bbbl = billion barrels]

Region	\$18 Oil (Bbbl)	\$2.11 Natural Gas (Tcf)	\$30 Oil (Bbbl)	\$3.52 Natural Gas (Tcf)
Alaska	3.3	1.6	10.1	3.0
Atlantic	0.5	6.6	1.3	12.8
Gulf of Mexico	17.5	100.3	28.1	140.7
Pacific	5.3	8.3	7.2	11.6
Total OCS	26.6	116.8	46.7	168.1

Table 3. Total Oil and Natural Gas Potential in the United States OCS.

(Bbbl = billion barrels; Tcf = trillion cubic feet)

Category	Oil (Bbbl)			Gas (Tcf)		
	Low	High	Mean	Low	High	Mean
Undiscovered Conventionally Recoverable Resources	63.7	88.3	75.0	292.1	486.6	362.2
Proved Reserves	-	-	3.8	-	-	31.3
Unproved Reserves	-	-	2.3	-	-	6.0
Reserves Appreciation	-	-	7.7	-	-	68.1

Comparison with Previous Assessments

A general comparison of 1995 and 2000 assessment results is given in Figure 2. The considerable increase in the Gulf of Mexico OCS Region's undiscovered, conventionally recoverable oil and natural gas resources accounts for most of the significant overall

increase in OCS conventionally recoverable estimates. This increase, in turn, is mostly attributable to recent deepwater exploration results and additional areas assessed. These areas include the deep, older section on the central and western gulf shelf below 20,000 feet sub-sea, the Cenozoic section beyond the Sigsbee Escarpment, and the deepwater

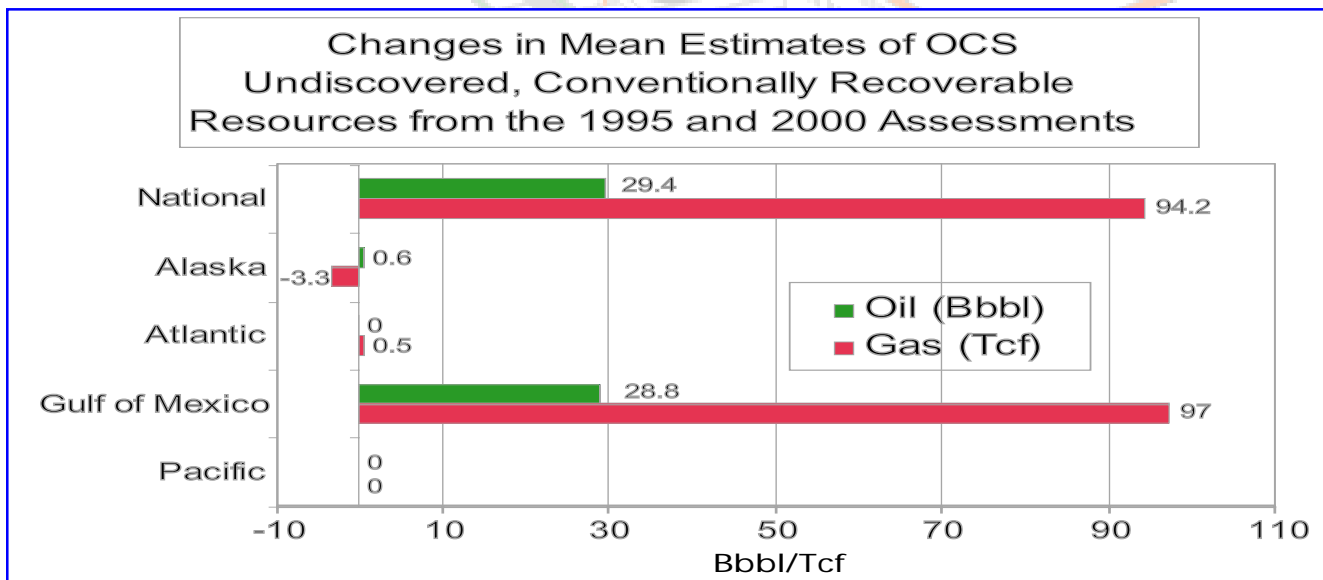


Figure 2. Comparison of Conventionally Recoverable Resources between the 1995 and 2000 Assessments.

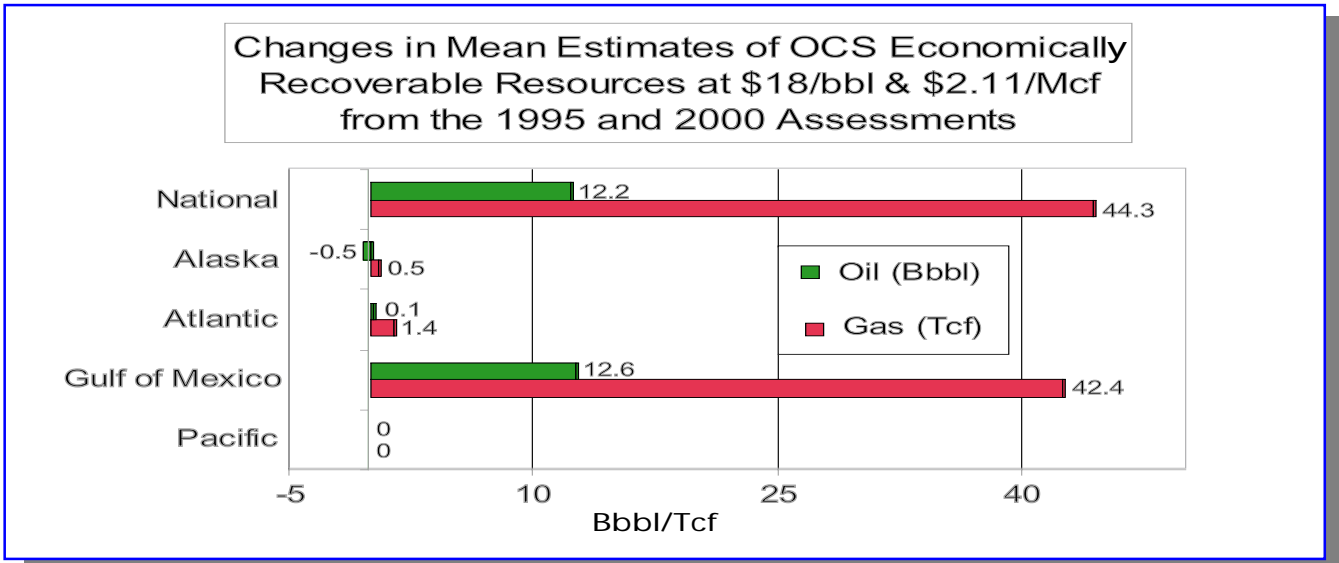


Figure 3. Comparison of Economic Resources between the 1995 and 2000 Assessments.

Mesozoic section not on the Florida platform.

The amount of Alaska OCS conventionally recoverable gas indicates a moderate decrease. This change results from slightly smaller resources in Chukchi and Hope basins. However, the former is masked by the change in basin boundary.

Changes in OCS economic resources are also primarily due to Gulf of Mexico changes. Alaska Region oil resources have declined in the arctic and the gas resources have increased due to a local market scenario in Cooke Inlet.

Assessed Resources for OCS Regions

The assessed results for the four OCS Regions are presented in the columns on pages 9, 10 and 11. For each region, the undiscovered conventionally recoverable resources and undiscovered,

economically recoverable resources are shown.

Cumulative Resource Distribution (S Curves)

An S curve as illustrated in figure 4 depicts resource volumes of conventionally recoverable oil or gas on the x axis and percentiles on the y axis. A percentile

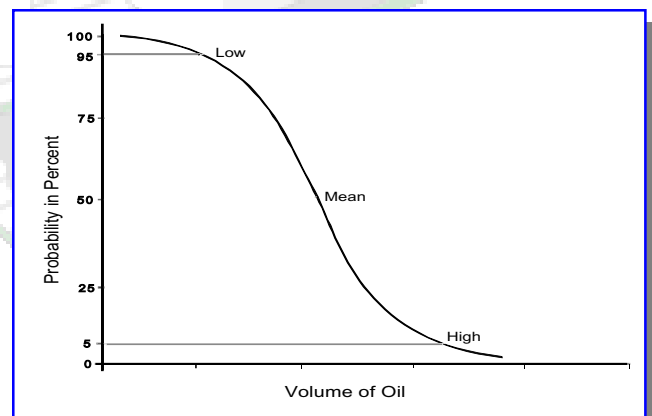


Figure 4. Sample S Curve Showing Cumulative Resource Distribution.

corresponds to a point on the distribution with a percent chance of that amount or greater occurring.

An S curve showing cumulative resource distribution is presented for each region. The mean value is also presented, and it is usually accepted as the best indicator of central tendency. The mean of a distribution is the arithmetic average of all the values in the distribution. Another unique attribute of the mean is that, when it is multiplied by its appropriate marginal probability, it can be added or subtracted. This attribute is only valid for the mean case, appropriately conditioned, and is not applicable to estimates at other percentiles.

Assessors frequently report estimates at 95th and 5th percentile levels, as well as the mean estimate. The 95th percentile estimate (sometimes called the *low* or *conservative* estimate) reflects the resource quantity having a 95-percent probability that the ultimate

Marginal Probability of Hydrocarbons: An expression, usually a decimal fraction, of the likelihood that an oil/natural gas accumulation may be present in a prospect, play, basin, province, or area.

resources will equal or exceed, whereas the 5th percentile estimate (sometimes called the *high* or *optimistic* estimate) reflects the level at which there is a 5-percent probability that the ultimate resources will be greater than or equal.

Price-Supply Curves

A price-supply curve shows the relationship of price to economically recoverable resource volumes (i.e., horizontal line from the price axis to the curve yields

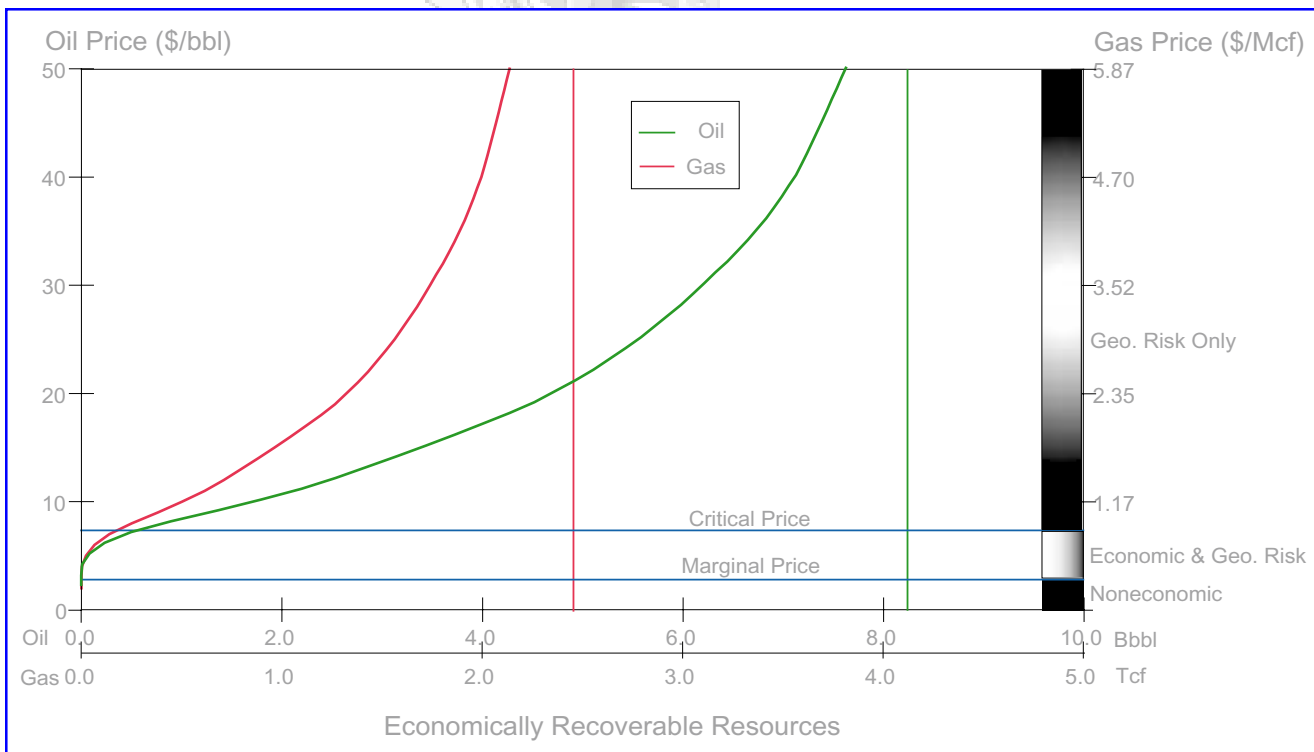
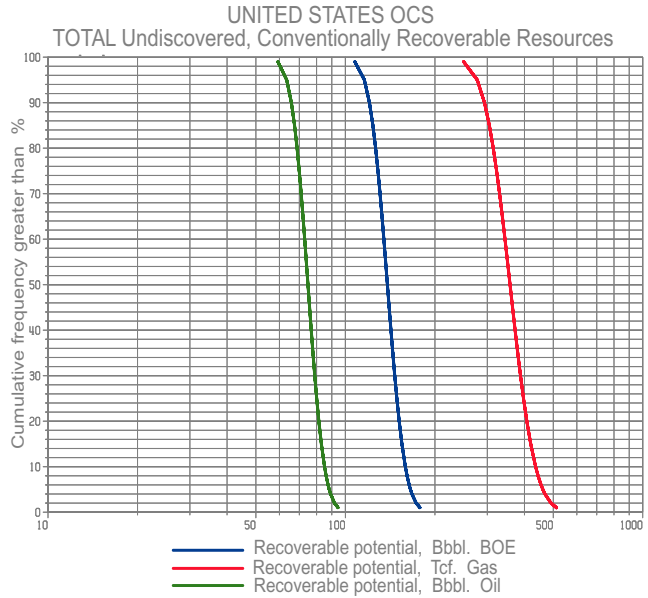


Figure 5. Sample Price - Supply Curve.

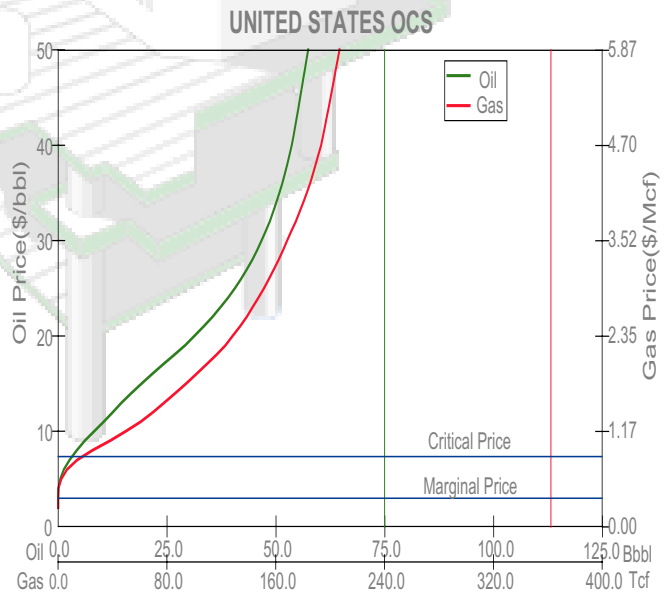
the quantity of economically recoverable resources at the selected price). (See fig. 5)

The price-supply curve for each region shows two curves and two price scales, one for oil and one for gas. The curves represent mean values at any specific price. They are not independent of each other; that is, one specific oil price cannot be used to obtain an oil resource and a separate gas price used to get a gas resource. The gas price is dependent on the oil price and must be used in conjunction with the oil price on the opposite axis to calculate resources. The reason for this condition is that oil and gas frequently occur together and the individual pool economics are calculated using the coupled pricing. A different gas price associated with the oil price would result in a different resource number than that shown on the curve.

Two horizontal lines within the graph indicate critical price and marginal price. Values above the critical price indicate that at least one economic pool exists. Below the marginal price, no resources can be recovered economically. Values between the critical price and the marginal price reflect both economic and geologic risks. The two vertical lines (green for oil and red for natural gas) indicate the mean estimates of conventionally recoverable oil and natural gas resources. At high prices, the economic resource volumes approach the conventionally recoverable volumes. These curves represent resources available with sufficient exploration and development efforts and do not imply immediate response to price changes.

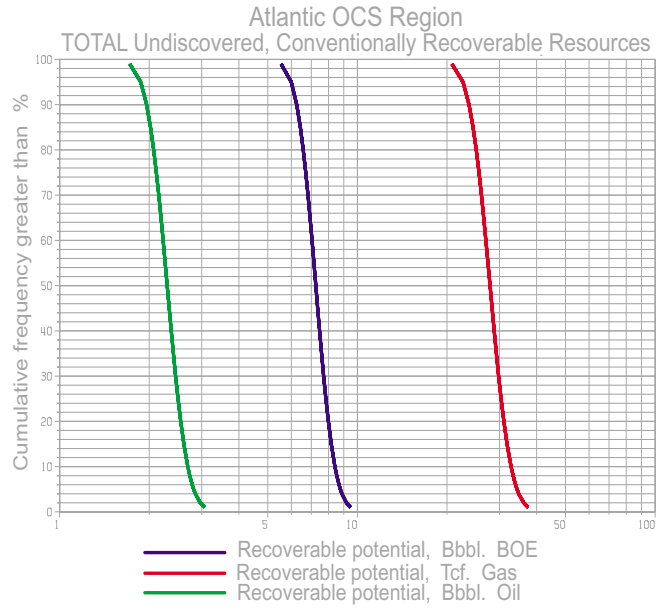
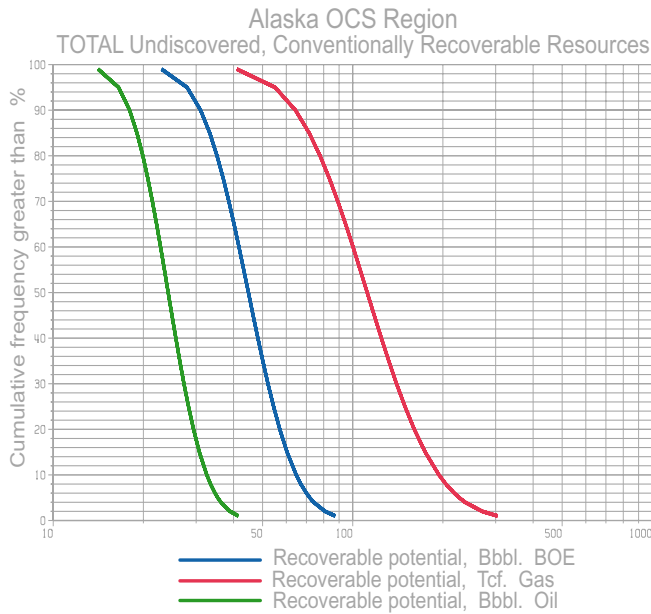


Undiscovered Resources	Mean Oil (Bbbl)	Mean Gas (Tcf)
Conventionally Recoverable	75.0	362.2
Economically Recoverable @ \$18/bbl 2.11/Mcf	26.6	116.8



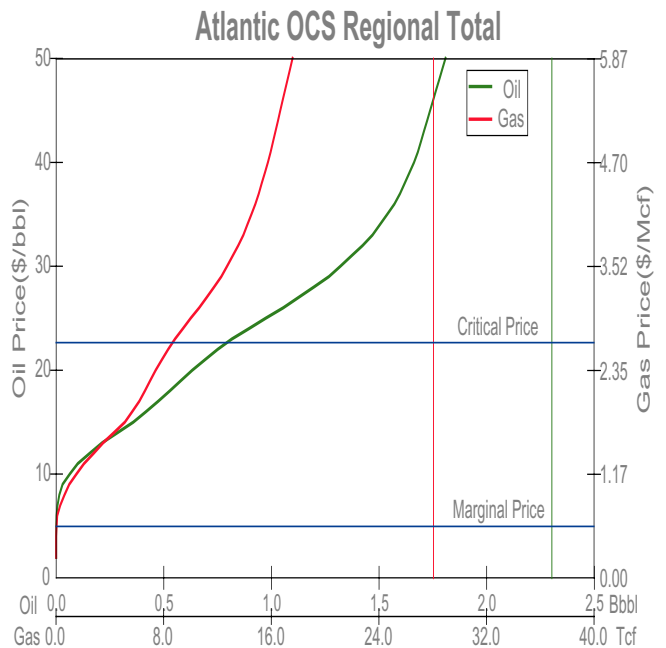
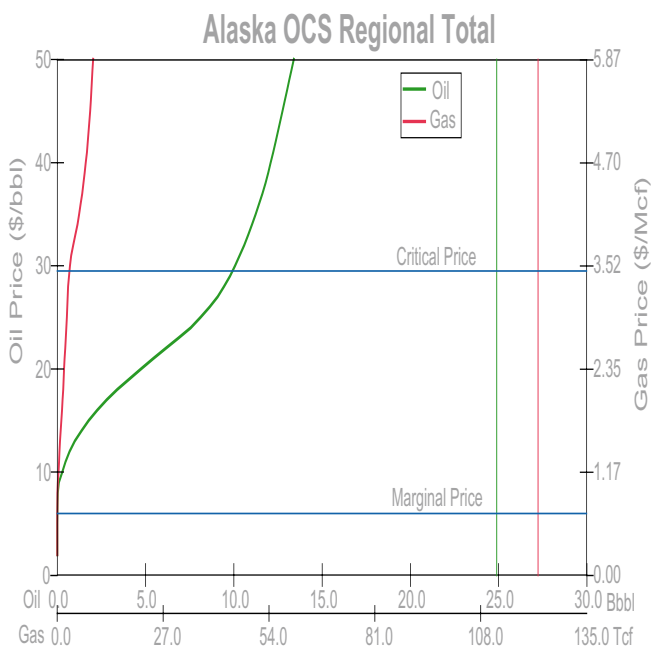


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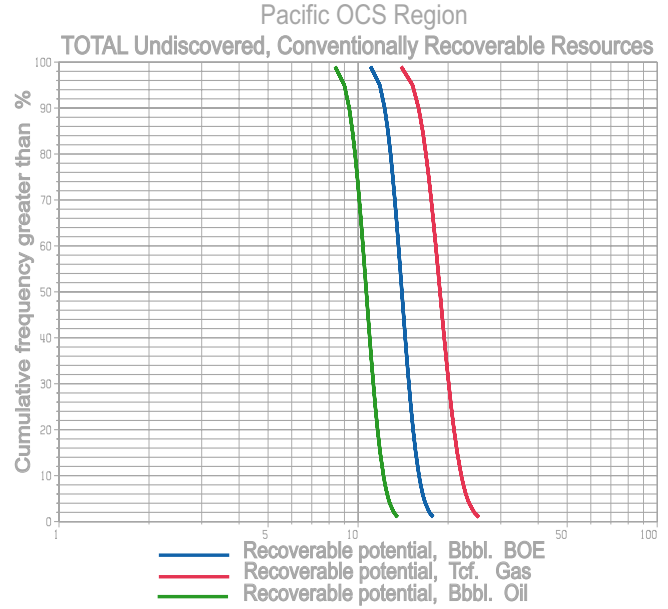
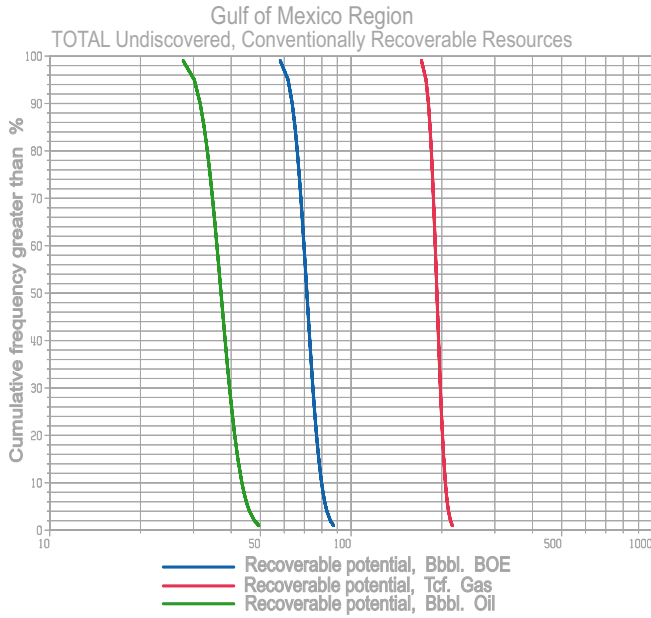
Undiscovered Resources	Mean Oil (Bbbl)	Mean Gas (Tcf)
Conventionally Recoverable	24.9	122.6
Economically Recoverable @ \$18/bbl 2.11/Mcf	3.3	1.6

Undiscovered Resources	Mean Oil (Bbbl)	Mean Gas (Tcf)
Conventionally Recoverable	2.3	28.0
Economically Recoverable @ \$18/bbl 2.11/Mcf	0.5	6.6



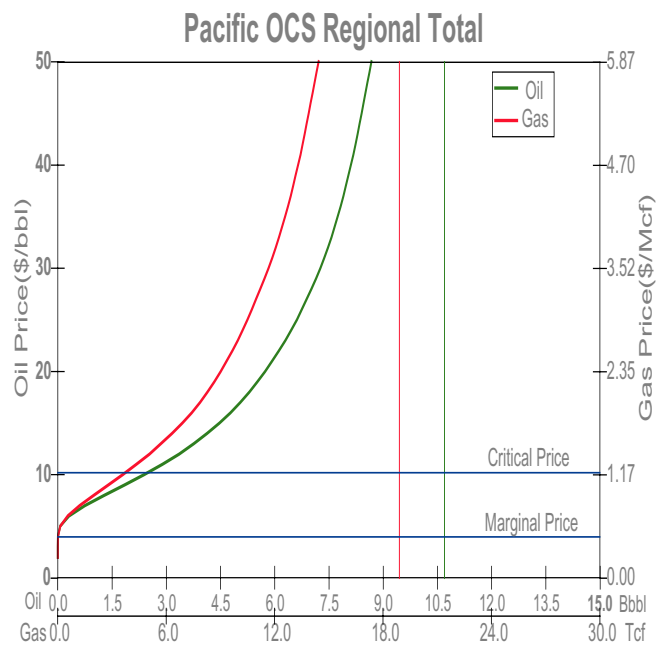
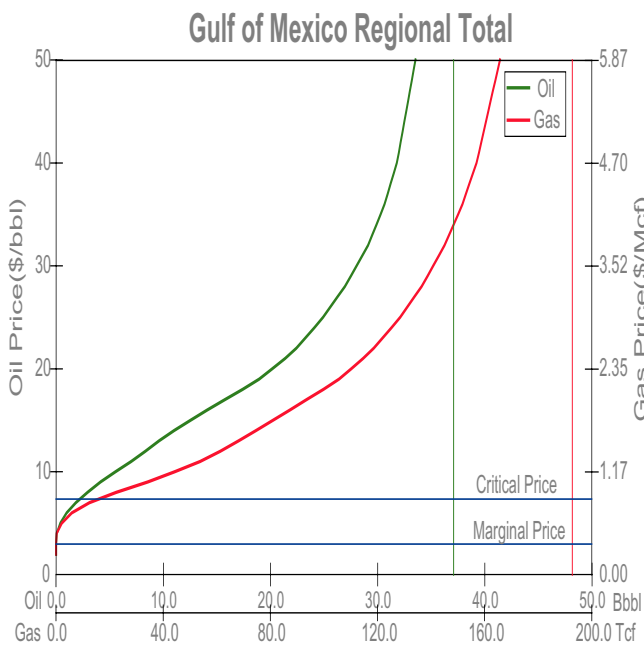


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Undiscovered Resources	Mean Oil (Bbbl)	Mean Gas (Tcf)
Conventionally Recoverable	37.1	192.7
Economically Recoverable @ \$18/bbl 2.11/Mcf	17.5	100.3

Undiscovered Resources	Mean Oil (Bbbl)	Mean Gas (Tcf)
Conventionally Recoverable	10.7	18.9
Economically Recoverable @ \$18/bbl 2.11/Mcf	5.3	8.3





***U. S. Department of the Interior
Minerals Management Service***

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