Analysis of Proposed Incentives for Enhanced Oil Recovery and CCUS

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Executive Summary

A lack of investment in carbon capture in Wyoming may lead to early closure of coal-fired power plants, reduced demand for coal, and lost severance tax revenues. New federal tax credits may alleviate this problem by promoting more carbon-capture, but these policies are inefficient because they incentivize dedicated storage of carbon dioxide (CO_2) rather than utilizing this captured CO_2 to create additional value through enhanced oil recovery.

Currently there are two complementary incentives for capture carbon. Under the Inflation Reduction Act of 2022, dedicated storage of CO_2 receives an $85 per tonne federal tax credit (45Q tax credit). With the cost of storage at $20 per tonne in Wyoming, dedicated storage nets $65 per tonne to the provider of captured carbon. In contrast, selling captured CO_2 for enhanced oil recovery (CO_2 -EOR) earns a $60 per tonne federal tax credit. With estimated transport costs of $5 per tonne, the provider to CO_2 – EOR projects nets only $55 per tonne. Hence, the capture provider earns more from dedicated storage than from CO_2 -EOR. Should the State of Wyoming take action to close this gap?

The answer to this question depends upon the costs and benefits of closing this gap. The costs are $10 for every tonne of captured carbon used for CO_2 – EOR projects. Since one tonne of carbon produces 5 barrels of oil in Wyoming, this cost is equivalent to $2 per barrel, which is about 3% of $70 oil. The direct benefits include additional severance and ad valorem taxes earned on oil from CO_2 – EOR projects that would occur by closing the gap. The net direct benefits are simply the additional revenues earned from new CO_2 – EOR oil less the costs of closing the gap.

This study finds that a “win-win” solution is to provide incentives equivalent to a 3% severance tax on new CO_2 – EOR projects claiming the 45Q tax credit. This proposed incentive would close the gap in incentives for storing versus utilizing captured CO_2 that in turn would promote investment in CO_2 – EOR projects, increase oil production, and contribute to net gains in state and local taxes.

To illustrate the potential gains from this incentive, this study evaluates four potential Wyoming CO_2 – EOR projects that could occur under the right incentives. These projects involve an aggregate investment of $1.5 billion and cumulative production of 200 million barrels of oil. The increase in severance and ad valorem taxes net of incentives is $800 million. Investment expenditures and higher oil production induced by these incentives also generate additional fiscal contributions.

Providing incentives to use captured CO_2 to produce oil and then permanently store it rather than dedicating all captured CO_2 exclusively for storage generates significant income for the State of Wyoming. At a minimum, for every dollar spent on incentives for CO_2 – EOR projects seeking 45Q tax credits, net severance and ad valorem taxes increase by 2.4 dollars. If indirect and induced fiscal contributions are included, the rate of return increases even more. These findings suggest that incentivizing CO_2 – EOR projects seeking 45Q tax credits may deserve consideration by the State of Wyoming.

1. Introduction

The Inflation Reduction Act (IRA) of 2022 allows an $85 per tonne tax credit for capturing and storing carbon dioxide (CO_2). This legislation also allows for a $60 per tonne tax credit for using captured carbon (45Q tax credits) for enhanced oil recovery. This $15 per tonne difference and the prevailing costs for storage and transportation in Wyoming, encourage projects permanently storing CO_2 over projects using CO_2 for enhanced oil recovery, CO_2 – EOR. As a result, current federal policy entails an opportunity cost in the form of lost potential oil production from CO_2 – EOR using captured carbon.

Wyoming state policymakers can restore balance in the incentives for storage and utilization of carbon by investing a portion of state severance taxes earned on new CO_2 – EOR projects using captured carbon and, thereby, regain the lost opportunities from additional oil production. The following section explains how this re-balancing could be accomplished. Section three describes the investment and production that could be stimulated by the proposed state policy incentives. The direct net severance and ad valorem taxes earned from these potential projects are estimated in section four. Collectively these projects involve the investment of $1.5 billion and the production of 200 million barrels of additional oil over the next several decades. The economic impacts are discussed in section five. This new investment and production stimulate the supply chain and induce additional consumer spending. These indirect and induced economic impacts are estimated in section six. The total fiscal impacts are summarized in the final section.

2. Incentives for Captured Carbon

Federal tax credits for captured carbon currently favor storage over utilization in Wyoming. The federal tax credit for storage is $85 per tonne while the credit for use in enhanced oil recovery is $60 per tonne. The cost for carbon storage in Wyoming is $20 per tonne, netting $65 per tonne to the capture provider. Transporting captured carbon to oil fields in Wyoming costs $5 per tonne, netting $55 per tonne to the capture provider. Hence, under current federal policy, carbon providers earn $10 more per tonne storing than selling carbon to oil companies for

enhanced oil recovery. If this $10 per tonne difference could be eliminated, then carbon providers would be indifferent between storing carbon and selling it for enhanced oil recovery. Federal policy, therefore, is inefficient because it encourages storage over utilization. This inefficiency imposes a cost on the economy that is equal to the value of oil production from enhanced oil recovery that could occur under an efficient policy that ensures balanced incentives.

The State of Wyoming, however, can take action to restore a balance in these incentives by investing a portion of severance taxes on new CO_2 – EOR projects claiming the 45Q tax credit. The four projects under consideration in this study on average produce 5 barrels of oil per tonne of CO_2. The $10 per tonne gap, therefore, is equivalent to $2 per barrel [($10 / tonne) x (1 tonne / 5 barrels)], which is roughly 3% of the $70 oil price assumed in this study. The statutory oil severance tax rate in Wyoming is 6%. Hence, closing the $10 per tonne gap would involve the equivalent of a 50% rebate (3% / 6%) on severance tax payments on new CO_2 – EOR projects claiming the 45Q tax credit. Ad valorem taxes would not be affected.

The combined historical average effective severance and ad valorem tax rate on Wyoming oil is 10.1%. New CO_2 – EOR claiming the 45Q tax credit under an efficient incentive structure, therefore, would generate tax revenues at a combined 7.1% rate (10.1% less the 3% CO_2 – EOR incentive). So clearly it is in the best interest of the State of Wyoming to restore a balance in the incentives for storage and utilization of carbon because any resulting new barrel of oil would earn at least 7.1% in additional severance and ad valorem tax revenue. Under current federal and state tax policies, this incremental tax revenue would never be realized because investments in CO_2 – EOR projects claiming the 45Q tax credit likely would not occur and instead be directed to carbon capture and storage exclusively.

3. Enhanced Oil Recovery Projects using Captured Carbon

Four Site-Specific Field Studies

Staff at EORI worked directly with industry representatives on specific oil fields that are actively being considered by the operators of these fields for the implementation of CO_2-EOR. Denbury and TR Operating provided EORI with historical data, production forecasts, and cost information associated with the implementation of CO_2-EOR floods targeting specific fields in the Powder River Basin. The cost information provided included CO_2 purchase costs, CO_2 transportation costs, capital costs required for project implementation, and operating costs.

The names of the specific fields have been held confidential at the request of the field operators. Accordingly, the fields analyzed are generically identified as two 3-field clusters and two larger stand-alone fields. Due to the large expenses of implementing a CO_2-EOR project, economics dictate that smaller fields be developed as a cluster, while larger fields can be stand-alone projects unto themselves. The map shown in **Figure 1** shows the general location of the two 3-field clusters and the two larger stand-alone fields included in this report.

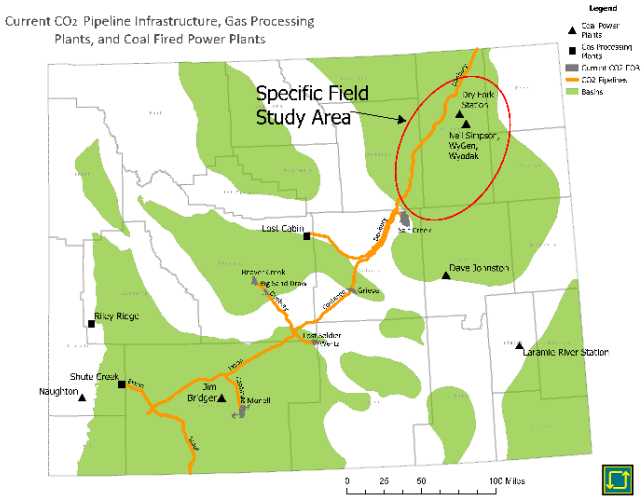

Figure 1. Map of Wyoming showing major stratigraphic basins, current CO_2 pipelines, current and potential CO_2 sources, and the area of specific focus for near-term CO_2-EOR projects.

High-Level, State-Wide Potential.

In addition to the specific fields where industry provided oil production and economic values, EORI staff also estimated the additional production potential to the state if CO_2-EOR were implemented in all areas of the state.

Methodology for Estimating Oil Recovery from CO_2-EOR Projects

Four Site-Specific Field Studies

Economic cash flow spreadsheets were developed for each of the four specific field scenarios. The spreadsheets contained forecasted injection and productions streams (injected CO_2 and water; produced oil, water, and CO_2; purchased CO_2; and recycled CO_2). Capital costs included costs associated with a CO_2 capture facility, pipeline construction, CO_2 compression, well refurbishing, new well drilling, in-field CO_2 distribution, and CO_2 recycle and compression. Operating costs included lease operating costs, CO_2 purchases, and CO_2 recycling costs. The field clusters were assumed to be developed in stages, such that a new development stage would be initiated each year.

High-Level, State-Wide Potential

The state-wide evaluation of potential CO_2-EOR oil production is a high-level estimation that does not include specific field evaluations. The approach used was to identify likely good field candidates for CO_2-EOR based on the primary reservoirs in each field. Oil fields identified as miscible with CO_2 and those with greater than 10 million barrels of recoverable oil currently in place were included in the analysis. 75 fields in Wyoming met the criteria for candidacy for the CO_2-EOR process.

Oil recovered from CO_2-EOR typically ranges from 10% to 15% of the original oil in place (OOIP). Experience has shown that some formations are generally more homogeneous than others. Recovery of oil from the CO_2-EOR process is generally more efficient for homogeneous formations. Accordingly, oil recovery from fields with more homogeneous formations was estimated to be 15% of the OOIP, while recovery from fields with more heterogeneous formations was estimated to be 10% of OOIP. The percentage of oil recovery for each field will be different, but the general rules-of-thumb employed are conservative and adequate for a high-level estimation of potential oil recovery from CO_2-EOR on a state-wide level. Note that this high-level approach does not consider the absence of CO_2 pipelines in certain basins of the state and assumes that there will be an economic distance between all 75 of the amenable oil fields and a CO_2 source.

Results

Four Site-Specific Field Studies

Forecasted rates for oil production and CO_2 purchases are shown in *Figure 2* for the four specific field-cases analyzed in this study. Purchased CO_2 peaked at 268 MMscf/D (5.2 Mtpa[1]) four years after project startup. Oil Production peaked at 40,000 bbl/D eight years after project startup. The total forecasted CO_2 purchased for the combined fields analyzed in this report was 6.1 Bscf (323 Mt) of CO_2 and the total forecasted incremental oil produced from these four field cases was 200 million barrels.

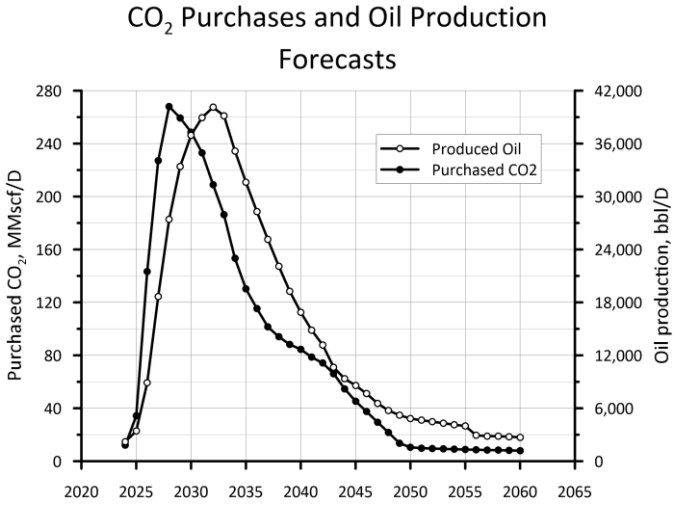

Figure 2. Forecasted CO_2 purchases and oil production for the combined CO_2-EOR floods of the four fields analyzed in this report.

High-Level, State-Wide Potential

Results of the state-wide analysis of oil production from CO_2-EOR potential is shown in **Table 1**. The potential CO_2-EOR oil recovery is broken out by basin in this table. The state-wide estimate totals over 2 billion barrels of oil that could be recovered by the CO_2-EOR process if employed in all appropriate fields in the state. The Bighorn Basin is estimated to contain the most

Table 1. Potential oil production from a state-wide

Wyoming Stratigraphic Basin	Estimated Recoverable Reserves from CO_2-EOR (bbls)	Number or Fields
Bighorn	981,430,298	17
Greater Green River	270,343,516	16
Laramie	25,377,110	1
Powder River	753,849,487	37
Wind River	115,434,001	4
Statewide Total	2,146,434,412	75

[1] Mtpa = megatonnes per annum, which is equivalent to million metric tons per year.

recoverable reserves—almost 1 billion barrels—followed by the Powder River, Greater Green River, Wind River, and Laramie basins.

Investment and Oil Production

To illustrate the potential gains from more efficient tax policies, this section presents the possible investment and oil production from four potential CO_2 – EOR projects in Wyoming. The investment expenditures for each of these projects are summarized in Figure 1. The first project, called large field, requires $471.8 million of investment. The Minnelusa and Kitty CO_2 – EOR fields each involve capital expenditures slightly less and more than $400 million respectively. The field cluster project would require $259.5 million of up-front capital spending. Collectively, these four projects would entail the outlay of $1.529 billion in capital investment. This investment spending would stimulate the state's economy through multiplied impacts on employment, income, and tax revenues that are discussed in section five and six.

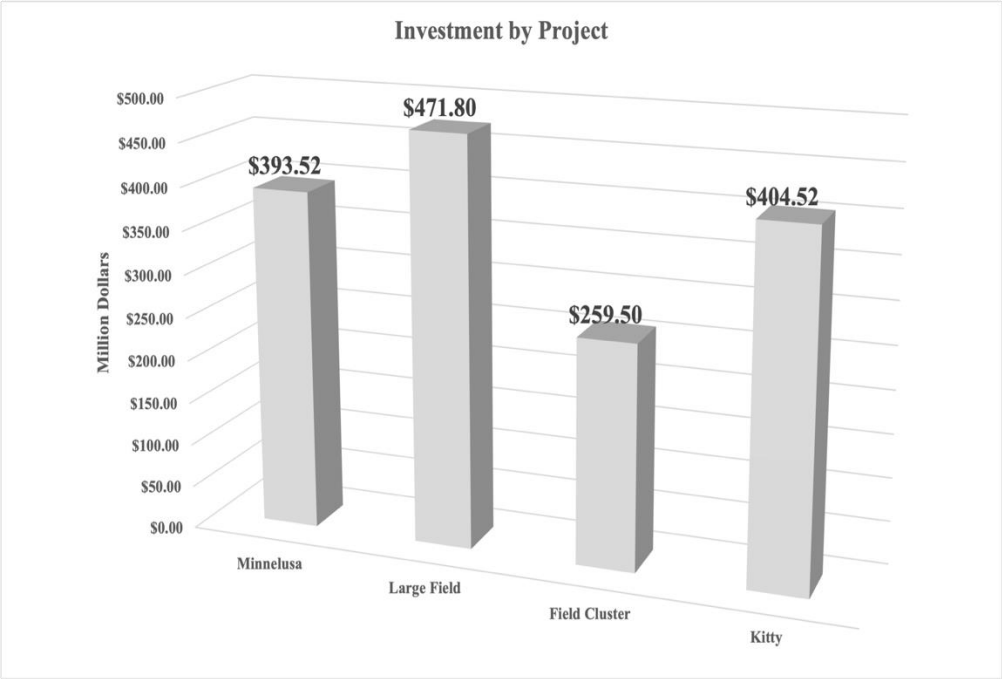

Figure 1: Investment by project in millions of 2023 dollars

These projects also would produce more than 200 million barrels of oil from 2024 through 2060. As Figure 2 illustrates oil production rises sharply during the first 10 years of these projects and together peak at more than 14 million barrels per year, which is just over 40,000 barrels per day. Total Wyoming oil production during 2022 averaged 249,000 barrels per day. Hence, these projects alone would increase total oil output in the state 16% in 2032 from current levels.

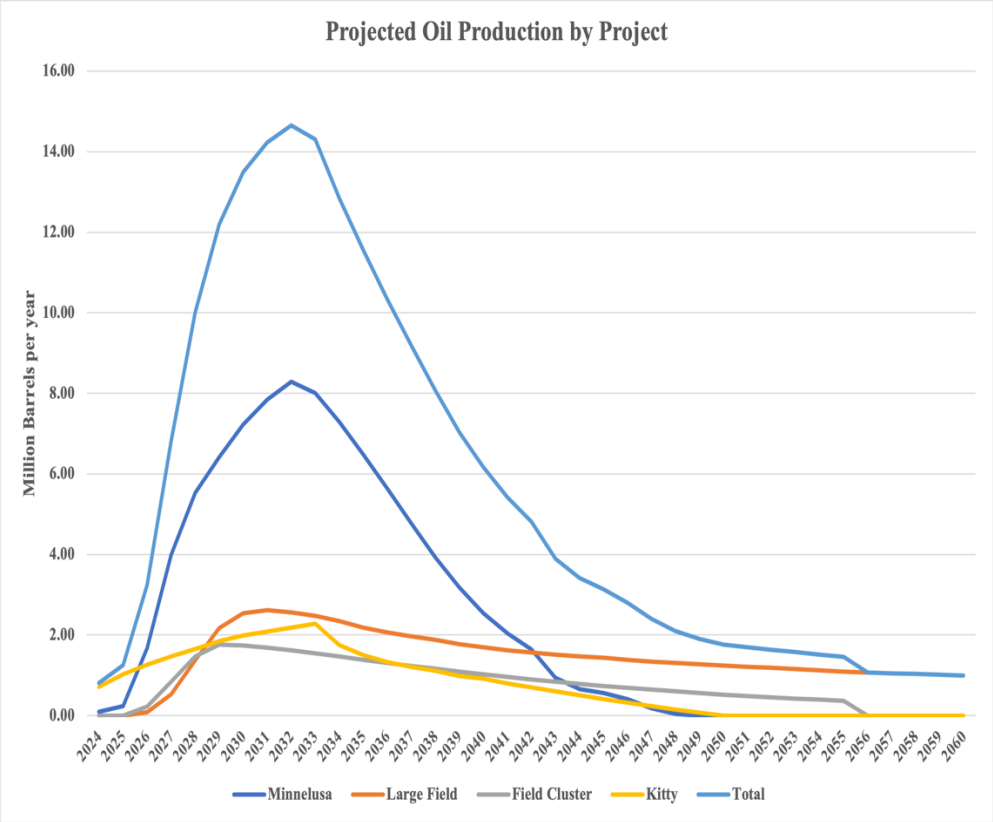

Figure 2: Oil production by project in million barrels per year

Purchased CO_2 from these projects would lead the oil production curves in Figure 2, peaking early on and tapering off as the projects recycle CO_2 recovered with extracted oil as increasing volumes of CO_2 are permanently sequestered in the oil field. Peak CO_2 demand for these four projects is 5.5 million tonnes in 2028. By 2045, purchased CO_2 drops below 1 million tonnes per year. Carbon storage would serve as a buffer between the demand for carbon for enhanced oil recovery and the supply from the carbon capture facilities. In this sense carbon capture and utilization are complementary.

4. Direct Fiscal Impacts

The direct fiscal impacts comprise the severance and ad valorem tax revenues from CO_2 – EOR projects claiming the 45Q tax credits. Gross tax revenues are simply production multiplied by the combined severance and ad valorem average historical rate of 10.1%. The cost of CO_2 – EOR incentives is 3% of incremental revenues. Net revenues are equal to gross tax revenues less the incentives. All calculations assume a constant real price of oil of $70 per barrel.

From 2024 through 2030, undiscounted gross severance and ad valorem tax revenues total $281 million. The CO_2 – EOR incentives total $83 million. Hence, total net severance taxes are $197 million from 2024 through 2030. Net tax revenues increase to $452 million from 2031 to 2040 and decline thereafter, see Table 1. The trajectory of tax revenues are displayed in Figure 3. Total net tax revenues total $810 million over the entire life of the projects from 2024 through

2060 and are $583 in present value terms assuming a 3% discount rate. For every dollar spent on incentives for CO_2 – EOR projects claiming the 45Q tax credits, the State of Wyoming earns 2.4 dollars in net severance and ad valorem tax revenue. Clearly, the direct fiscal rate of return on incentives for using captured carbon for enhanced oil recovery projects claiming the 45Q tax credit is significant.

Table 2: Severance and ad valorem taxes and 45Q CO_2 – EOR incentives in million dollars

	Undiscounted		
Period	Gross	Net	Incentive
2024 - 2030	$281	$197	$83
2031 - 2040	$643	$452	$191
2041 - 2050	$151	$106	$45
2051 - 2060	$78	$55	$23
Total	$1,153	$810	$342
	Discounted @ 3%		
2024 - 2030	$247	$174	$73
2031 - 2040	$470	$330	$139
2041 - 2050	$82	$58	$24
2051 - 2060	$31	$22	$9
Total	$830	$583	$246

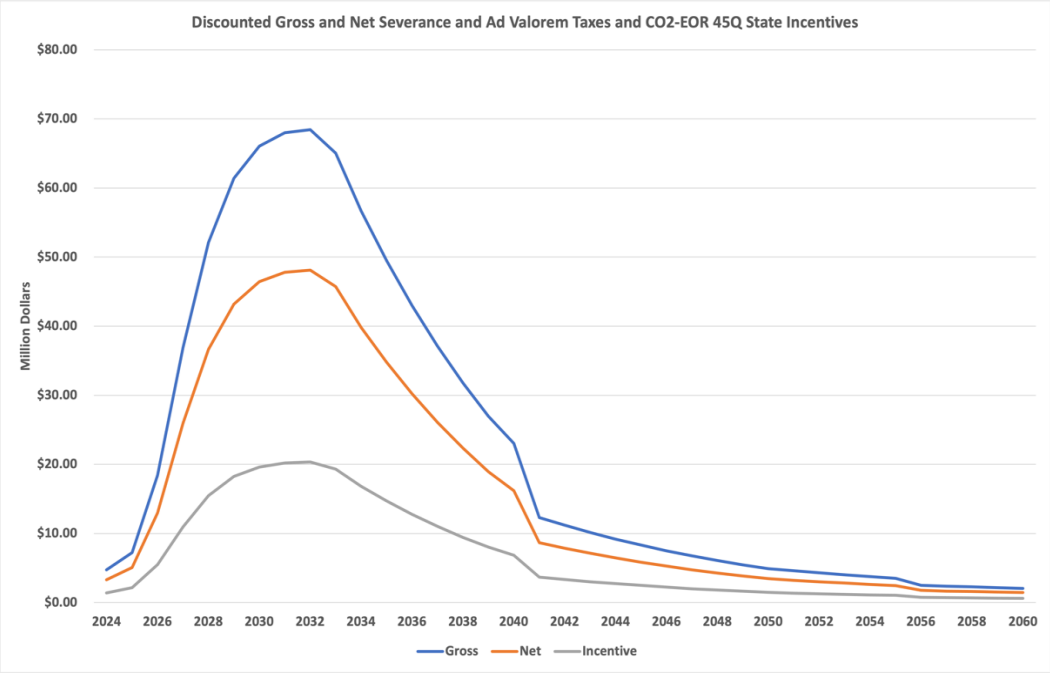

Figure 3: Tax revenues and state incentives for 45Q CO_2 – EOR, 2024 to 2060

5. Economic Impacts

The CO_2 – EOR projects claiming the 45Q tax credits would generate additional tax revenues as the state and local economies provide goods and services for the construction and

operation of these facilities. Indirect or supply chain fiscal impacts arise from the purchase of goods and services that support project activity. Fiscal gains also can be induced by the spending of wages and salaries paid by the projects and by supporting supply chain industries.

This study employs input-output analysis to estimate these fiscal contributions, which is an analytical framework developed by Professor Wassily Leontief in the late 1930s, for which he received the Nobel Prize in Economic Science in 1973. This framework is also known as interindustry analysis, since the fundamental purpose of the input-output framework is to analyze the interdependence of industries in an economy, according to Miller and Blair (2009). This framework is ideal for estimating how purchases by these projects affect other industries.

This modeling framework has been implemented by IMPLAN (2023) in an online platform providing complete sets of economic accounts for every county and zip code in the United States. This model balances industry inputs with outputs and can be used to determine the contributions of specific industries to regional economies. For this study, the scope of the study region is the State of Wyoming.

The direct, indirect, and induced impacts on employment and value added are summarized in Table 2. For example, the peak direct, indirect, and induced employment impacts are 940, 742, and 434 average annual full time job equivalents respectively over the 2031 through 2040 period. The corresponding impacts on average annual value added, which is the regional equivalent of gross domestic product, are $644, $97, and $37 million respectively. These impacts on real economic activity from the investment and production stimulated by state incentives for CO_2 – EOR claiming the 45Q tax credits generate indirect and induced impacts on state and local taxes, which are discussed in the next section.

Table 3: Impacts on employment and value

	Average Annual Job Equivalents			
	Direct	Indirect	Induced	Total
2024 - 2030	780	598	370	1,748
2031 - 2040	940	742	434	2,115
2041 - 2050	216	171	100	487
2051 - 2060	110	87	50	247
	Average Annual Value Added in Million Dollars			
2024 - 2030	$379	$70	$32	$480
2031 - 2040	$644	$97	$37	$778
2041 - 2050	$150	$22	$9	$181
2051 - 2060	$77	$11	$4	$93

6. Indirect and Induced Fiscal Impacts

The indirect and induced fiscal contributions from the four proposed projects are summarized in Figure 4. These contributions arise primarily from sales and property taxes. During the period 2024 through 2030 indirect and induced tax revenues increase by $483 million

and are $792 million from 2031 through 2040. Total indirect and induced tax revenues increase $1.5 billion.

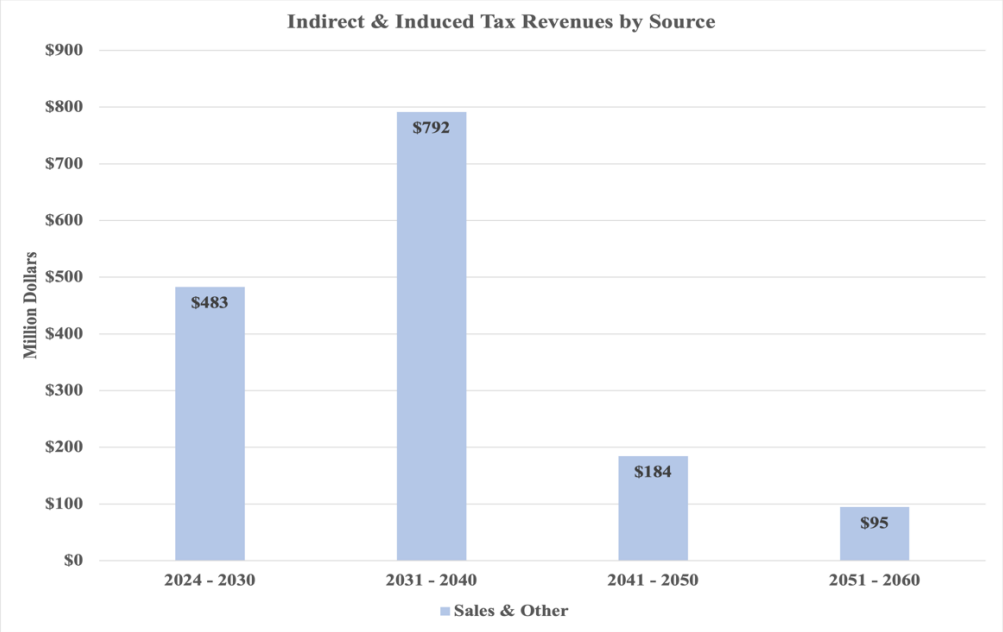

Figure 4: Indirect and induced fiscal contributions, 2024 to 2060

7. Total Fiscal Impacts

The total fiscal impacts of the four CO_2 – EOR projects seeking the 45Q tax credits include the direct effects on severance and ad valorem taxes and the indirect and induced tax impacts. These impacts are summarized in Figure 5 on an average annual basis. During 2024 through 2030, annual average tax contributions are $97 million with $28 million from direct severance and ad valorem taxes net of the incentives and another $69 million from indirect and induced impacts. Total average annual tax contributions increase to $178 million during the 2031 to 2040 period with $65 million coming directly from net severance and ad valorem taxes and another $113 million indirectly and induced by the construction and operation of the facilities.

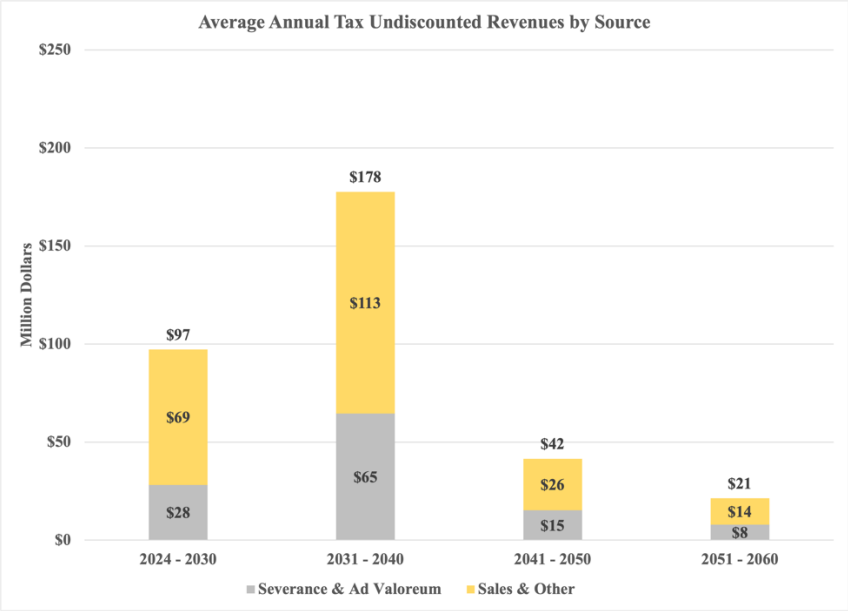

Figure 5: Total average annual fiscal contributions, 2024 to 2060

8. Conclusions

Current federal tax policy for carbon capture is inefficient, encouraging the storage of carbon over its utilization. The State of Wyoming can capture the resulting lost economic output by providing incentives equivalent to 3% of incremental oil revenues. At a minimum, for every dollar spent on incentives, net severance and ad valorem taxes increase by $2.4. If indirect and induced fiscal contributions are included, the rate of return increases even more. These findings suggest that incentivizing CO_2 – EOR projects seeking 45Q tax credits warrants additional research and analysis.

References

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