**Effect of Carbon Taxes Applied to Upstream Carbon Emissions on Reserves Estimates**

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**Section 1: Problem Statement**

In this increasingly carbon-conscious era, policies and regulations on greenhouse gas emissions are becoming ubiquitous. One mechanism for managing carbon emissions is the implementation of a carbon price applied on a per tonne of CO2 equivalent (tCO2e) basis, effectively putting a price on emissions. According to the World Bank, 20% of global emissions are currently subject to carbon pricing regulation, ranging from $1 to $139/tCO2e and an average of $7/tCO2e. The impact of a carbon price is an important consideration, especially for a relatively carbon-intensive industry like the oil and gas industry. A carbon price on upstream emissions would affect project economics and could impact hydrocarbon reserves (as defined under the Society of Petroleum Engineers’ Petroleum Resources Management System) potentially creating “stranded assets”.

**Section 2: Methodology**

In this study, an illustrative mature onshore oil field was chosen to assess the impact of applying a carbon price to emissions on field economics and ultimately reserves. In order to estimate carbon emissions for the chosen field, an open-source engineering-based analysis tool developed at Stanford University called Oil Production Greenhouse gas Emissions Estimator (OPGEE) was used. OPGEE takes a set of up to 50 inputs for a field based on a static representation of the field’s properties and productivity averaged over its life. The model uses a well to tank based assessment methodology which accounts for emissions from exploration, drilling & completions, production, processing and transportation, in order to calculate the average carbon intensity (CI), provided in terms of grams of CO2 equivalent per Mega Joule of crude oil produced. This analysis leverages OPGEE to focus on emissions from the production and processing phases and applied on a year-by-year basis to develop a CI profile of the chosen field through time. The temporal CI profile is then translated into yearly emissions volumes and ultimately into a component of field opex at different levels of carbon pricing considered.

**Section 3: Results of Study**

Multiple scenarios were considered for assessing the impact of carbonpricing on reserves, including various levels of carbon pricing, levels of flaring etc. The economic evaluation based on OPGEE emissions estimates suggests that a carbon price between $50/tCO2e and $150/tCO2e has the potential of reducing reserves in the range of 2-4% in this particular illustrative case. Moreover, if significant flaring is a feature of the field, the reduction in reserves at the considered carbon prices escalates to 7-17%. Such material impacts on reserves illustrates the importance of assessing and reducing sources of emissions in such cases in order to maximize expected ultimate recovery (EUR).
Figure 1: Profile of carbon intensity and emissions volumes relative to crude production for the illustrative field

<table>
<thead>
<tr>
<th>Case</th>
<th>Total Flare (Bcf)</th>
<th>Carbon Price ($/tCO₂)</th>
<th>Economic Limit (Year)</th>
<th>Reserves (MMBbl)</th>
<th>Cum. Pre Tax CF (US$MM)</th>
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<tbody>
<tr>
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<td>$</td>
<td>-</td>
<td>17</td>
<td>4.6</td>
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<td>15</td>
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<td>11</td>
<td>3.8</td>
<td>$</td>
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</tbody>
</table>

Table 1: Summary of scenarios considered for evaluation of reserves and pre-tax cash flow impact to a range of carbon prices

**Section 4: Recommendations for further work**

Given the material effect of carbon pricing on reserves estimates, it’s worth decomposing the aggregate CI on a yearly basis into major and minor sources. Based on this understanding, a feasible plan to reduce the CI by implementing cost effective alternative solutions for the major contributors to emissions may be developed. This may warrant the assessment of various carbon abatement options (i.e. avoiding emissions, reducing inefficiencies, replacing with alternative energy sources, offsetting emissions elsewhere, sequestering captured CO2) that could be implemented through time as part of a carbon management strategy. Furthermore, as major emissions sources differ between different archetype oil and gas fields, this requires the development of multiple approaches to address these challenges.

**References**