Financial Feasibility Study of Carbon Capture, Utilization, and Storage Project in West Java, Indonesia

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ABSTRACT

Following The Paris Agreement, Indonesia submitted an Enhanced Nationally Determined Contribution with an emission reduction target of 31.89% unconditionally or 43.20% conditionally. Indonesia envisions to reach net zero emission by 2060 or sooner. Contributing approximately a third of the carbon emission nationally, the decarbonization of the energy sector plays a big role in the ENDC pathways. From the oil and gas subsector, one of the programs designated to reduce their greenhouse gas emission are CCS (Carbon Capture and Storage) and CCUS (Carbon Capture, Utilization, and Storage). In oil and gas upstream industry, CCS is a combination of technologies that involves sequestering carbon dioxide (CO₂) from oil and gas upstream activities, utilize it as an enhanced oil recovery to increase liquid production before storing it permanently underground. However, the development of CCUS is filled with challenges. Other than the technical challenge of CCUS, the project is deemed to be too expensive and unable to generate a positive return for the project owner. Carbon trading is one of the mechanisms intended to provide added revenue for CCUS project. Using the carbon offset and trade mechanism, entities that conduct emission-reducing activities receive credit for the amount of emission reduced. The carbon credits can be sold in the market to other companies that need it. This research aims to determine whether carbon trading could increase the profitability of a CCUS project owned by an oil and gas company located in West Java, Indonesia. The project consists of capturing CO₂ generated from natural gas purification, transporting it via pipeline to a nearby depleted oil field where the CO₂ is used as an enhanced oil recovery, and storing it permanently underground.

Keywords: CCS, CCUS, Carbon Offset, Carbon Trading, Emission Reduction.

I. INTRODUCTION

Following the Paris Agreement, Indonesia has published an Enhanced Nationally Determined Contribution (ENDC) with a target of 32% emission reductions against Business-as-Usual scenario by 2030. Indonesia has imposed a cap level and carbon tax for power generation subsector. Following this target, government of Indonesia imposed Law no 7 of 2021 regarding Harmonization of Tax Regulations stated that every kilogram of carbon equivalent emissions that exceed a certain cap will be subjected to Rp 30 (0.21 cent dollar) tax. That is roughly equal to about $1.95 per metric ton of carbon equivalent. Furthermore, Indonesia will also implement emission trading scheme, where the emission-producing organization above the cap must purchase an emission permit certificate (SIE) from another party whose emissions are below the cap level. The government targets the carbon tax to be fully implemented by 2025.

In 2021, Indonesia’s oil and gas production reached 658,5 MBOPD and 6,662 MMSCFD. The Ministry of Energy and Mineral Resources has set an oil and gas production target of 1,000 MBOPD and 12 BSCFD by 2030. Compared to the current production, this target seems very steep and hard to reach. The Minister of Energy and Mineral Resources stated that the upstream oil and gas sector will still play an important role in fulfilling national energy demand. Although a decrease of contribution percentage from oil and gas is expected, the increase in population and economic growth will create more demand for energy.

Two contrary targets need to be fulfilled by the oil and gas contractors in Indonesia; to increase oil and gas production while at the same time decrease carbon emissions. One of the technological breakthroughs enabling emission reductions in oil and gas is carbon capture, utilization, and storage (CCUS). CCUS refers to a combination of technologies involving the process of capturing CO₂ from a large point source, transporting it via pipeline or other methods, utilizing it in a range of application, and finally injecting it into deep geological formations which trap the CO₂ for permanent storage (International Energy Agency, 2021). In oil and gas industry, CO₂ injection can be utilized as an enhanced oil recovery to supplement the reservoir’s natural drive mechanism and increasing liquid production.
II. BUSINESS ISSUE

The problem faced by oil and gas companies in implementing CCUS into their operations is that the project needs a very high capital investment and financial feasibility analysis shows that it couldn’t generate a positive return for project owners. CO₂ is highly corrosive substance, oil and gas upstream facilities typically are not designed to process high concentration of CO₂. A whole new corrosive-resistant wells and production surface facilities needs to be built, along with CO₂ capture plant and pipeline for transportation when the CO₂ is not utilized or stored in the same location it is captured.

Carbon trading is one of the ways CCUS project owners can receive a financial incentive on their emission reduction activities. Article 17 of the Kyoto Protocol allows countries that have emission units to spare – emissions permitted them but not “used” – to sell this excess capacity to countries that are over the target. Following this, a new commodity of emission reduction is created. Emission is now tracked and traded as a commodity. Since CO₂ is the main contributor of greenhouse gas, people refer to this new commodity as “carbon market”.

The objective of this research is to assess the financial feasibility of a CCUS project planned to be implemented in an oil and gas field in West Java, Indonesia for the project owner, and determine if carbon trading would help this CCUS project become more attractive. The questions which will be explored in this research are:

1. Will the CCUS project in West Java, Indonesia be economically viable to be implemented under current condition?
2. Will the CCUS project in West Java, Indonesia become more profitable if carbon trading is implemented in Indonesia?

III. LITERATURE REVIEW

Climate change is a serious and potentially irreversible damage to human societies and the environment we live in. To prevent further damage caused by human activities, countries around the world adopted the Paris Agreement in 2015 aimed to limit global temperature rise to well below 2°C, preferably to 1.5 °C, above pre-industrial levels. Following the agreement, participating countries submitted their NDC (Nationally Determined Contributions) containing programs and pathways for decarbonization to reach net zero emission.

One of the programs aligned to the decarbonization strategy is Carbon Capture, Utilization, and Storage (CCUS). In oil field, injection of CO₂ acts as enhanced oil recovery and help supplement the natural driving mechanism of the reservoir, increasing the oil production. Additionally, with the development of carbon trading, oil and gas company can monetize their emission reduction using the carbon offset mechanism.

A. Enhanced Nationally Determined Contribution (ENDC) of Indonesia

Indonesia submitted Intended Nationally Determined Contribution (INDC) prior to COP21. In this INDC, Indonesia sets a target of emission reduction by 29% or equal to 835 million metric ton CO₂. As mandated in Paris Agreement, parties are requested to revisit and strengthen their NDC to align with the Paris Agreement temperature goal by the end of 2022. Complying to this mandate, Indonesia submits an Enhanced NDC to UNFCCC Secretariat on September 23rd, 2022. In this ENDC, Indonesia raises its emission reduction target to 32% or equal to 912 million metric ton CO₂. Under the scenario compatible with 1.5’ goals, greenhouse gas emissions will peak in 2030 at 1,24 gigatonic ton CO₂ and then continue to decline to reach 0,54 gigatonic ton CO₂ in 2050. Indonesia aims to reach net zero emission by 2060 or possibly sooner.

In order to reach their emission reduction target, Indonesian government has imposed several regulations that encourage decarbonization pathways. Carbon cap and tax has been implemented for coal power plant through Law No 07/2021 and Ministry of Energy and Mineral Resources Regulation No 16/2022. On the oil and gas sector, MEMR recently passed the Regulation No. 02/2023 on the implementation of carbon capture and storage (CCS) as well as carbon capture, utilization, and storage (CCUS) in upstream sector of oil and gas.

B. Carbon Capture, Utilization, and Storage

Carbon capture and storage, commonly abbreviated as “CCS” is a combination of technologies that involves sequestering carbon dioxide (CO₂) – the biggest contributor of greenhouse gas – from the use of fossil fuel or industrial activities and storing it permanently underground. CCS is regarded as a potentially important method of reducing CO₂ emissions, along with the effort to switch into less carbon intensive source of energy. A large reduction in greenhouse gas emission is needed to comply to the internationally agreed goal of limiting the rise in global temperature to below 2°C under the Paris Agreement.

CO₂ enhanced oil recovery (EOR) is a proven technology to maximize oil recovery at depleted reservoir by injection of CO₂. CO₂ EOR also provides a means of CO₂ storage since some of the injected CO₂ will stay permanently underground. CO₂ EOR used with a purpose to store CO₂ from anthropogenic sources is a type of carbon capture, utilization, and storage (CCUS) technology.

Oil fields have three main production phases: primary, secondary, and tertiary. The recovery of oil by any of the natural drive mechanisms is called primary recovery. Secondary recovery, or improved oil recovery (IOR), refers to the additional oil recovery resulting from water and or immiscible gas injection. Tertiary recovery, also known as enhanced oil recovery (EOR), is additional recovery over and above what could be recovered by primary and secondary recovery. EOR methods involve injection of substances which causes changes in compositions, temperature, and rock-fluid interactions in the reservoir.

C. Carbon Pricing and the Carbon Market

According to The World Bank (2021), carbon pricing is a cost-effective policy tool that governments and companies can use as a part of their strategy. Carbon pricing creates a financial incentive to emission reduction activities. However, their effectiveness is limited is used without other policies that can complement them by addressing other climate change challenges.
Carbon pricing can be divided into explicit and implicit carbon pricing. Explicit carbon pricing is enacted by a government regulation and impose a price based on carbon content. Most commonly, explicit carbon pricing is enacted through government mandate using carbon tax or emission trading system (ETS) framework. The two main forms of an ETS are cap and trade and baseline and credit system.

Cap and trade are a mechanism where the government implement a limit of emission level called “cap”. Entities that produce lower emission than their cap level are allowed to sell their emission quota in the carbon market. Entities who produce higher than their cap level can buy this quota. Baseline and credit or offset credit mechanism is where the entities that conduct an emission reducing activities receives credit for the amount of emission reduced. The carbon credits can be sold in the market to other companies that needs it.

IV. METHODOLOGY

To determine the profitability of the CCUS project owned by an oil and gas company in Indonesia, a cost recovery production sharing contract (PSC) financial model is used. Production Sharing Contract (PSC) is a type of contract signed between a government and a resource extraction company (commonly referred as contractor) to determine how much of the resource extracted from the country each will receive. In PSC, the government granted an oil and gas company the rights to conducts exploration and production of an oil and gas resources in a specific working area. The oil and gas company will pay the initial cost that occurs from exploration and development of the field. When successful, the company is allowed to use the revenue from the produced oil to recover capital and operational expenditures (cost recovery). The remaining profit will be split between the government and the company.

The net contractor’s take will be calculated using two scenarios:
- As Is, which means that the revenue of the project comes only from the commercialization and monetization of oil and gas produced.
- The revenue of the project comes from the commercialization and monetization of oil and gas produced and also from selling carbon credits.

The project’s profitability will be judged using several economic indicators namely NPV, IRR, Pay Out Time, and Profitability Index. The criteria are as follows:
- If the NPV is greater than 0 (positive), accept the project. If the NPV is less than 0 (negative), reject the project.
- If the IRR is greater than the hurdle rate, accept the project. If the IRR is less than the hurdle rate, reject the project.
- If the POT is less than 50% of the project age, accept the project. If the POT is longer than 50% of the project age, reject the project.
- If the PI is greater than 1, accept the project.

V. RESULTS

This CCUS project is owned by an Indonesian oil and gas company with working areas located in West Java, Indonesia. The CO₂ is sourced from natural gas processing produced by a gas field, transported by about 180 km via pipeline, and injected to a depleted oil reservoir as CO₂ enhanced oil recovery before stored permanently in an underground reservoir. The CO₂ storage volume increases at constant rate from 2031 to 2050 and achieves total 11,39 million metric ton. Cumulative oil production for 25 years is 44.059,93 million barrels. The total investment needed for this project is estimated at 1,3 billion USD with operation cost averaging at 55,8 million USD per year.

In the base case scenario, the contractor’s final take is calculated under cost recovery PSC scheme with no added subsidy or incentives using three scenarios of Indonesian Crude Price (ICP) projections. The flow of the production sharing contract to calculate contractor and government take is as follows:

A. Gross Revenue

Gross Revenue is the total of money generated from business activities, in this case the revenue from oil commercialization. Gross revenue is calculated by multiplying oil production with oil price. The oil price used in this research is Indonesian Crude Price (ICP) projections with 3 projections scenario: low, mid, and high.

B. First Tranche Petroleum (FTP)

First Tranche Petroleum is a percentage of production that should be deducted and shared between contractor and government before cost recovery. FTP ensures a share of revenue for both government and contractor before cost recovery deduction. In this research, the FTP percentage is 5% from gross revenue (shareable between government and contractor).
Fig. 2. PSC Calculation Flow for Base Case Scenario.

Fig. 3. PSC Calculation Flow for Carbon Trading Scenario with Regulated Price.
C. Cost Recovery

As stated in President Decree No 35/2004 Article 55, the contractor may recover the costs incurred to carry out exploration and exploitation activities in accordance with the work plan and budgeting (WPNB) and authorization financial expenditure (AFE) approved by the government after commercialization of production.

D. Equity to be Split

Equity to be split is calculated by deducting FTP and cost recovery from gross revenue. The split for contractor and government is agreed on in the production sharing contract, for this research the split pre-tax is 67:32:77 (government: contractor).

E. Domestic Market Obligation

Domestic Market Obligation or DMO is the obligation for contractor to supply local market from contractor’s share. Usually in the first 5 year of field development, DMO is priced the same as market price; this is called DMO Holiday. After 5 years, DMO price is discounted according to the agreement (example: 10% discount from market price). In this research, DMO price is fixed at 100% ICP.

F. Tax

Tax is 40.5% of contractor taxable income (contractor’s share of equity to be split plus contractor’s share of FTP). Split after tax is 60:40 (government: contractor).

The calculation result shows that the project will cause a loss of money for project owner with negative NPV of 231,29 million USD even in the highest case of ICP.

This CCUS project is a high capital project with total investment of 1.3 billion USD. An effort to reduce cost without compromising the project’s safety and quality needs to be explored. A sensitivity analysis of the project’s CAPEX shows that the project needs to be at least 60% cheaper (preferably 50%) in order to generate a positive NPV without any additional incentives or revenue.

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TABLE I: Calculation Result of the Base Case Scenario

<table>
<thead>
<tr>
<th>ICP</th>
<th>NPV (MUSD)</th>
<th>IRR</th>
<th>PI</th>
<th>POT (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>-429,923,05</td>
<td>2.55%</td>
<td>0.67</td>
<td>14.27</td>
</tr>
<tr>
<td>Mid</td>
<td>-306,383,79</td>
<td>4.70%</td>
<td>0.77</td>
<td>10.98</td>
</tr>
<tr>
<td>High</td>
<td>-231,288,39</td>
<td>6.03%</td>
<td>0.82</td>
<td>9.83</td>
</tr>
</tbody>
</table>

The Law No 7/2021 stated that the carbon price in Indonesia is set higher or equal to carbon prices in carbon markets. In the event where carbon price in the market is below Rp 30 per kilogram of carbon dioxide equivalent, the carbon price is set at Rp30 per kilogram of carbon dioxide equivalent. Using the lowest carbon price of 1.95 USD/ton (equals to Rp 30,000 per ton), the added revenue from carbon trading does not create a significant change on the project’s profitability.

TABLE IV: Calculation Result of the Carbon Trading Scenario with Regulated Price

<table>
<thead>
<tr>
<th>ICP</th>
<th>NPV (MUSD)</th>
<th>IRR</th>
<th>PI</th>
<th>POT (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>-427,749,38</td>
<td>2.61%</td>
<td>0.67</td>
<td>14.18</td>
</tr>
<tr>
<td>Mid</td>
<td>-304,472,86</td>
<td>4.75%</td>
<td>0.77</td>
<td>10.96</td>
</tr>
<tr>
<td>High</td>
<td>-229,489,76</td>
<td>6.07%</td>
<td>0.82</td>
<td>9.82</td>
</tr>
</tbody>
</table>

The World Bank Published State of Trends of Carbon Pricing 2021 that provides a snapshots of carbon pricing all around the world. More governments are adopting net zero targets and carbon pricing instruments are becoming more competitive. According to experts, an ambitious carbon prices of USD 40 – 80 per ton of carbon dioxide equivalent are needed to meet Paris Agreement’s 2°C goal. Currently, the Europe Union Emission Trading System (EU ETS) has the highest carbon price of 50 USD/ton CO2e.

TABLE V: Calculation Result of the Carbon Trading Scenario with EU ETS Price (2021)

<table>
<thead>
<tr>
<th>ICP</th>
<th>NPV (MUSD)</th>
<th>IRR</th>
<th>PI</th>
<th>POT (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>-375,981,58</td>
<td>3.92%</td>
<td>0.71</td>
<td>12.66</td>
</tr>
<tr>
<td>Mid</td>
<td>-258,445,11</td>
<td>5.83%</td>
<td>0.80</td>
<td>10.61</td>
</tr>
<tr>
<td>High</td>
<td>-185,169,81</td>
<td>7.02%</td>
<td>0.86</td>
<td>9.7</td>
</tr>
</tbody>
</table>

From Table V, it can be concluded that the project still couldn’t generate a positive NPV even when the carbon credits is traded using the highest price available currently. Positive NPV is generated at carbon price above 250 USD/ton, which is an unrealistically high price. Therefore, depending on the development of carbon trading is not enough and other means such as cost reduction should be pursued.

VI. Conclusions and Recommendations

The objective of this research is to assess the financial feasibility of a CCUS project for the project owner and determine if carbon trading will help CCUS and similar projects become more attractive. Under Indonesian cost recovery production sharing contract and regulations in power, CCUS project is not financially feasible and will cause loss of money to the project owner. For this CCUS project in West Java, without any subsidy or incentive, the capital investment needs to be lowered by 40 - 50% in order to generate a positive return. Cost reduction of CCUS project have already been achieved in a large scale CCUS project. Oil and gas companies with adjacent working areas should aim to create a synergy or collaboration such as shared facilities and shared storage space.

Carbon trading is supposed to give a financial ease for emission reduction projects by providing an added revenue from the monetization of carbon storage volume. UU No 07/2021 stated the minimum price of carbon equivalent in Indonesia is 1.95 USD per metric ton of carbon dioxide equivalent. When the volume of carbon storage is priced at USD 1.95/metric ton of CO2e, the added revenue is very small.
and does not impact significantly to the project’s profitability.

Further development of emission trading system of the countries will enable carbon credit to be traded globally. Each emission trading system has a different carbon price, the highest carbon price is found at the EU ETS (Europe Union) at USD 50/metric ton of carbon dioxide equivalent. At the price, the monetization of carbon storage volume helps increase the profitability of the project. However, in this research the project still generates negative NPV albeit the loss is lower than without carbon trading revenue. Therefore, it can be concluded that emission trading systems and implementation of carbon trading is helping CCUS project to become more financially feasible, however project owner could’t rely solely on carbon trading to make CCUS project financially feasible.

CONFLICT OF INTEREST

Authors declare that they do not have any conflict of interest.

REFERENCES


