Factoring Greenhouse Gas Emissions in Upstream Portfolio Decisions

BY FLORENT ROUSSET AND FERNANDO ROLLA

Introduction

The reduction of greenhouse gas (GHG) emissions has increasingly become a priority for the business community, including companies active in the oil and gas supply chain. According to the IEA, 15% of global energy sector GHG emissions are associated with oil and gas supply, about 5200 million tonnes (Mt). In Exploration and Production (E&P) activities, the majority of emissions are associated with the venting, flaring and fugitive emissions of natural gas, associated with the production of oil, which releases significant amounts of carbon dioxide (CO_2) and methane (CH_4) emitted into the atmosphere. While CO_2 and CH_4 have significantly different GHG impacts, their combined effects can be aggregated as a single unit measured in tonnes of CO_2 equivalent (tCO_2e).

According to the World Bank, 20% of global emissions are currently subject to carbon pricing regulation, ranging from \$1 to \$139/tCO_2e with an average of \$7/tCO_2e. Even in jurisdictions where no such carbon tax is currently in effect, E&P companies are increasingly applying a cost to their future CO2e emissions, in order to factor into project economics a hypothetical cost associated with GHG emissions.

The purpose of the illustrative case study that follows is to demonstrate that factoring in the economics of GHG emissions from the initial decision points of new projects can yield significant value.

The first scenario presented here is intended to highlight the potential for the economic attractiveness of early stage investments to be materially impacted by the cost of GHG emissions. This in turn could result in increased effectiveness of investments, by deployed capital to other resource development. The second scenario is designed to highlight how the assessment of GHG emissions in development concepts can materially improve project economics and mitigate the lifecycle economic risks of such assets.

For the purpose of this illustration, a single economic metric used for exploration decision making has been utilized. Indeed, while there are of course many factors that are assessed in this context, the Expected Monetary Value (EMV) is one of the most commonly used metrics for evaluating exploration opportunities.

Methodology

In this study, an illustrative exploratory offshore oil prospect was designed to assess the impact of applying a carbon price to emissions on the EMV. Two scenarios were considered, one where the development concept, should a discovery be made, would entail flaring all of the associated gas and the other where all of the associated gas would be reinjected in the reservoir.

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The only difference between these two scenarios from an economics perspective is cost, as the second scenario requires additional capital expenditure (CAPEX) and operating expenditure (OPEX) related to gas reinjection operations. It is worth noting that while both scenarios were assumed to yield the same volume of oil, a case could be evaluated where the reinjected gas contributes to an increase in oil production – however this has not been performed as part of this evaluation.

The Carbon Intensity (CI), the volume of carbon emitted per unit of energy produced, for each of the two scenarios evaluated was estimated using an open-source engineering-based analysis tool developed at Stanford University called Oil Production Greenhouse gas Emissions Estimator (OPGEE). The OPGEE model takes a set of up to 50 inputs representing the field's properties and productivity averaged over its life in order to calculate the average CI. For this case study, the OPGEE model was modified in order to generate an annual profile for the tCO_2e emissions associated with the production of a hypothetical oil discovery.

The cost associated with these emissions was factored in the economic model by incorporating a range of carbon prices in \$/tCO_2e as a "carbon price". A number of sensitivities on the carbon price were run in order to identify the \$/tCO_2e threshold above which the second scenario, which has higher CAPEX and OPEX than the first scenario, becomes more attractive due to its lower CO_2 and CH_4 emissions and therefore \$/tCO_2e cost.

The EMV is calculated as the probability weighted average of two potential exploration outcomes: a discovery is made and developed thereby generating a positive Net Present Value (NPV) or to the contrary, the exploration and appraisal investments do not yield a commercial project and generate a negative NPV.

Profiles

The exploration and appraisal phase is assumed to be identical in all scenarios, with 3D seismic acquired, two exploratory wells and two appraisal wells being drilled. This is intended as a simplification, as in practice the initial outcome of the first exploration well may not justify the drilling of the two subsequent appraisal wells assumed here, which is nevertheless adequate for illustrative purposes.

The development of this illustrative offshore oil resource assumes the drilling of 18 production wells for both scenarios, yielding a short plateau of 60,000 barrels per day (bbl/d) resulting in a profile recovering 300 million barrels of oil (MMbbl) over 20 years. The production of associated gas is estimated on the basis of a constant gas to oil ratio of 300 standard cubic feet per barrel of oil (scf/bbl).

The chart below displays the oil production profile, identical in both scenarios for the purpose of this case

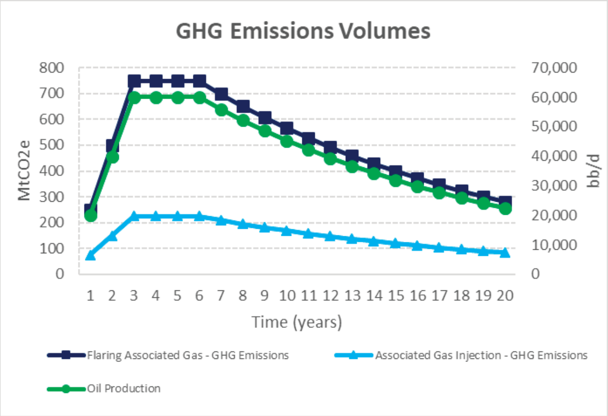

Figure 1: Profiles of oil production and GHG emissions volumes for the illustrative scenarios

study, and the GHG emissions profiles, in thousands of tCO_2e ($MtCO_2e$) per annum. The GHG emissions in the first scenario, where gas is flared, significantly exceed the emissions in the second scenario, where gas is reinjected into the reservoir.

These profiles are then incorporated for economic modelling, described in the following section.

Economic Assessments

The main assumptions used in order to estimate the NPV and then EMV of the various cases were:

- Discount Rate: 10%
- Oil price: flat $60/bbl
- Royalty: 12.5%
- No corporate income tax
- Geological Chance of Success (GCoS): 20%

The formula for the EMV is as follows:

*EMV = GCoS * NPV Successful Project + (1 - GCoS) * NPV Exploration Failure*

When the NPV of a successful project (discovery made and developed) multiplied by the probability associated with this outcome exceeds the NPV of an exploration failure multiplied by the associated probability, the EMV is positive. The more the EMV of an exploration opportunity is positive, the more attractive it would be considered. Likewise, when a project EMV is negative, or in other words proceeding with this investment is expected to destroy value, this project is unlikely to go ahead, no exploration wells are drilled and the potential hydrocarbons present become stranded.

The following tables summarizes the component parts of the EMV for the two scenarios described above across a range of carbon price sensitivities to illustrate the impacts of accounting for GHG emissions on exploration economics.

Project Indicators	**Unit**	**Flaring Associated Gas Scenario**	**Associated Gas Injection Scenario**
CGoS	%	20%	20%
NPV Exploration Sunk Costs	MM$	-155	-155
NPV Development	MM$	781	717
Expected Monetary Value	MM$	32	19
Estimated Ultimate Recovery (EUR) Oil	MMbbl	302	302
GHG Emissions Development Phase	tCO_2e	10455	3136

Table 1 Project Indicators assuming no carbon price

Project Indicators	**Unit**	**Flaring Associated Gas Scenario**	**Associated Gas Injection Scenario**
CGoS	%	20%	20%
NPV Exploration Sunk Costs	MM$	-155	-155
NPV Development	MM$	634	675
Expected Monetary Value	MM$	3	11
Estimated Ultimate Recovery (EUR) Oil	MMbbl	302	302
GHG Emissions Development Phase	tCO_2e	10455	3136

Table 2: Project Indicators assuming $50/$tCO_2e$

Project Indicators	**Unit**	**Flaring Associated Gas Scenario**	**Associated Gas Injection Scenario**
CGoS	%	20%	20%
NPV Exploration Sunk Costs	MM$	-155	-155
NPV Development	MM$	486	629
Expected Monetary Value	MM$	-27	2
Estimated Ultimate Recovery (EUR) Oil	MMbbl	302	302
GHG Emissions Development Phase	tCO_2e	10455	3136

Table 3: Project Indicators assuming $100/$tCO_2e$

The tables above illustrate how the scenario which assumes gas being flared yields a higher EMV than the gas reinjection scenario when there is no tax paid on carbon emissions, due to the higher costs required to reinject the gas. However, the attractiveness of these two scenarios reverses as a carbon price is incorporated in project economics, with the gas reinjection scenario becoming increasingly more attractive relative to the gas flaring scenario as the carbon price increases.

The EMV of both scenarios is reduced by a carbon price, as in both cases, even where gas is reinjected instead of flared, there are GHG emissions that trigger additional costs. However, it is noteworthy that the scenario with the lowest CI, the one without flaring, yields much more resilient economics, its EMV being significantly less impacted by a carbon price than the other scenario.

Multiple cash flow runs were considered for assessing the impact of different carbon prices on project economics for both scenarios:

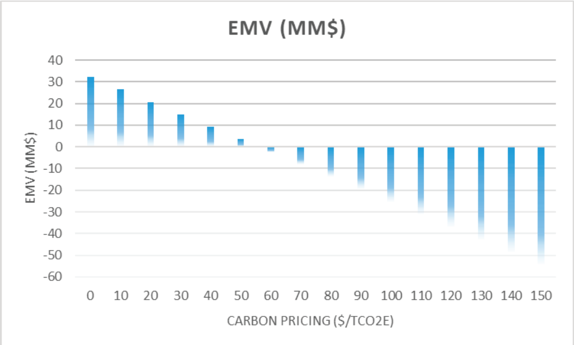

Figure 2: EMV Flaring Scenario across a range of carbon prices

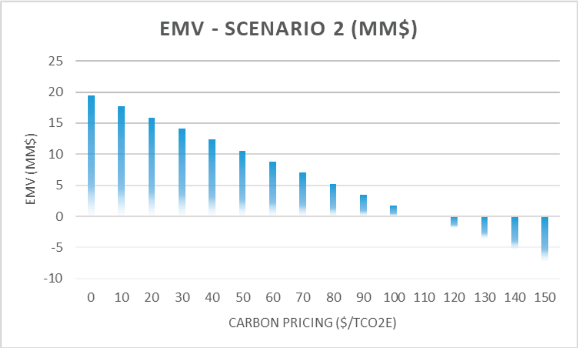

Figure 3: EMV gas reinjection scenario across a range of carbon prices

These figures confirm the earlier observation made that projects with reduced CI may yield lower EMVs due to their higher costs, but remain nevertheless attractive across a broader range of carbon prices. In the examples above, the gas flaring scenario would not justify any exploration investment if a carbon price in excess of \$50/tCO_2e is assumed, whereas the gas reinjection scenario would remain attractive up to a carbon price of \$100/tCO_2e.

Conclusions

Since an exploratory prospect would only be attractive if Expected Monetary Value (EMV) > 0, oil & gas companies should consider the potential impact of a "Carbon Price" when they run economics, even during the exploration phase, and take this into account when screening development concepts.

This is expected to generate a greater emphasis on reducing a project's CI from very early stages of evaluation, when an operator has the greatest ability to influence the development concept that will ultimately be adopted.

A prudent consideration of the potential impacts of GHG emissions on upstream project economics is essential, starting with an estimation of CO_2e emissions profiles and relying on a broad range of sensitivities to carbon prices.

Such an approach is increasingly warranted to preserve upstream value, rank exploration prospects and mitigate the risks of having stranded assets in a company's portfolio.