STUDY TITLE: Long-Term Oil and Gas Structure Installation and Removal Forecasting in the Gulf of Mexico: A Decision- and Resource-Based Approach

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BACKGROUND: The Resource and Economic Analysis (REA) Unit of the U.S. Minerals Management Service (MMS) performs infrastructure forecasting in support of economic and environmental impact studies in the Gulf of Mexico (GOM). he MMS performs a number of forecasts related to GOM infrastructure, including but not necessarily limited to, number of exploratory wells, number of delineation wells, number of development wells, number of production wells, number of workovers, number of structures installed, number of structures removed, number of subsea completions, and miles of pipeline.

Infrastructure forecast is an important input element to decision making at the MMS, and because of the scale of activities involved, drilling activity and structure installations are closely watched and used as a general guide on resource levels and development expectations.

There is only a limited amount of documentation supporting the REA/MMS forecast models, however, and so the first task of this report is to formalize the REA/MMS procedure in a quantitative framework. The REA's platform forecasting procedure is analyzed in an effort to add operational insight into the methodology and to provide support for refinements to the approach.

OBJECTIVES: The primary purpose of this paper is three-fold: (1) to document and specify the procedures currently employed by the REA in the construction of a platform forecast in the Gulf of Mexico, (2) to analyze the assumption set employed in the REA forecast and to critique the procedure, and (3) to develop an alternative methodology for platform forecasting.

DESCRIPTION: In this report we developed a methodological framework to forecast structure installation and removal rates in the GOM over a 40-year time horizon. The framework is based on a model structure developed by the REA of the MMS, but departs from the REA approach in terms of the level and type of disaggregation employed and the methodology used to construct the forecast.

The number of structures required to develop a field is affected by a number of factors, including but not necessarily limited to, the expected size of the field, the number of productive wells drilled from each platform, the amount of oil/gas each productive well produces, environmental factors such as water depth, soil conditions, and storm intensity, capital cost, availability of platforms, and strategic opportunity. The emphasis of this paper is to present a decision- and resource-based framework to an infrastructure forecast in a manner subject to an explicit set of assumptions.

SIGNIFICANT CONCLUSIONS: Forecasting is a traditional blend of art and science, and under conditions of unknown uncertainty, it is desirable to maintain a consistent, simplistic, and structured methodology that explicitly enumerates the assumption set and does not mix scenario assumptions or introduce additional uncertainty external to the modeling framework. Infrastructure forecast deserve careful attention to detail and deliberate methodological development, and should be performed on a regular basis to develop a better understanding of the system drivers and limitations of the analysis. The REA/MMS has done a good job in developing and promulgating the GOM platform forecast, and as discussed in this paper, the main criticism is aimed at refining the methodology, explicitly enumerating the assumption set, and ensuring that the solution methodology is consistent within the model framework. A set of recommendations was described addressing these concerns.

The methodology suggested in this paper is an adaptation of the REA approach that formalizes the framework in a consistent manner, modifies some key elements of the methodology, and incorporates decision parameters within the procedure. A formal development of the proposed methodology was presented and compared with the REA approach. Comparison of the two approaches illustrates that the REA and CES procedures represent a trade-off between the preferences of the user and the

assumptions of the methodology. It is suggested that the two procedures evolve into an automated "best practice" model.

STUDY RESULTS: The task of this paper was to develop a unified approach to infrastructure forecasting in the Gulf of Mexico and to forecast the number of structures expected to be installed and removed per water depth and planning area category over a long-term horizon. The consistency of the methodology, the application of a discrete assumption set, and the inclusion of a decision-oriented framework within the model represent the central tenants of the procedure. The model results should be interpreted as a first-order approximation to a very complex reality, and as such, should serve as a guide to infrastructure forecast requirements.

The need to properly select and specify aggregation categories is a critical ingredient in any forecast strategy, and the decomposition of the data into appropriate categories is an important aspect of pre-processing to ensure that the methodology is consistent and the procedure is sufficiently structured. No matter how fine the infrastructure data is decomposed and disaggregated within various categories, however, forecasting procedures rely upon other forecast and judgmental adjustments which can differ enormously in scope and magnitude. The uncertainty in these adjustments should be understood and clearly communicated to the user group. One of the principal tasks of this paper was to identify this uncertainty and to employ decision-oriented parameters as a means to explore the sensitivity of the model results.

The infrastructure forecast developed is a decision- and resource-based model similar to the methodology employed by the MMS but more broadly defined and executed within an analytic and computational framework. The output of the model is derived from the forecast of a supply curve and an infrastructure requirement ratio. A decision-oriented framework is employed to construct the supply curve which incorporates the beliefs of the user and variables such as technology change. The results of the forecast were presented under various assumptions on recovery rate and development timing.

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