Oil & Natural Gas Technology

DOE Award No.: DE-FG26-06NT42745

Quarterly Progress Report
(July - September 2007)

SOLVENT BASED ENHANCED OIL RECOVERY FOR IN-SITU UPGRADING OF HEAVY OIL

Submitted by:
Florida International University
Miami, FL

Prepared for:
United States Department of Energy
National Energy Technology Laboratory

October 2007

Office of Fossil Energy

BUREAU OF ECONOMIC GEOLOGY
THE UNIVERSITY OF TEXAS AT AUSTIN

SUPPORT FOR

"SOLVENT BASED ENHANCED OIL RECOVERY FOR IN-SITU UPGRADING OF HEAVY OIL SANDS"

OCTOBER 2007

1 TABLE OF CONTENTS

2 ACTIVITY DESCRIPTION

The University of Texas at Austin Bureau of Economic Geology's Center for Energy Economics is providing support for the DOE funded 3 year project "Solvent Based Enhanced Oil Recovery For In-Situ Upgrading Of Heavy Oil Sands". This report presents an overview of work performed during the previous quarter and future activities.

3 RESEARCH TASKS

The subcontract covers support for tasks 1, 2 and 8. During the previous quarter, funding was obligated to the grant to allow for the completion of all three tasks.

Task 1: Review in-situ upgrading processes proposed for heavy oil and the modeling tools developed for them.

Task 2: Quantify, based on available bitumen characterization data, the capacity of solvent injection based processes of addressing the need to reduce chlorides, nitrogen and other unwanted substances from upgraded crude.

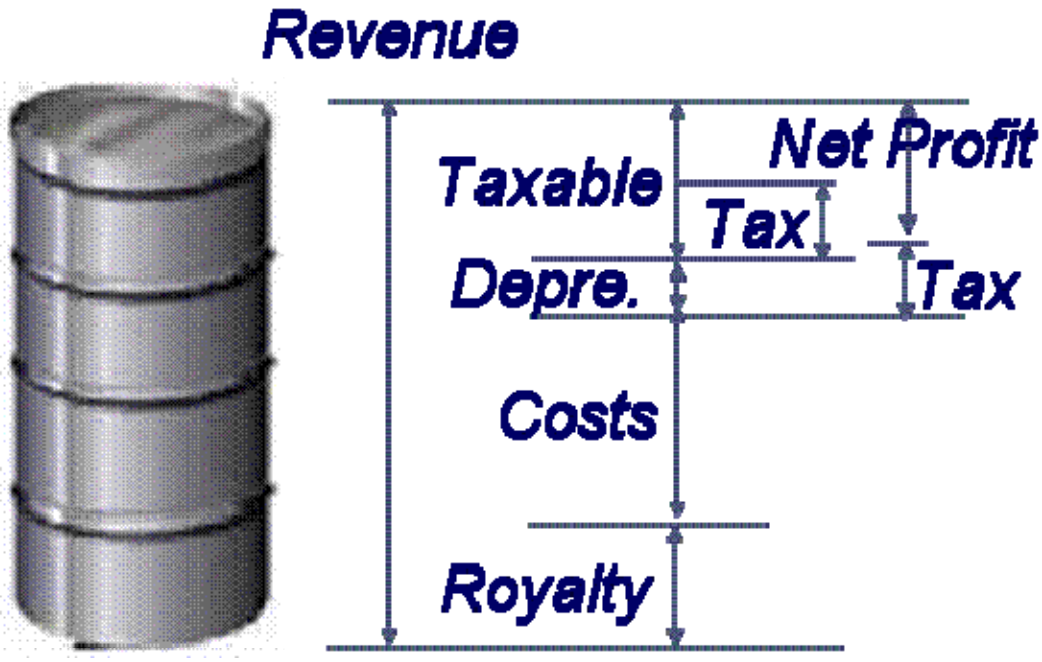
Task 8: Develop an economic model that provides cost estimates of the implementation of in-situ processing of crude oil based on reservoir performance and typical facilities and drilling costs. The critical variables that govern in-situ upgrading via cyclic solvent injection will be

identified. This information will be the basis for the experimental design and conceptual engineering of the field demonstration test.

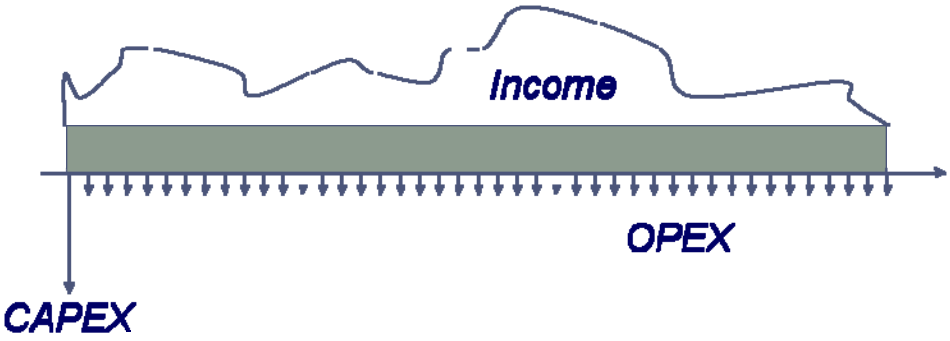
4 PROGRESS ON TASKS

An economic model for the development of a Greenfield extra-heavy oil project was developed that incorporates the required capital expenses for midstream investments such as an export pipeline and an upgrader. The model incorporates uncertainty in capital expenditures, operating cost data, well production, in place crude quality, project delays and the obvious price uncertainty. The model will serve as the baseline with which to compare the proposed in-situ upgrading process or any other process.

As with most oil production projects, the fiscal regime is of great importance and determines the viability of investment. A simplified tax-royalty fiscal model was developed for the exploitation of an extra-heavy or tar sand resource. Depreciation of the capital expenditures is also incorporated and allows for scenarios which consider rapid depreciation.



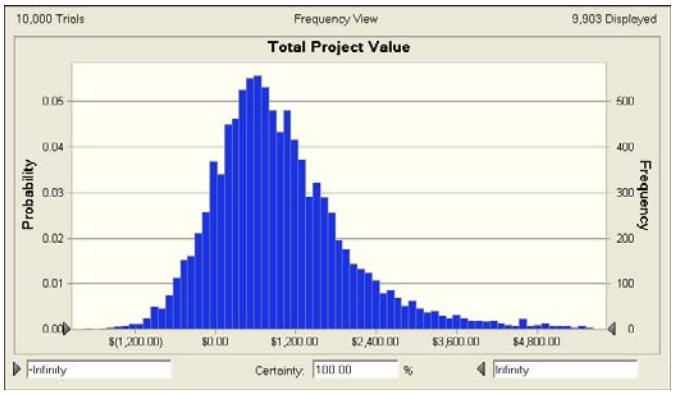
The economic model is a simplified discounted cash flow model. The model categorizes capital expenditures into two groups, large expenditures that are associated with the startup (initial wells, export pipeline, upgrader) and those made during production (additional well, flow stations).



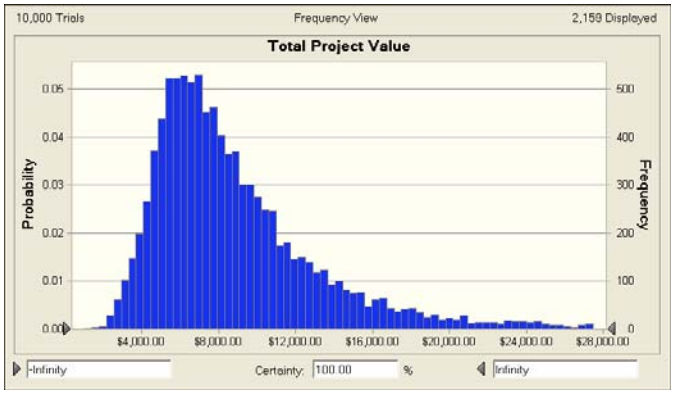
Sample runs were performed to value a project with a target throughput of 100,000 barrels per day of upgraded crude oil. The project value is split between the owner of the mineral rights (royalty payments), the taxing authority and the company that is making the investment. In some cases, the owner of the mineral rights and the taxing authority are one and the same reducing the split into a company take and the government's take.

Model runs were performed for a hypothetical project[1] with a production start date of 1998 (low price expectations). This resulted with in a distribution of net present value as shown below and a NPV(P50) of $815 million.

[1] The fiscal regime considered was the regime existing in 1998 in Venezuela for the exploitation of the Faja del Orinoco.

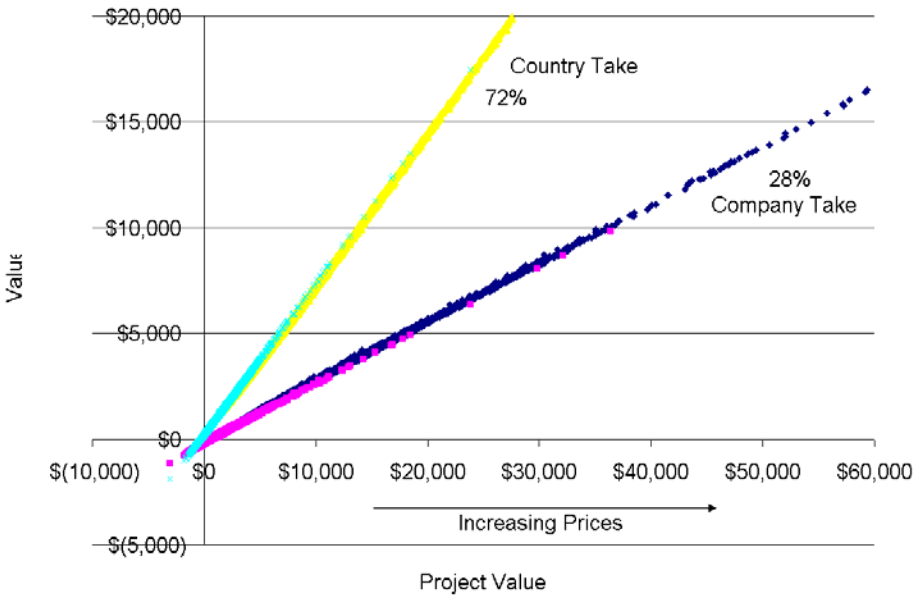


Interestingly, low price expectations were not met, but rather prices rose considerably. The project was then re-evaluated fixing prices between 1998 and 2006 to the real market prices and leaving the rest of the project with current higher price expectations. This results in a project with a NPV distribution as shown below, with a NPV(P50) of $7,786 million.

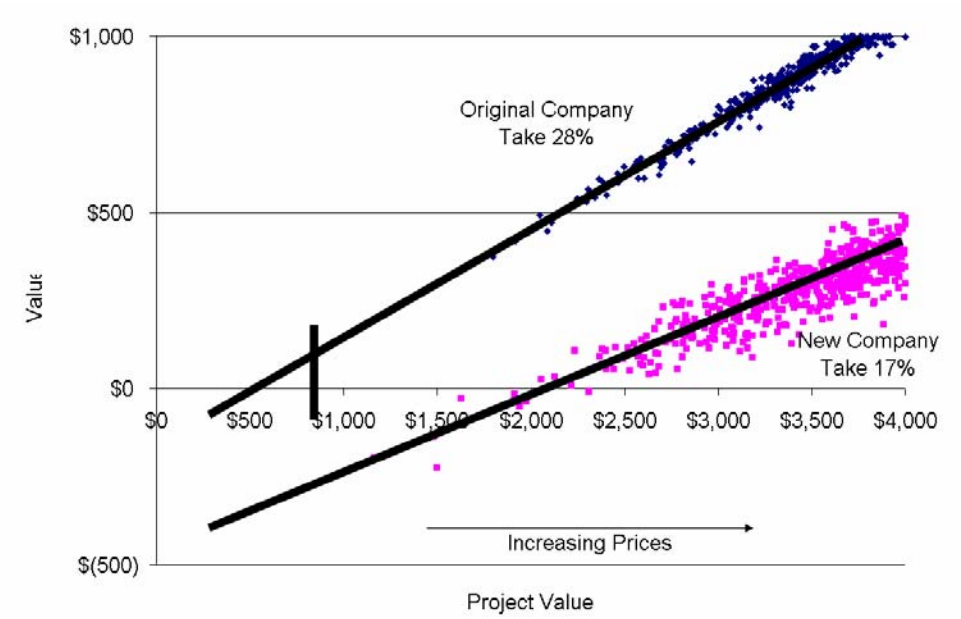


During the 7 year period, given the increase in oil prices, the expected value of the project increased an order of magnitude. More over, during the first 7 years, the original expected value was achieved leaving 90% of the value for future returns. The plot below shows the cloud of possible values for the project as a function of the price of crude in year 10. The considerable increase in value in the project is a clear consequence of the rise in oil prices during that period.

The value of the project is distributed among the owner of the resource, the taxing authority and the company that makes the necessary investments. In the case considered here, the national oil company is assumed to participate as an equal partner in the venture, increasing the government take by adding to the royalty and tax payments, half of the profits associated with the project. The distribution of value with the assumed fiscal regime is shown below in which the horizontal axis is the value of the project, and the different takes are shown.



As is customary, as different uncertainties are resolved, governments seek to renegotiate contracts. In the case studied, as the royalty and tax structure was revised, the company value or take was reduced considerably as shown below.



However, given price expectations, the commercial partner still preserves a net present value for the project. The loss of value to the company is of the order of $1,000 million since it can be estimated to be of the order of $2,000 million.

5 FUTURE EFFORT

- Task 1: UT will be concluding the review of the literature of solvent based heavy oil upgrading processes and the tools being developed to model the processes.
- Task 2: Finish simplified model of the solvent extraction process and calibrate it based on available data for addressing the need to reduce chlorides, nitrogen and other unwanted substances from upgraded crude. To date, most of the processes indicate that elements associated with asphaltenes are the ones removed and provide a good approximation for the capacity of the process to remove the unwanted substances.
- Task 8: The economic model will be expanded to include the elements associated with the upgrading process. These entail new infrastructure, new operating costs and new crude valuation. The will allow for the estimation of the value proposition of in-situ upgrading.

National Energy Technology Laboratory

626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940

3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880

One West Third Street, Suite 1400
Tulsa, OK 74103-3519

1450 Queen Avenue SW
Albany, OR 97321-2198

2175 University Ave. South
Suite 201
Fairbanks, AK 99709

Visit the NETL website at:
www.netl.doe.gov

Customer Service:
1-800-553-7681