OCS Report
BOEM 2022-022

U.S. Outer Continental Shelf Gulf of Mexico Region

Oil and Gas Production Forecast 2022-2031

U.S. Department of the Interior
Bureau of Ocean Energy Management
Gulf of Mexico OCS Region

Cover: Shell's Appomattox Platform. Appomattox is a semi-submersible platform with first production in May, 2019 with a capacity of 200,000 BOPD. Photo from Chron.com (accessed on 12/13/2021): https://www.chron.com/business/energy/article/Shell-starts-production-at-new-Appomattox-13878528.php#photo-16986450

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Oil and Gas Production Forecast:
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Gulf of Mexico OCS Region
Office of Resource Evaluation

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A Message From the Regional Director

Since the Bureau of Ocean and Energy Management (BOEM) published its previous production forecast in 2017, many things have changed. The COVID-19 pandemic began in 2020, the U.S. Gulf Coast experienced significant hurricanes in both 2020 and 2021 – and Federal Gulf of Mexico (GOM) oil production reached all-time highs in 2018 and 2019. Furthermore, the U.S. Federal Government has taken on a renewed focus on the transition to renewable energy.

As the U.S. actively transitions to renewable sources of energy, the Gulf of Mexico remains an important hydrocarbon basin for meeting our Nation's energy needs. As of March 2022, 15% of U.S. oil production and 1% of natural gas production comes from Federal Outer Continental Shelf (OCS) leases in the GOM with more resources yet to be discovered (EIA, 2022). Per BOEM's 2021 Resource Assessment Fact Sheet, estimates of undiscovered technical recoverable resources for the GOM range from approximately 23.31 billion barrels of oil (BBO) in the low side to 36.27 BBO in the high side, with an expected value of 29.59 BBO. Similarly, gas estimates range from 46.88 trillion cubic feet of gas (TCFG) to 62.56 TCFG, with an expected value of 54.84 TCFG (BOEM, 2021a). Such estimates of technically recoverable resources indicate the GOM will continue to have hydrocarbon resources to help meet the energy needs of the United States for years to come, and, as this report will show, that continued annual oil production growth is anticipated in the GOM region over the coming years.

Despite the significant changes which have occurred since the last production forecast was published, the mission and vision of BOEM have remained the same. The Mission of the Bureau of Ocean Energy Management is to manage development of U.S. Outer Continental Shelf energy and mineral resources in an environmentally and economically responsible way. The Vision of BOEM is excellence in this effort to ensure environmental sustainability and efficient economic development.

While the goal of balancing environmental responsibility and economic development is difficult, this balance can be achieved when all stakeholders have access to the best available information, provided with full transparency. Thus, in accordance with the Outer Continental Shelf Lands Act (OSCLA), BOEM provides the following forecast and discussion so that all stakeholders may benefit from science-based, data-driven conclusions and make informed decisions which are critical to the future of the United States for generations to come.

In fulfillment of this requirement, I am pleased to present the U.S. Outer Continental Shelf Gulf of Mexico Oil and Gas Production Forecast: 2022-2031.

Michael A. Celata
Regional Director
Gulf of Mexico Region
Bureau of Ocean Energy Management

Cautionary Note

This report contains forward looking statements concerning exploration, development and production activity, and operations of a wide range of private businesses that are directly or indirectly involved in the development of oil and gas resources on the Outer Continental Shelf of the U.S. Gulf of Mexico. All text, figures, tables, charts, and graphs other than those that state or represent historical facts are forward-looking statements. Forward-looking statements in this report reflect the current expectations of the Bureau of Ocean Energy Management, Gulf of Mexico Region regarding oil and gas production from the Gulf of Mexico, OCS and include known and unknown risks and uncertainties that may cause actual results to differ materially from those expressed or implied.

Forecast Highlights

The BOEM, Gulf of Mexico Region (GOMR) Oil and Gas Forecast 2022-2031 is shown in **Figure 1** (historical oil and gas production are also shown for reference). During the forecast period, GOMR oil production is expected to experience continued growth and multiple record years of total oil production, despite off-trend production levels in 2020 and 2021. Gas production is expected to experience moderate increases but is not expected to rebound near previous highs. The growth in annual oil production predicted in the following years is supported by a strong project queue (as deferred projects will now be executed).

The off-trend production seen in 2020 and 2021 is attributed to the impact of hurricanes in both years, as well as the financial impact of COVID-19 which resulted in the deferral of several offshore projects. The hurricane impacts of these two years are historically abnormal. As such, this forecast assumes that the large hurricane production impacts of 2020 and 2021 will not be representative of the years to come.

The transition to renewable sources of energy is underway. Renewable energy sources and increases in energy efficiency have begun to decrease demand for oil production and this trend will continue. While these impacts are not explicitly forecasted in this report, they are inherently included in the forecast. The transition to renewable energy sources has already affected the various inputs and data sources on which this forecast is based, and therefore, this transition is integral to the BOEM, GOMR Oil and Gas Forecast 2022-2031.

This forecast demonstrates that for the next ten years, the Gulf of Mexico can and will continue to support America's energy demands and economic development as needed - even as the United States continues to make strides toward sustainable energy sources.

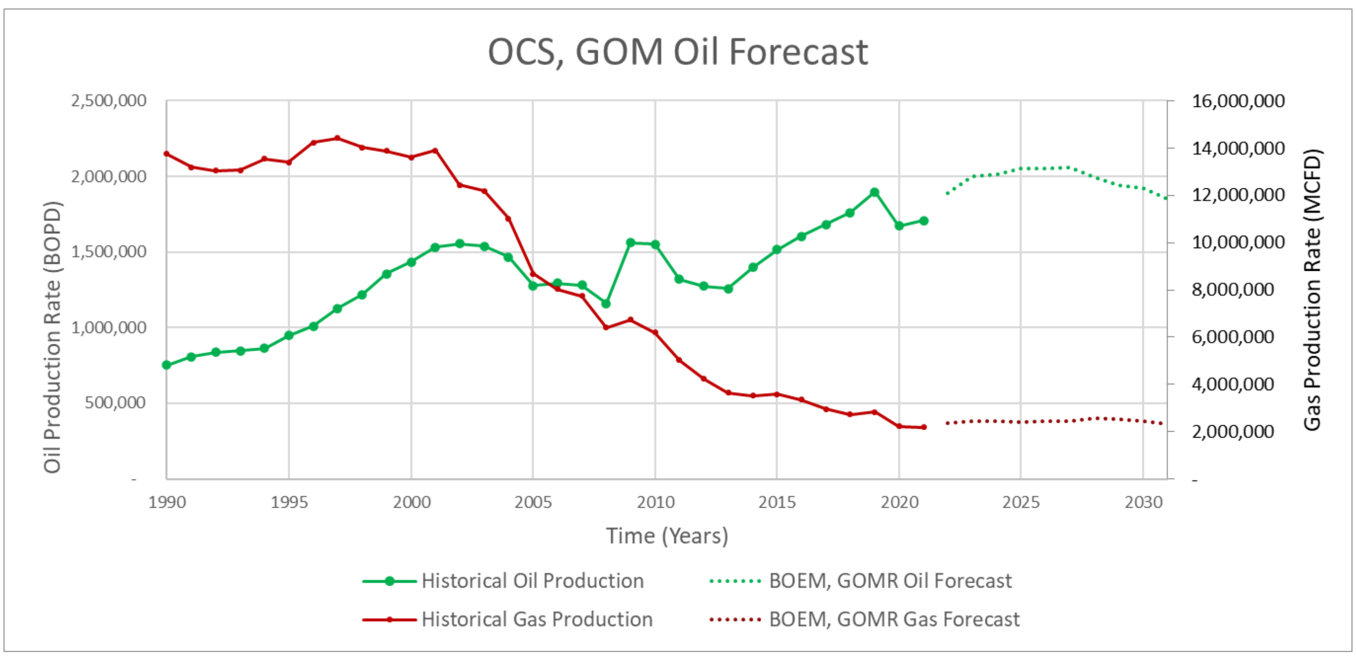

Figure 1: BOEM, GOMR Oil & Gas Forecast, 2022-2031

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Abbreviations and Acronyms

BBO – Billion barrels of oil
BBL – Barrel(s)
BCFG – Billion cubic feet of gas
BCFPD – Billion cubic feet per day
BOEM – Bureau of Ocean Energy Management
DCA – Decline Curve Analysis
GOM – Gulf of Mexico
GOMR – Gulf of Mexico Region
MCF – Thousand standard cubic feet of gas
MCFD – Thousand standard cubic feet of gas per day
MMBO – Million barrels of oil
MMBOE – Million barrels of oil equivalent
OCS – Outer Continental Shelf
OCSLA – Outer Continental Shelf Lands Act
QA/QC – Quality Assurance & Quality Check
TCFG – Trillion cubic feet of gas
U.S. – United States

Introduction

This production forecast provides the public with BOEM's 10-year annual oil and gas production outlook for the U.S. Outer Continental Shelf (OCS), Gulf of Mexico (GOM) and is the first of its kind published by BOEM since 2017 (BOEM, 2017). The OCS includes all portions of the Gulf of Mexico which are owned by and under the jurisdiction of the U.S. Federal Government. However, the forecasts provided in this report are limited to oil and gas volumes which originate in the Western Planning Area, Central Planning Area, and a small portion of the Eastern Planning Area, as shown in **Figure 2** below.

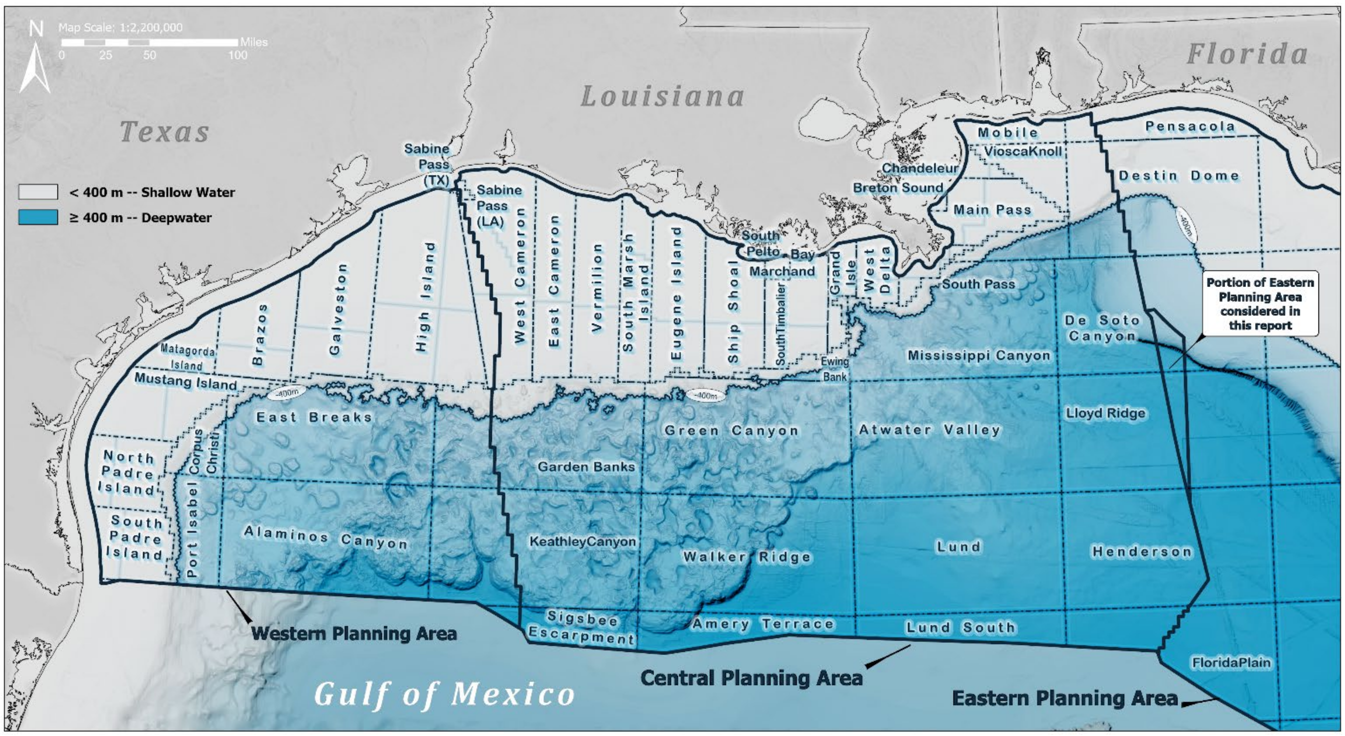


Figure 2: OCS, GOM Deepwater and Shallow Water Areas Considered in this Report

Definition of Assumptions

Below, several important assumptions of this forecast are described.

Hurricane Production Impacts: It is assumed that hurricanes will not dramatically impact production rates. This assumption has been true for the majority of the last two decades[1]. The impact of hurricanes will be described in more detail later in this report.

[1] Notable exceptions include, but are not limited to, Hurricanes Katrina, Ike, Gustav, Ida and the abnormally active 2020 hurricane season.

Shallow Water vs Deepwater: Shallow Water is defined as water depths less than 400 meters and Deepwater is defined as water depths greater than or equal to 400 meters. The water depth category of a field is defined by the deepest water depth found on a lease within that field.

Petroleum Commodities assessed in this report: The petroleum commodities assessed and reported in this forecast are crude oil, natural gas liquids (condensate), and natural gas that exist in conventional reservoirs and are producible with conventional recovery techniques. Crude oil and condensate are reported jointly as oil; associated and non-associated gas are reported jointly as gas. Oil volumes are reported in units of stock tank barrels (BBL) and gas volumes are reported in units of thousands of standard cubic feet (MCF).

Federal Leasing: This forecast assumes that Federal Leasing of offshore tracts (via Lease Sales) will continue during the forecast period. This assumption primarily affects the "Undiscovered Resources" component of the forecast and could also affect the "Contingent Resources" component. The components of the forecast are discussed in more detail in the Methodology and Discussion of Inputs section of this report. Figure 14 graphs the production forecast by each component. In general, the impact of Federal Lease Sale frequency becomes more significant as time goes on due to the development time between when tracts are leased versus when they contribute to Federal production.

Uncertainty in Volume & Timing of Forecast

Prior to considering either the methodology of this forecast or the results, it is important to understand the types of the uncertainties which are inherent in the model and their respective impacts on the results. The uncertainties in this production forecast can be subdivided into two main types: uncertainties in volume and uncertainties in timing. Here, "uncertainties in volume" refers to the degree to which we are confident in *how much* oil and gas can economically be recovered from the GOM while "uncertainties in timing" refers to the degree to which we are confident in *how quickly* these resources will be recovered.

See **Figure 3** below. The figure contains two visuals, one which represents uncertainty in volume and the other, uncertainty in timing. Both visuals show a graph of oil production, in barrels of oil per day (BOPD) versus time. In each, the green portion of the graph represents current production, which stops at the present. After this point, potential versions of an example forecast are drawn which reflect uncertainties in either volume or timing. In the graph on the left, volume uncertainty (only) is represented, while in the graph on the right, timing uncertainty (only) is represented.

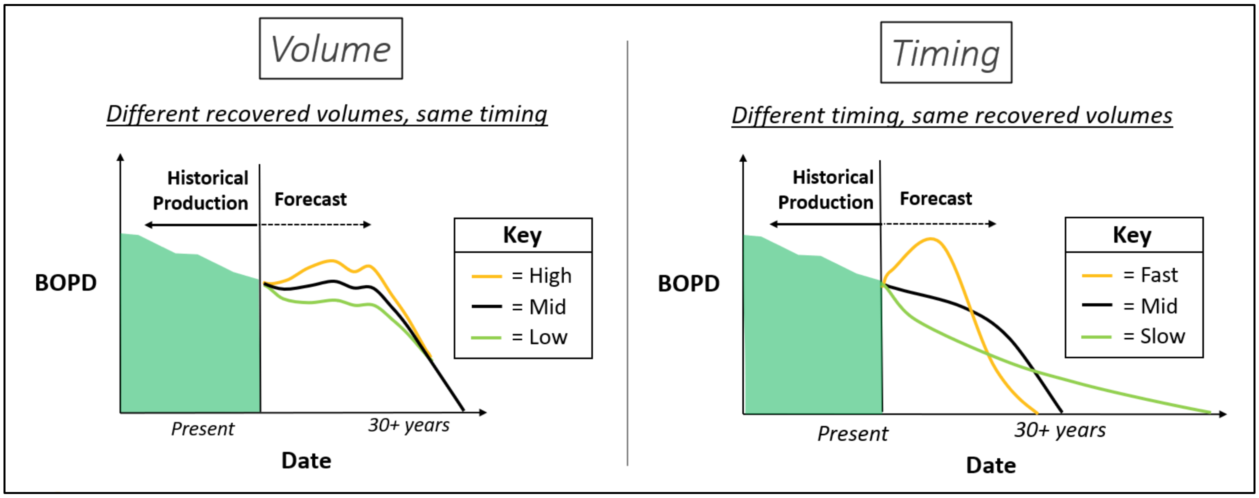


Figure 3: Two categories of uncertainty affecting the GOM production forecast[2].

In the volume uncertainty graph (left), the shapes of the curves are similar, but the total volume recovered (the area under the curve) varies. Stated another way, the "high" volume case consistently has higher daily rates as compared to the other two cases and as a result, the "high" volume case results in greater cumulative recovery of resources.

In the timing uncertainty graph (right), the area under the curves (i.e. the total recovered volumes) is the same, however, the timing of production varies. As such, the "fast case" has higher rates initially, but lower rates later in the forecast as compared to the other two cases.

Now that we have introduced these two broad categories of uncertainty which affect the forecast, we will consider both in more detail. To begin, consider **Table 1** below which lists some of the factors which contribute to uncertainties in volume and timing. In general, the factors contributing to volume uncertainty pertain to the science of petroleum engineering and petroleum geology whereas the factors contributing to timing uncertainty pertain to the field of economics.

Table 1: Categorized uncertainities affecting the GOM production forecast

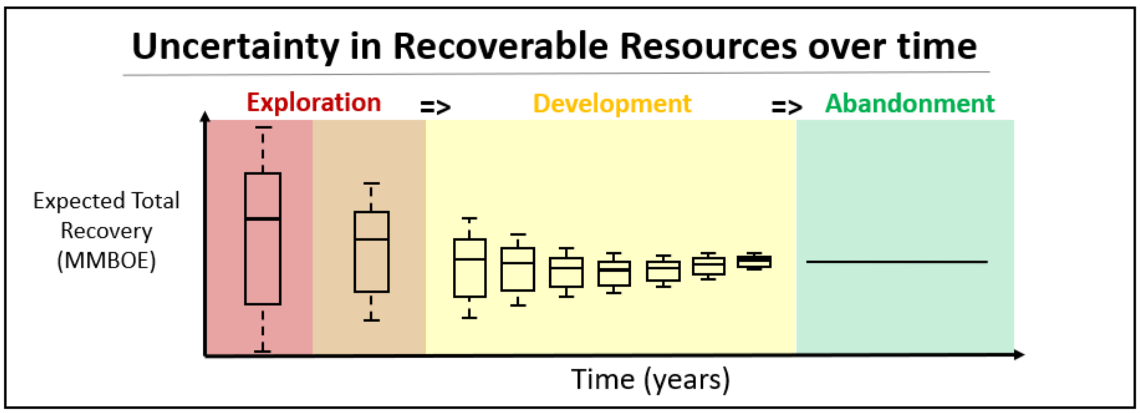
	Volume	Timing
	"How much oil and gas is recoverable?"	*"How quickly will resources be developed (if at all)?"*
Uncertainties	• Reservoir Characterization Parameters • Discovery of new resources • Development of new technology • Economic limit of field	• Net Oil Demand • Viability of alternatives (e.g. solar, wind, biofuels) • Regulatory policy changes • Impact of future hurricanes

[2] Note: this figure is a conceptual, visual aid; it is not explicitly created from data.

Uncertainty in the volume – the quantity of recoverable oil and gas resources in GOM

The sciences of petroleum engineering and geology are used to determine how much oil and gas may be recovered economically. As an oil and gas field is developed, the uncertainty in the recoverable resources decreases. Prior to any wells being drilled, geologists and petroleum engineers use seismic data, analog production data (when available), and many simplifying assumptions (or ranges of inputs) to attempt to characterize how much oil and gas is in place and is economically recoverable. As wells are drilled and put on production, more reliable data becomes available to geologists and engineers which can then be employed to significantly narrow the amount of uncertainty associated with the total expected recoverable volumes of oil and gas within that field.

Figure 4 consists of a chart and corresponding table. The chart at the top qualitatively shows how the volume uncertainty in a field reduces over time as the field is developed. The table below this chart shows the key activities conducted in each field development stage and the pertinent BOEM processes which occur during each stage.



Stage	Exploration		=> Development	=> Abandonment
Activities	- Seismic evaluation. - Analog analysis. - Uncertainty analysis.	- Exploration and delineation wells drilled. - Various forms of well logs obtained.	- Production facilities installed. - Field is developed and produced. - Various forms of new data are analyzed to improve knowledge of field.	- All facilities are removed/abandoned. - Final, cumulative production is known.
BOEM Evaluation Processes	Fair Market Value Evaluations	G&G Lookback Studies		
		Field Reserves Analysis		
	GOM Resource Assessment			

Figure 4: How "uncertainty in volume" changes over time for a typical oil field.[3]

As can be seen in Figure 4, BOEM oversees and studies fields throughout the life of the field. BOEM petroleum engineers and geologists devote significant, ongoing effort to analyzing and understanding the total expected recovery of GOM fields and document the findings of their analysis. The data and findings from these ongoing

[3] Note: The upper portion of this figure is a conceptual, visual aid; it is not explicitly created from data.

BOEM Evaluation Processes are foundational to the production forecast and data from each of these processes is leveraged in the creation of the forecast (as will be explained in more detail later in the report).

Uncertainty in Timing – if and when new oil and gas resources in the GOM will be developed

The timing of production is driven by the oil industry's development activity which is itself driven by the ability of companies to make profit. This in turn is dependent on (1) the availability of resources to develop and (2) sufficient oil demand to allow for economic oil development and production.

As listed in **Table 1**, the timing of production is dependent on net oil demand (which influences oil price), the viability of alternative energy sources, the impact of hurricanes, and the impact of governmental policies. Each of these factors influences oil industry activity and each tend to be difficult to predict with accuracy.

For the sake of this forecast, it is assumed that the economic environment will be similar in the next 10 years to what it has been recently. Furthermore, a general, most-likely case is assumed for the influence of these factors of uncertainty in timing rather than multiple cases with different oil price expectations and activity rate expectations (etc.).

Foundational BOEM Processes which contribute to this forecast

As mentioned previously, BOEM performs several important evaluation processes to study and understand the full life of the development of GOM fields. These processes significantly contribute to the agency's mission and provide critical data used throughout the production forecast:

Gulf of Mexico OCS Resource Assessment

BOEM performs an assessment of the undiscovered oil and gas resources for the U.S. Outer Continental Shelf (OCS). This assessment uses a probabilistic play-based approach to estimate both technically and economically recoverable oil and gas resources. Geologic, geographic, and engineering parameters are generated to model the recoverable resources in each play. The play-based resource estimates provide insight to future leasing targets, and possible field-based distributions of resources left to be discovered. BOEM's most recent publications related to the Gulf of Mexico Assessment may be accessed here (BOEM, 2021).

Reserves Section, Field Studies

BOEM's Reserves Section of the Office of Resource Evaluation develops independent estimates of recoverable reserves within discovered fields by performing field studies which are comprehensive, in depth, and ongoing analyses. Important reservoir and production data is generated and captured in BOEM's proprietary database. Reserve estimates are revised periodically to reflect new information obtained from development and production activities. BOEM's "Estimated Oil and Gas Reserves Report" provides the best, most recent estimates for total Gulf of Mexico Reserves and may be accessed here (BOEM, 2021b).

Geological and Geophysical Lookback Studies

The Geological and Geophysical (G&G) Section of the Office of Resource Evaluation performs an annual proprietary self-evaluation process whereby geoscientists compare their pre-drill risked resource estimates (made during bid adequacy evaluations) to the results of the first exploratory well drilled on the new leases. The findings are compiled in a database and used to refine tract evaluation strategies and identify industry drilling trends. Initial volume estimates are generated for new discoveries, and, within this forecast, these estimates are the preferred data source for contingent resource estimates when a full field study has yet to be completed by the Reserves Section.

Fair Market Value Evaluations

The G&G Section is also responsible for assuring the receipt of Fair Market Value for OCS tracts that receive bids during the lease sale. This process involves a complete geological interpretation and engineering analysis of the prospect being evaluated, including a stochastic discounted cash flow model using BOEM's proprietary simulation software, MONTCAR. The results of the simulation model are captured in a database. The resource estimates for the undrilled prospects in this database are used for the undiscovered resources portion of this production forecast.

Methodology and Discussion of Inputs

The plot below in **Figure 5** shows the components of the forecast. The forecast is built sequentially. It starts with Component 1, Historical Production. Next, the production associated with each of the other components is added in order of increasing uncertainty (in volume and timing).

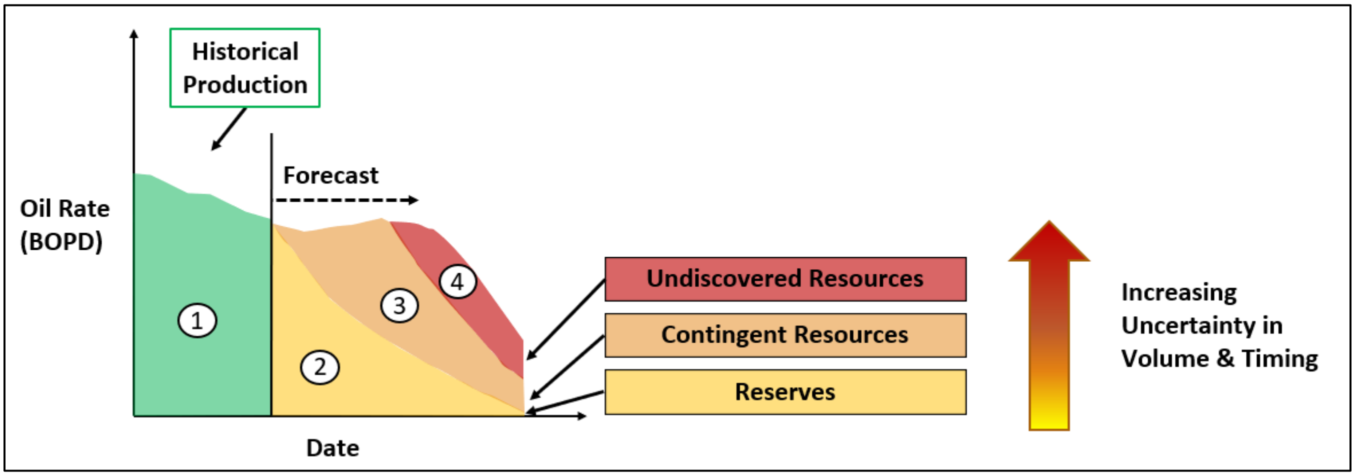


Figure 5: The 4 Components of the Forecast[4]

Components 2, 3, and 4 (Reserves, Contingent Resources, and Undiscovered Resources) are consistent with the BOEM resource and reserves classification system. Definitions for each of these reserve classes are provided below in **Table 2**. The BOEM resource and reserve classification system is described in detail in the most recent BOEM Estimated Oil and Gas Reserves Report (BOEM, 2021b) and may be accessed here.

Table 2: BOEM Resource and Reserves Definitions

Reserves	Reserves are those quantities of petroleum anticipated to be commercially recoverable by application of development projects to known accumulations from a given date forward under defined conditions. Reserves must further satisfy four criteria: They must be discovered, recoverable, commercial, and remaining (as of a given date) based on the development project(s) applied.
Contingent Resources	Those quantities of petroleum estimated, as of a given date, to be potentially recoverable from known accumulations by application of development projects but which are not currently considered to be commercially recoverable due to one or more contingencies.
Undiscovered Resources	Resources postulated, on the basis of geologic knowledge and theory, to exist outside of known fields or accumulations. Included also are resources from undiscovered pools within known fields to the extent that they occur within separate plays. BOEM assesses two types of undiscovered resources, Undiscovered Technically Recoverable Resources (UTRR) and Undiscovered Economically Recoverable Resources (UERR).

[4] Note: this figure is a conceptual, visual aid; it is not explicitly created from data.

Forecast Component 1: Historical Production

Every forecast starts with what is known. This production forecast begins with the current production within the Gulf of Mexico federal waters. **Figure 6** below shows the historical OCS GOM oil production since its inception. The plot is separated into two categories, Shallow Water and Deepwater. As seen in the figure, Shallow Water production has been declining since the 1990s while Deepwater production has generally been on the rise over the same period. As of 2022, Deepwater production constitutes roughly 90% of total production. Furthermore, the downward trend in Shallow Water production and upward trend in Deepwater production are both expected to continue over the next ten years.

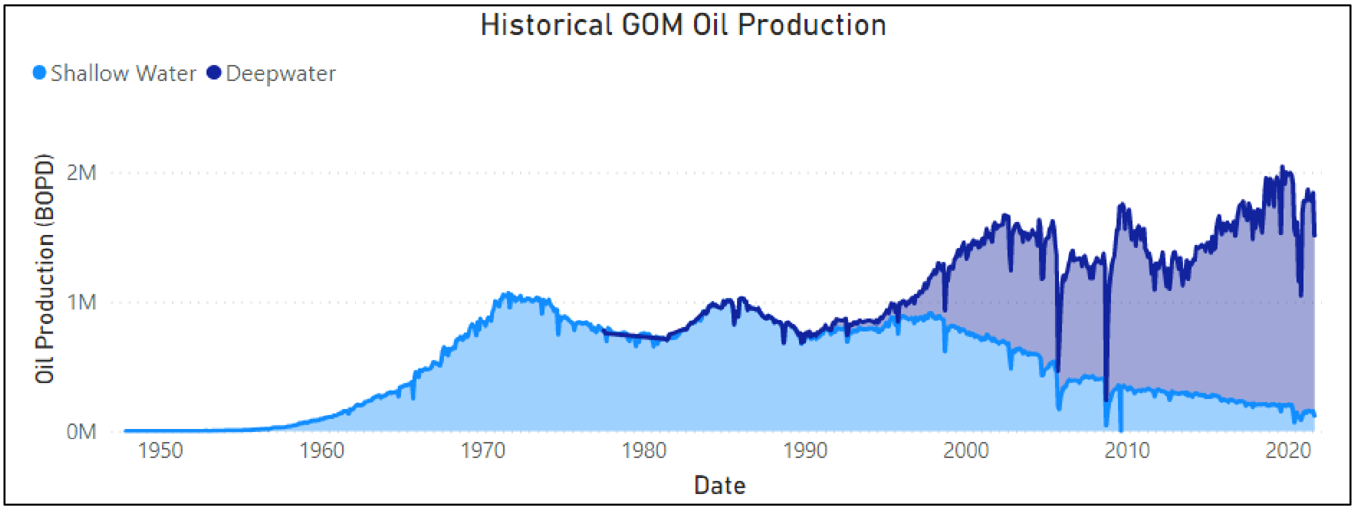


Figure 6: GOM Historical Oil Production

Figure 7 shows the last 20 years of GOM oil production with several major events annotated. Over the last 20 years, Hurricanes Katrina, Ike, and Gustav have had large impacts to production. Additionally, one can observe that from 2015 through the end of 2019 the oil production rate increased at a relatively steady rate; however, this trend did not continue in 2020. The low production in 2020 can be accounted for by the impact of COVID-19 and an active hurricane season.

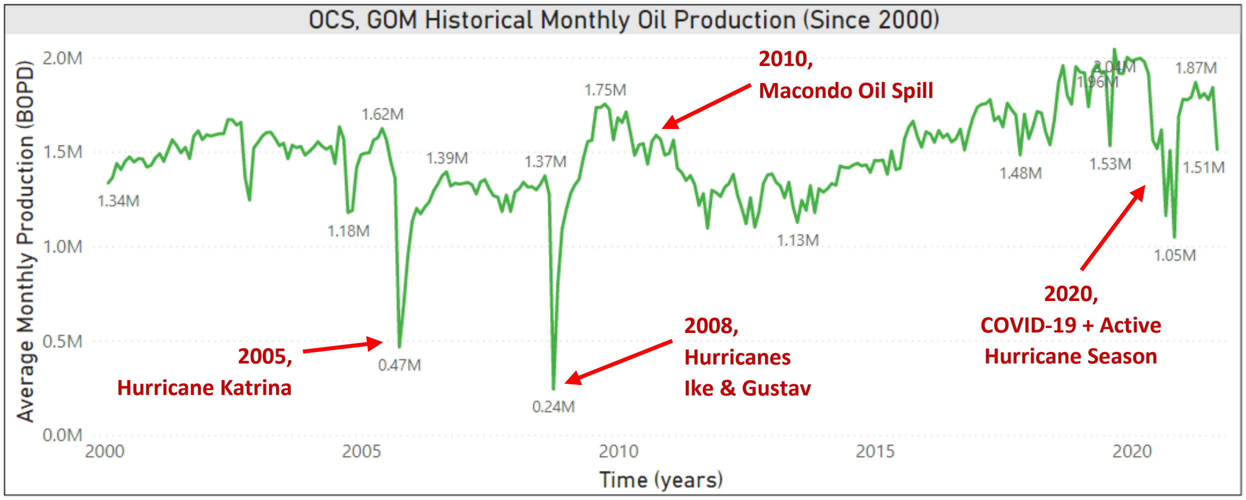


Figure 7: Last 20 Years of GOM Oil Production

2020 GOM production and annotated events are shown in more detail in **Figure 8.** Hurricanes that occurred in 2020 are identified.

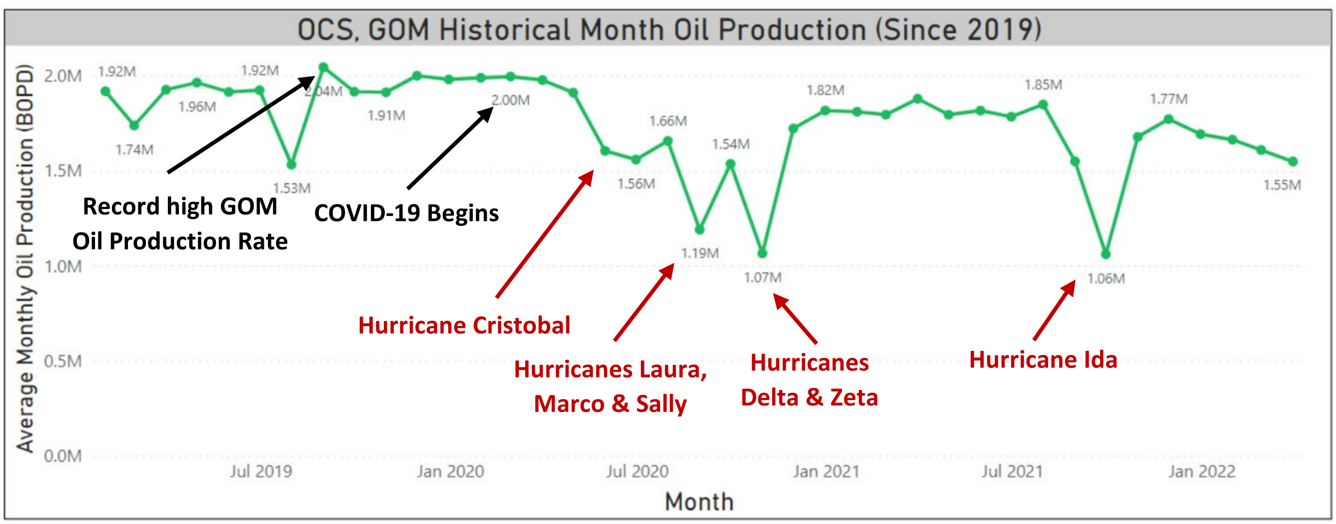


Figure 8: 2020 Hurricane Season Impact to GOM Production

The three figures above give context to current GOM oil production and show: 1) present production is predominantly Deepwater, 2) hurricanes can cause significant disruption to GOM production, 3) significant hurricane impacts were common in the last two years but were rare in the last 20 years. Since the majority of GOM production is Deepwater (and because the majority of current and upcoming development activity are focused in Deepwater), Deepwater trends and fields are more impactful to this forecast. Since significant hurricane impacts have been rare over the last 20 years, these impacts have not been explicitly incorporated into this forecast, as previously mentioned.

Forecast Component 2: Reserves

Figure 9 below shows the next component under consideration, Reserves. This component may be thought of as the oil and gas resources within currently producing fields which have a very high likelihood of being produced.

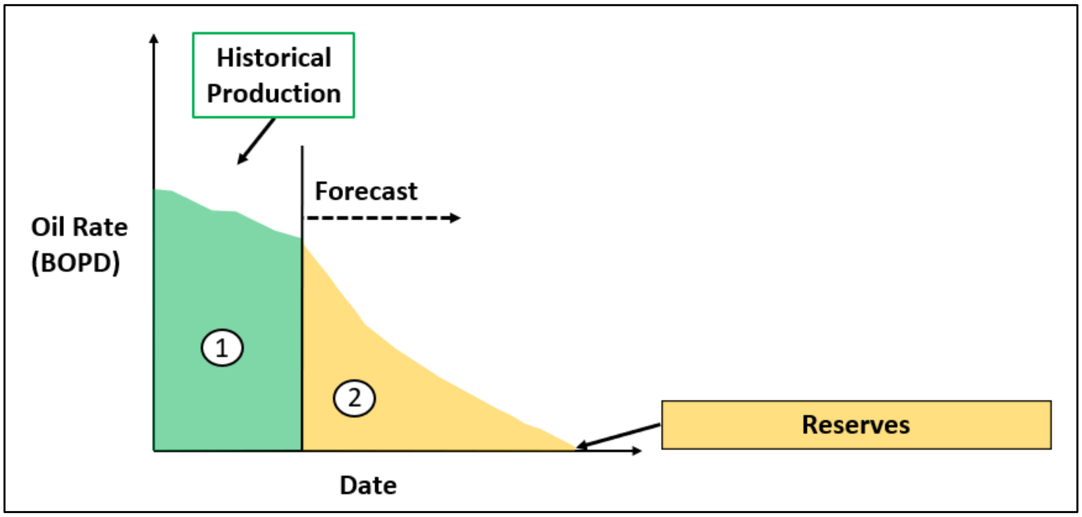


Figure 9: Forecast Components – (2) Reserves[5]

Reserves were estimated by performing decline curve analysis (DCA) on all actively producing wells in the Gulf of Mexico and then aggregating the forecasted production of these wells. This aggregate was then compared to the reserves in the BOEM Reserves databases.

Decline curve analysis is a classical tool of petroleum engineering in which the engineer performs a regression on existing production data to create a fit to the data which may then be used to forecast future production.

Since there were over 3000 wells on which decline curve analysis needed to be applied, an automated process was employed to forecast the decline of current Gulf of Mexico production. **Figure 10** below shows the steps in the workflow followed and programs used during those steps.

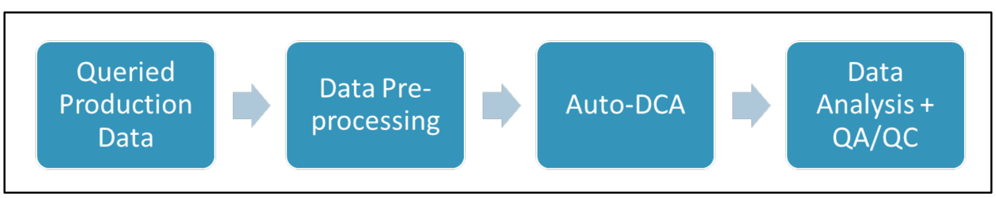


Figure 10: Automated Decline Curve Analysis Workflow

Performing decline curve analysis on each active Gulf of Mexico completion provided several advantages: it standardized the analysis performed (making it more replicable in the future and therefore more useful for future comparison); it significantly increased the processing time as compared to manual analysis; it allowed for much more useful data analytic capabilities due to the ability to aggregate production profiles by various categories (e.g. lease, field, operator etc).

[5] Note: this figure is a conceptual, visual aid; it is not explicitly created from data.

The first three steps of the process utilized a data querying and analysis software to query the pertinent production data, perform data pre-processing, and perform an automated decline curve fit to the data of each well in order to forecast a production profile for each well. The fourth step consisted of aggregating the data, analyzing the data, and quality checking the data using a business intelligence, data analytics and visualization software.

Each of these steps is described in more detail below.

1) Querying Production Data: The last three years of oil and gas production were queried for any well in the Gulf of Mexico which had production in the last year.

2) Data Pre-Processing: When an engineer performs DCA on a given well, the engineer will account for many factors while performing his or her analysis (e.g. data quality, exclusion of outliers in the data, exclusion of gaps in production due to shut-ins etc.). While a human does this intuitively, a computer must be given explicit instructions, or its analysis may differ substantially from what is realistic (and intuitive to an engineer). As such, a program was written to perform data pre-processing so that an automated regression would more closely resemble the data fit an engineer would intuitively create. The data pre-processing, for instance, included the elimination of obvious outliers so that these would not impact the line of best fit created.

3) Automated Decline Curve Analysis: Once the data pre-processing was completed, a regression was performed on the production data of each active completion to create a production forecast for each.

4) Data Analysis and Quality Checks: During the final step of the workflow, the automated production decline forecast of each completion was imported into a business intelligence software which allows for quick data analysis. In this software, the forecasted production was compared against the reserves from BOEM databases for quality; hundreds of individual forecast profiles were checked for reasonableness; and high impact fields[6] and high impact completions[7] were checked for reasonableness. Several iterations of quality checking and improving the data pre-processing occurred until the automated DCA fit fell within the range of reasonable fits an engineer could assign. After this step was completed satisfactorily, the process was complete, providing the data necessary for this component of the forecast.

[6] Fields were considered "high impact" if they had expected remaining reserves greater than 25 MMBO (million barrels of oil).
[7] Completions were considered "high impact" if they had expected remaining reserves greater than 1 MMBO.

Forecast Component 3: Contingent Resources

Figure 11 below shows the next component under consideration, Contingent Resources.

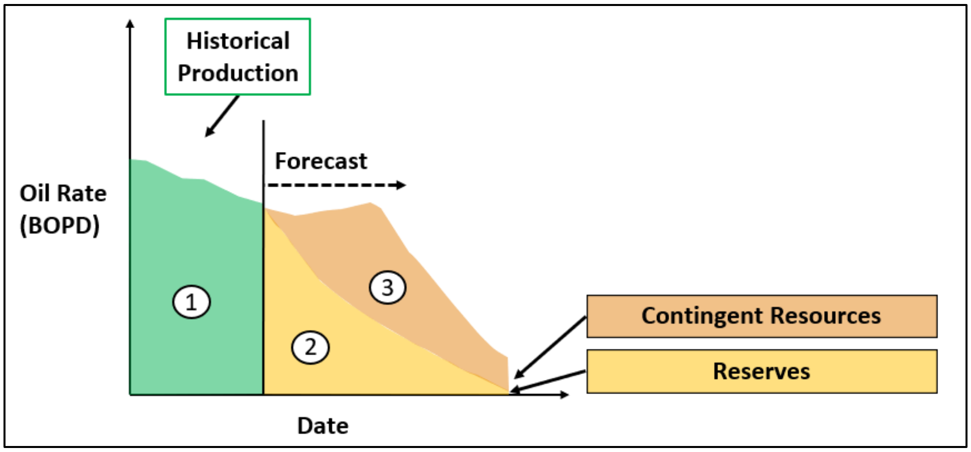


Figure 11: Forecast Components – (3) Contingent Resources[8]

The first part of the Contingent Resources Component of this forecast starts with resources that are in proved fields. The Reserves Section within the Office of Resource Evaluation continually studies proved fields in the Gulf of Mexico and updates BOEM databases. As new successful wells are drilled and fields are being developed, reservoirs can be added to these existing fields. The reservoirs will be classified as contingent until the Reserves engineers can determine if the company plans to develop and produce these new reservoirs. Production from contingent resource reservoirs that are in developed fields is forecasted using a spreadsheet-based data analysis tool which estimates the annualized oil and gas production volumes. Historical production profiles, individual well performance, and exploration and development activities are analyzed and used to build the model, so that the model outputs resemble empirical field development patterns.

This second part of the Contingent Resources Component consists of contingent resource fields that have not yet been developed. When a discovery is made, the identified accumulation of hydrocarbons is classified as a Contingent Resource, since a development decision has not yet been identified. When a field is in the Contingent Resource category, often geophysical mapping and limited well data are the basis for defining reservoir limits and the associated resource estimate. The resource estimates used for this forecast were derived from the Reserves Section's Field Studies and from G&G Lookback studies (as discussed earlier in this report). Commonly these estimates are reevaluated once a field is moved into the reserve category and more data becomes available. Well logs, well field data, seismic data, and production data are continuously analyzed throughout the productive life of the field to improve the accuracy of the resource estimate.

The forecast of the contingent resource fields that are yet to be developed is based on the following assumptions:

1) Ultimate recoverable volumes are taken from independent, proprietary BOEM assessments.

[8] Note: this figure is a conceptual, visual aid; it is not explicitly created from data.

2) During the first year of production, each project is assumed to produce at half its peak rate[9].

3) The estimated peak oil production rate for each project was determined from its estimate of recoverable reserves according to an empirically based relationship. This relationship was derived by plotting maximum production rates of known fields against the ultimate recoverable reserves of those fields and performing a linear regression[10]. The peak gas rate is determined by each field's gas-oil-ratio (GOR).

4) Projects with estimated discovered resource volumes over 200 MMBOE are assumed to reach peak production in their second year, sustain that peak rate for a total of 4 years, then decline at an effective annual decline rate of 12 percent from that time forward.

5) The year when each discovery is expected to begin production is estimated by using available information from submitted plans and press releases.

[9] This is a qualitatively observed trend which can be seen when plotting field production rates over time and comparing the average rate of the first year of production to the peak production rate.

[10] It was assumed that the relationship of peak rate and total reserves, calculated with data at a field-level, is also predictive when applied at a project level.

Forecast Component 4: Undiscovered Resources

Figure 12 below shows the addition of the last component under consideration, Undiscovered Resources.

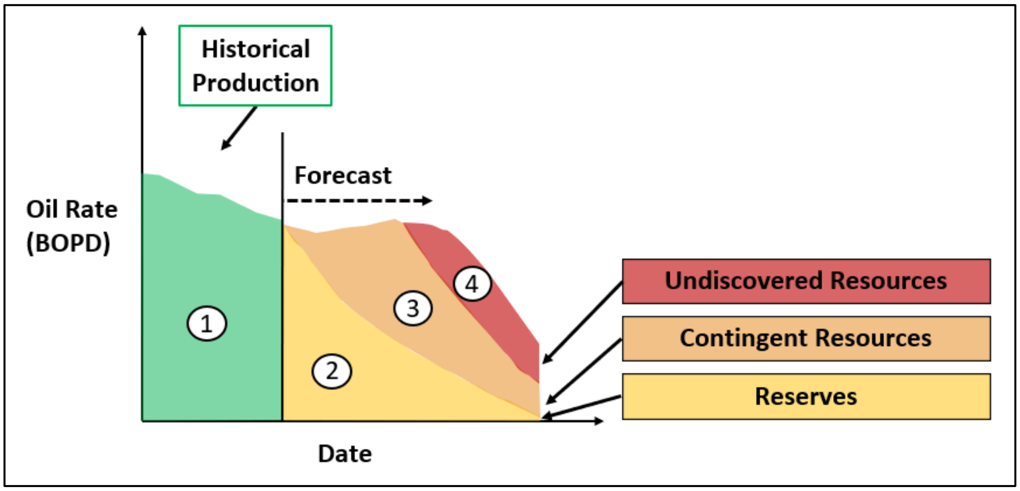


Figure 12: Forecast Components – (4) Undiscovered Resources[11]

The Undiscovered Resources section of the forecast consists of anticipated production from fields which have not yet been discovered, but which are anticipated to commence production during the forecast period. Two main categories were evaluated for Undiscovered Resources: *Leased Identified Resources* and *Unleased Identified Resources.* Both categories are made up of prospects which BOEM evaluated during the Fair Market Value evaluation process (completed for tracts bid upon in GOM lease sales). The first category, *Leased Identified Resources*, consists of evaluated prospects *which are currently leased*. The second category, *Unleased Identified Resources*, consists of evaluated prospects *which are not currently leased*.

Unleased, unidentified resources were not included in this forecast directly as they are not expected to contribute significant production during the forecast period. This is in part due to the amount of time typically required for resources to be leased and developed (a process which typically takes several years for a company even after resources *are* identified). Furthermore, this category was not explicitly included in the forecast because the category has a large degree of uncertainty – it is difficult to define this "known, unknown".

The forecast methodology for the Undiscovered Resources is very similar to that of the Contingent Resources in undeveloped fields as explained in the previous section. The historical annual data for past field discoveries, development activities, and production are used to predict how the identified resources will be developed during the forecast timeline. BOEM assumes that the leased identified resources will begin producing before the unleased identified resources.

[11] Note: this figure is a conceptual, visual aid; it is not explicitly created from data.

Forecast Results and Discussion

The compiled results of the forecast components described in the previous section are presented in this section. The oil production forecast and gas production forecast will be discussed separately. For each, the data and results will be presented, and relevant trends and implications will be discussed.

Oil Production Forecast

The BOEM, Gulf of Mexico Region (GOMR) forecast of annual oil production from 2022 through 2031 is shown in **Figure 13** below (and historical production values are plotted for reference). As seen in Figure 13, strong, continuous growth in oil production occurred from 2013 to 2019, followed by below-trend production years in 2020 and in 2021. From 2022 through 2024, oil production is forecasted to have strong growth, followed by a relative plateau (until 2027) and a gradual decline through the end of the forecast period

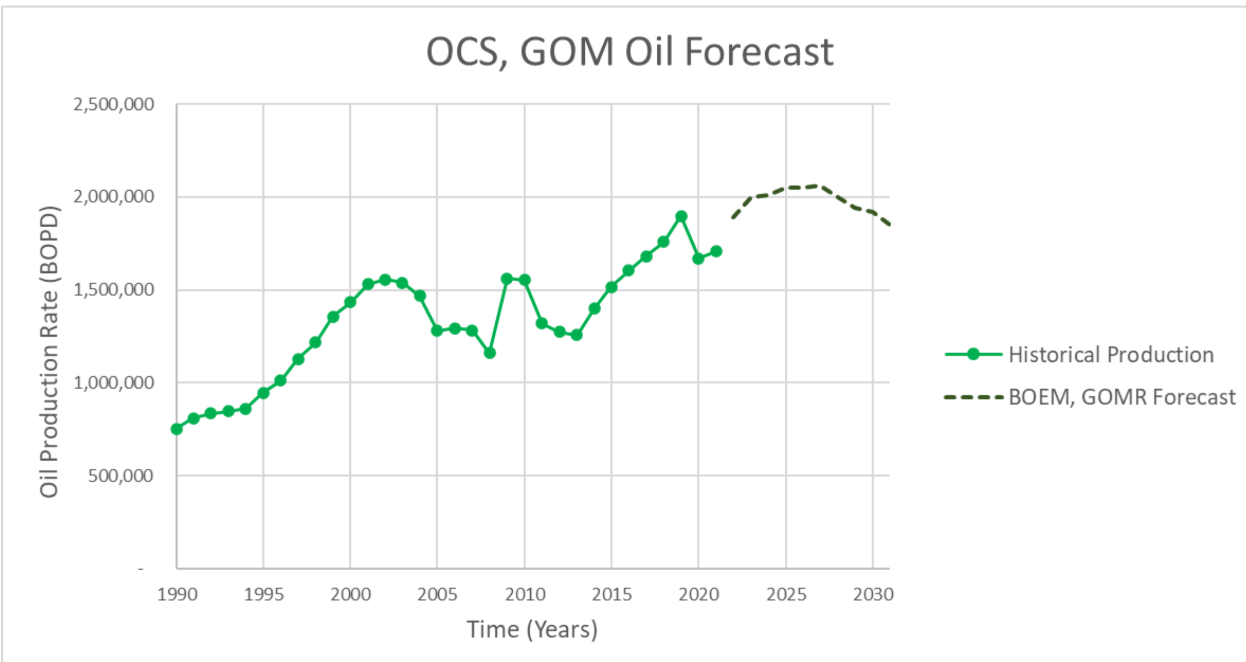


Figure 13: BOEM, GOMR Oil Forecast, 2022-2031

The below-trend years of 2020 and 2021 occurred due to production impacts from COVID-19 and lost oil production due to hurricanes. During COVID-19 many projects were deferred, resulting in a steepening aggregate decline in oil production. In 2020, an active hurricane season caused 43 MMBO of lost production and in 2021, Hurricane Ida caused 45 MMBO of lost production, and the most damage to the Gulf Coast since Hurricanes Gustav and Ike in 2008.

Despite the off-trend years of 2020 and 2021, GOMR oil production is forecasted to recover during the forecast period. The magnitude and speed of the forecasted growth resemble the growth from 2013 to 2019, prior to the off-trend years. Furthermore, the forecast is supported by a strong queue of projects in the GOMR (especially due to projects which were deferred during COVID-19).

Figure 14 shows the OCS, GOMR Annual Oil Forecast by Reserves category (which correlate to the components of the forecast discussed in the methodology section of this report).

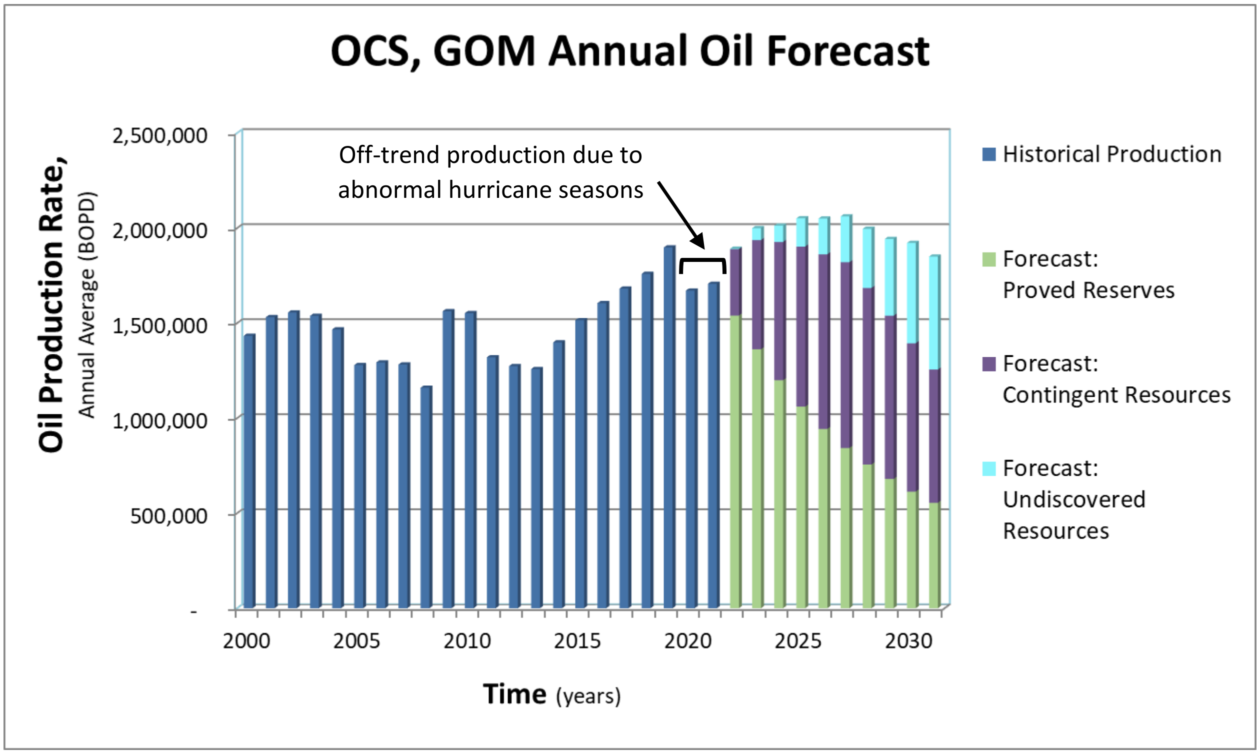


Figure 14: OCS, GOMR Annual Oil Forecast

Table 3 below shows the oil forecast in tabular form.

Table 3: Annual Oil Forecast by Forecast Component *(thousands of barrels of oil per day)*

Year	Reserves	Contingent Resources	Undiscovered Resources	Total Forecast
2022	1,540	350	2	**1,892**
2023	1,363	575	62	**2,000**
2024	1,200	728	86	**2,013**
2025	1,061	842	149	**2,052**
2026	944	919	188	**2,050**
2027	843	977	241	**2,062**
2028	756	929	311	**1,996**
2029	681	859	404	**1,943**
2030	614	781	528	**1,922**
2031	555	701	594	**1,850**

Gas Production Forecast

Figure 15 below shows the corresponding gas forecast. Since 2001, gas production has declined significantly despite some periods of strong growth in oil production over the same timeframe. This trend may seem counter-intuitive at first glance; the causes of this trend are made clearer by plotting gas production by categories of Shallow Water and Deepwater, as in **Figure 16.**

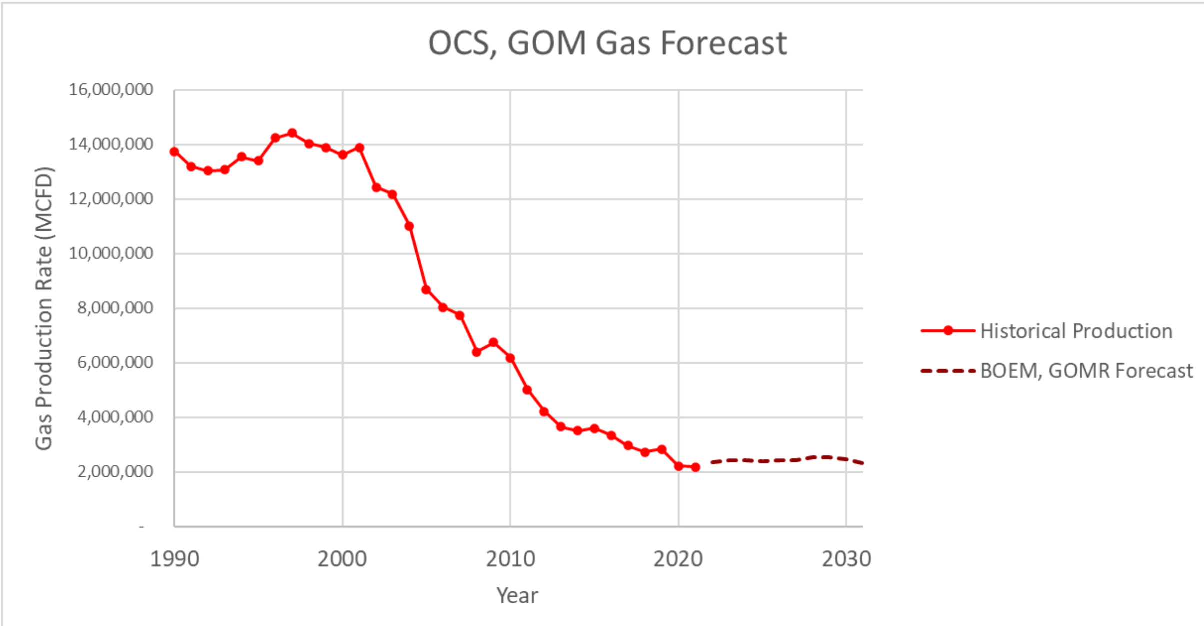


Figure 15: BOEM, GOMR Gas Forecast, 2022-2031

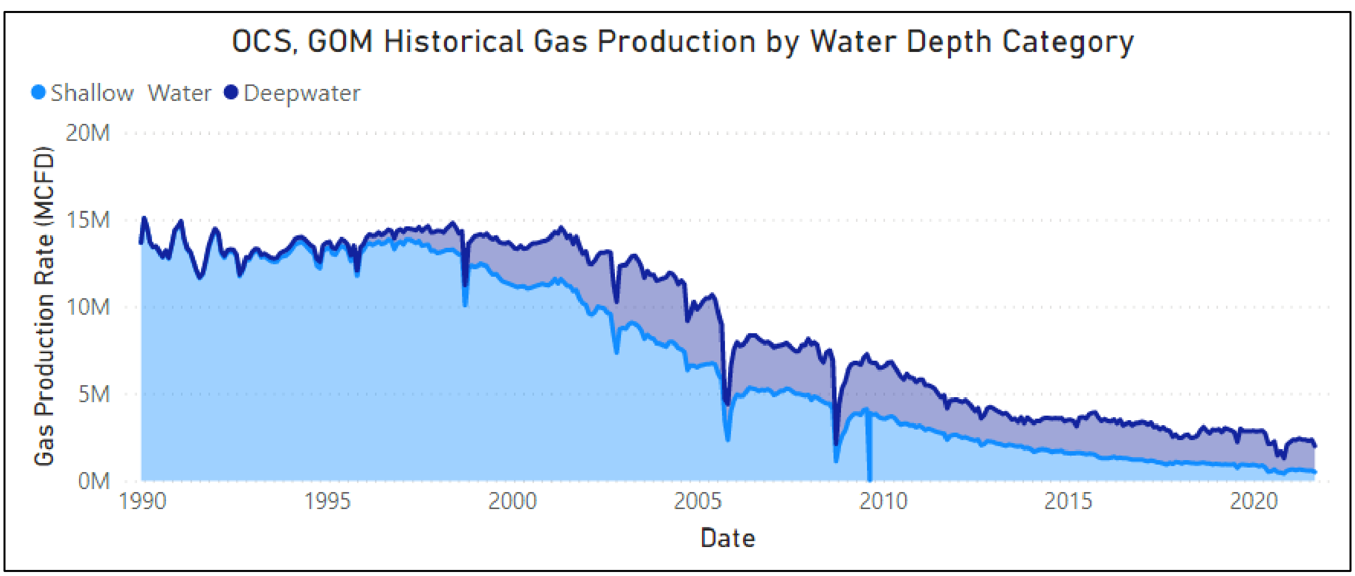


Figure 16: OCS, GOM Historical Gas Production by Water Depth Category

As seen in Figure 16, a large decline has occurred in Shallow Water gas production, while Deepwater gas production has remained relatively stable over the same period. This decline in Shallow Water gas production has occurred as shallow gas reservoirs were depleted and as Shallow Water fields reached their economic limits and were abandoned. Thus far, Deepwater gas reservoirs have been uneconomic to develop – a trend which is expected to continue. As a result, Deepwater gas production is predominantly *associated gas* – gas which bubbles out of the oil as pressure decreases. Due to this, the Deepwater gas forecast correlates to the Deepwater oil forecast.

Figure 17 below shows the OCS, GOMR Annual Gas Forecast by Reserves category (which correlate to the components of the forecast discussed earlier in the [Methodology Section](#) of this report).

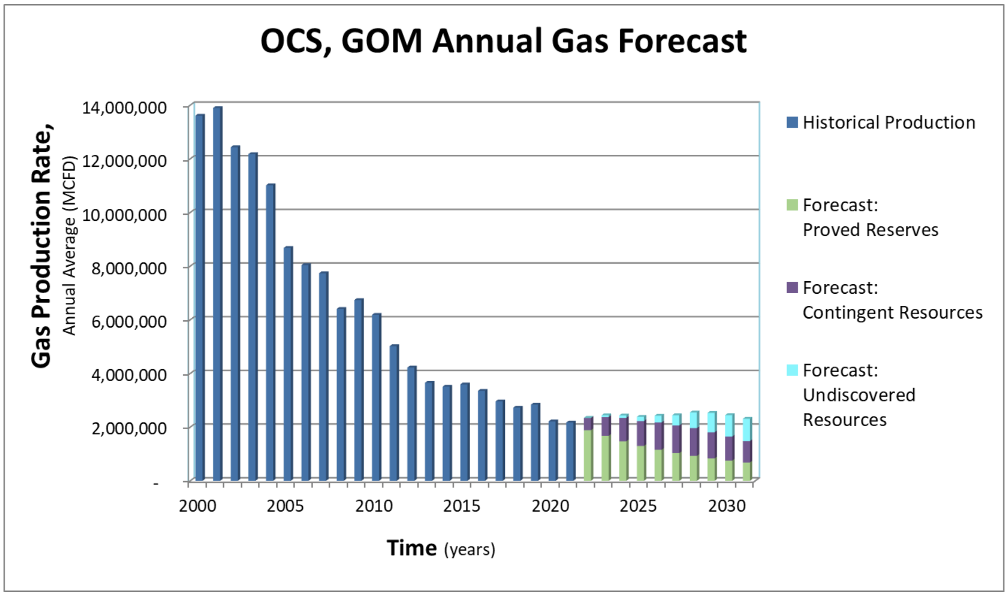


Figure 17: OCS, GOM Annual Gas Forecast

Table 4 below shows the gas forecast in tabular form.

Table 5: Annual Gas Forecast by Forecast Component *(millions of cubic feet of gas per day)*

Year	Reserves	Contingent Resources	Undiscovered Resources	Total Forecast
2022	1,889	454	6	**2,349**
2023	1,679	698	68	**2,446**
2024	1,475	872	91	**2,438**
2025	1,302	928	158	**2,388**
2026	1,158	1,020	249	**2,427**
2027	1,036	1,028	383	**2,446**
2028	930	1,037	584	**2,551**
2029	837	971	727	**2,535**
2030	756	897	797	**2,450**
2031	849	748	835	**2,432**

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Glossary

Field: A producible accumulation of hydrocarbons consisting of a single or multiple reservoirs all related to the same geologic structure and/or stratigraphic condition. In general usage, this term refers to a commercial accumulation.

Reservoir: A subsurface, porous, permeable rock body in which an isolated accumulation of oil and/or gas has accumulated.

Project: A Project represents the link between the petroleum accumulation and the decision-making process, including budget allocation. A project, for BOEM's classification of Resources and Reserves, is the Field (see also Field).

Resources: Concentrations in the earth's crust of naturally occurring liquid or gaseous hydrocarbons that can conceivable be discovered and recovered. Normal usage encompasses both Discovered Resources and Undiscovered Resources.

Undiscovered Resources: Hydrocarbons postulated, based on geologic knowledge and theory, to exist outside of known fields or accumulations.

Undiscovered Technically Recoverable Resources (UTRR): Oil and gas that may be produced by natural pressure, artificial lift, pressure maintenance, or other secondary recovery methods, but without any consideration of economic viability.

Undiscovered Economically Recoverable Resources (UERR): The portion of the Undiscovered Technically Recoverable Resources that is economically recoverable under imposed economic and technologic conditions.

Discovered Resources: Hydrocarbons in which the location and quantity are known or estimated from specific geologic evidence. Included are Reserves and Contingent Resources depending upon economic, technical, contractual, or regulatory criteria.

Contingent Resources: Those quantities of hydrocarbons estimated, as of a given date, to be potentially recoverable from known accumulations by application of development projects but which are not currently considered to be commercially recoverable due to one or more contingencies.

Reserves: Those quantities of petroleum anticipated to be commercially recoverable by application of development projects to known accumulations from a given date forward under defined conditions. Reserves must further satisfy four criteria: They must be discovered, recoverable, commercial, and remaining (as of a given date) based on the development project(s) applied. Reserves are further sub-classified based on economic certainty.

Cumulative Production: The sum of all produced volumes of oil and gas prior to a specified date.

Developed Reserves: Developed Reserves can be expected to be recovered through existing wells and facilities and by existing operating methods. Improved recovery reserves can be considered as Developed Reserves only after an improved recovery project has been installed and favorable response has occurred or is expected with a reasonable degree of certainty. Developed reserves are expected to be recovered from existing wells, including reserves behind pipe. Improved recovery reserves are considered developed only after the necessary equipment has been installed, or when the costs to do so are relatively minor. Developed Reserves may be sub-categorized as Producing or Non-producing.

> **Developed Producing Reserves:** Reserves that are expected to be recovered from completion intervals that are open and producing at the time of the estimate. Improved recovery reserves are considered producing only after the improved recovery project is in operation.

> **Developed Non-Producing Reserves:** Reserves that are precluded from producing due to being shut-in or behind-pipe. Shut-in includes (1) completion intervals which are open at the time of the estimate, but which have not started producing, (2) wells which were shut in for market conditions or pipeline connections, or (3) wells not capable of production for mechanical reasons. Behind-pipe refers to zones in existing wells which will require additional completion work or future re-completion prior to the start of production. In both cases, production can be initiated or restored with relatively low expenditure compared to the cost of drilling a new well.

Undeveloped Reserves: Reserves that are expected to be recovered from future wells and facilities, including future improved recovery projects which are anticipated with a high degree of certainty in reservoirs which have previously shown favorable response to improved recovery projects.

Reserves Justified for Development: The lowest level of reserves certainty. Implementation of the development project is justified based on reasonable forecast commercial conditions at the time of reporting and that there are reasonable expectations that all necessary approvals/contracts will be obtained