U.S. POLICY

CARBON DIOXIDE ENHANCED OIL RECOVERY: A CRITICAL DOMESTIC ENERGY, ECONOMIC, AND ENVIRONMENTAL OPPORTUNITY

National Enhanced Oil Recovery Initiative

C2ES CENTER FOR CLIMATE AND ENERGY SOLUTIONS

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ABOUT THE NATIONAL ENHANCED OIL RECOVERY INITIATIVE

The National Enhanced Oil Recovery Initiative (NEORI) was formed to help realize CO_2-EOR's full potential as a national energy security, economic, and environmental strategy. Organized and staffed by the Center for Climate and Energy Solutions (C2ES) and the Great Plains Institute (GPI), the Initiative brought together a broad and unusual coalition of executives from the electric power, coal, ethanol, chemical, and oil and gas industries; state officials, legislators, and regulators; and environmental and labor representatives. (See Project Participant List on the NEORI website.)

NEORI was launched on July 17, 2011 in Washington, D.C., with bipartisan support from four U.S. Senators and a member of Congress. Project participants met on three occasions to define the scope and expectations of the project, provide feedback on technical matters, and provide policy guidance. They gathered in Washington, D.C., with the launch of the project on July 17, 2011; in Traverse City, MI on September 21-22; and in Houston, TX, on November 1-2. The latter two meetings included field visits to commercial EOR operations and to a CO_2 capture facility.

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I. INTRODUCTION

Amidst economic uncertainty, fiscal crisis and political division over energy policy, carbon dioxide enhanced oil recovery (CO_2-EOR) offers a safe and commercially proven method of domestic oil production that can help the United States simultaneously address three urgent national priorities:

- Increasing our nation's energy security by reducing dependence on foreign oil, often imported from unstable and hostile regimes;
- Supporting job creation, increasing tax revenue, and reducing our trade deficit by keeping dollars now spent on oil imports here at home and at work in the U.S. economy; and
- Protecting the environment by capturing and storing CO_2 from industrial facilities and power plants, while getting more American crude from areas already developed for oil and gas production.

A largely unheralded example of American ingenuity, CO_2-EOR was pioneered in West Texas in 1972 as a way to sustain oil production in otherwise declining oil fields. It works by injecting CO_2 obtained from natural or man-made sources into existing oil fields to free up additional crude oil trapped in rock formations. In this way, CO_2-EOR can significantly extend the lifespan and revitalize production of mature oil fields in the United States.

Today, over 3,900 miles (Dooley, et al., 2009) of pipelines in the United States annually transport approximately 65 million tons of CO_2 (Melzer, 2012) that the oil industry purchases for use in EOR, producing 281,000 barrels of domestic oil per day, or six percent of U.S. crude oil production (ARI, 2011). The EOR industry has captured, transported, and injected large volumes of CO_2 for oil recovery over four decades with no major accidents, serious injuries or fatalities reported.

America has the potential to expand CO_2-EOR significantly. Advanced Resources International (ARI) estimates that an additional 26-61 billion barrels of oil could economically be recovered with today's EOR technologies, potentially more than doubling current U.S. proven reserves. Moreover, "next generation" EOR technology could yield substantially greater gains, potentially increasing recoverable domestic oil from EOR to 67-137 billion barrels, and storing 20-45 billion metric tons of CO_2 that would otherwise be released into the atmosphere (ARI, 2011).

The National Enhanced Oil Recovery Initiative (NEORI) was formed to help realize CO_2-EOR's full potential as a national energy security, economic and environmental strategy. Organized and staffed by the Center for Climate and Energy Solutions (C2ES) and the Great Plains Institute (GPI), the Initiative brought together a broad and unusual coalition of executives from the electric power, coal, ethanol, chemical, and oil and gas industries; state officials, legislators and regulators; and environmental and labor representatives. (See Project Participant List on the NEORI website.)

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NEORI participants also formed subgroups focused on developing policy recommendations, analysis and modeling, and communications and outreach materials. The subgroups held conference calls over several months, often on a weekly basis, to develop, refine, and reach consensus on recommendations and work products.

This report presents NEORI participants' consensus recommendations for targeted federal and state incentives to expand CO_2-EOR. If implemented, these recommendations would significantly increase U.S. domestic oil production while generating net new tax revenues for the federal government and states struggling to fill budget gaps and jumpstart our nation's economy.

II. OVERVIEW OF RECOMMENDATIONS

Federal Production Tax Credit for CO_2-EOR: A Revenue-Positive Policy for Domestic Energy Security

NEORI's centerpiece recommendation is a competitively awarded, revenue-positive federal production tax credit for capturing and transporting CO_2 to stimulate CO_2-EOR expansion. Crucially, this federal tax credit would more than pay for itself. Indeed, analysis of the incentive outlined below indicates that federal revenues from existing tax treatment of additional incremental oil production would exceed the fiscal cost of the incentive itself by $100 billion over 40 years. Further, modeling shows that this incentive program, properly designed, would become revenue-positive within the ten-year timeframe typically used by Congressional budget score-keepers.

Analysis undertaken by NEORI suggests that this tax credit would result in the production of an additional 9 billion barrels of American oil over 40 years, quadrupling CO_2-EOR production and displacing U.S. oil imports (See Figure 1). At the same time, the proposed incentive would save the United States roughly $610 billion in expenditures on imported oil, while storing approximately 4 billion tons of CO_2 captured from industrial and power plant sources, thereby reducing total U.S. CO_2 emissions in the process.

Focusing Incentives on Industrial Suppliers of CO_2, not the Oil Industry

With oil at around $100 per barrel, world-class experience and expertise in the U.S. oil industry, and private capital available to invest, why are new financial incentives needed to expand CO_2-EOR? To be sure, EOR represents an American can-do commercial success story, and the U.S. oil industry does not need or seek additional financial incentives to sustain EOR production at present levels.

While the business model of the U.S. EOR industry has worked profitably for decades utilizing existing sources of natural and man-made CO_2, the principal constraint on the EOR industry's ability to expand domestic oil production is the lack of sufficient additional CO_2 at current market prices. Therefore, NEORI recommends that incentives be primarily directed to capture and pipeline projects serving industrial facilities and power plants, rather than to EOR operators.

This approach will enable a variety of industry sectors to market new sources of CO_2 to the oil industry and develop the technological and operational experience that will drive innovation and cost reduction in CO_2 capture, compression, and transport over time. In addition to increasing CO_2 supply for the oil industry, these projects will benefit participating industries by helping them to reduce their carbon footprint in response to emerging and expected state and federal regulatory requirements and by making them more competitive in a global marketplace that increasingly values lower-carbon products and services. Finally, the deployment of CO_2 capture and pipelines for use in EOR will establish a national infrastructure that can eventually be utilized by many industries for long-term carbon capture and storage (CCS) in geologic formations beyond oil and gas fields.

Complement Federal Policies with State Incentives

States also have an important role to play in fostering CO_2-EOR deployment by implementing incentive policies that can complement the federal production tax credit recommended in this report. A number of states have already taken the lead, filling the current vacuum left by the absence of adequate federal policy. Therefore, this report identifies existing state policies that NEORI members believe should serve as models for policy-makers in other states to adopt and tailor to their particular needs.

Multiple Benefits of CO_2-EOR Can Marshall Broad Support for Policy Change

The federal and state policy recommendations in this report will, if implemented, create a virtuous circle of linked and growing benefits to the American people: expanding CO_2 supply, increasing domestic oil production and associated job creation, expanding federal and state revenues, and declining CO_2 emissions. Thus, at a time

Box 1: Rationale for Incentives to Support CO_2-EOR

The Challenge: Limited Supply of Man-Made CO_2 for Use in EOR

Today's supply of CO_2 available for purchase by the oil industry is simply inadequate to achieve the tens of billions of barrels of additional domestic oil production possible through EOR. In a fortunate, if ironic, twist of fate, a key to increasing America's domestic energy security lies in capturing and productively utilizing a portion of our nation's industrial CO_2 emissions, thereby meeting a critical domestic energy challenge, while also helping to solve a global environmental problem.

Expanding the supply of CO_2 available for EOR depends upon wide-scale deployment of carbon capture and compression equipment at a broad range of industrial sources, including natural gas processing; ethanol fermentation; fertilizer, industrial gas and chemicals production; gasification of various feedstocks; coal, natural gas and biomass-fueled power generation; and the manufacture of cement and steel. In addition, a substantial build-out of the existing CO_2 pipeline network will be required to deliver CO_2 from industrial facilities where it is produced to existing oil fields where it is needed.

The Solution: Reducing the Cost of Capturing and Transporting Man-Made CO_2

NEORI's federal and state incentive recommendations aim to bring down the cost of man-made, or anthropogenic, CO_2 capture and transport over time to a level that private capital can finance without additional government support and based solely on crude oil prices and the economics of commercial EOR operations.

The EOR industry currently purchases CO_2 on the open market. Market prices support using anthropogenic CO_2 only in those cases where the costs of capture from a particular industrial source are low, and the amount of CO_2 produced justifies private financing of pipeline infrastructure.

However, CO_2 capture technologies for some applications, notably electric power generation and some other industrial processes, are not yet fully commercialized and remain expensive to deploy, even at today's oil prices. Also, the costs of building trunk pipelines to deliver CO_2, especially from smaller industrial sources, often exceed the scope of what individual EOR projects can privately finance without the addition of incremental incentives recommended in this report.

when our nation's energy policy is mired in regional, partisan and ideological debate, CO_2-EOR can help lay the groundwork for a different policy path forward, one that weaves together a broad coalition of Americans united by common interests.

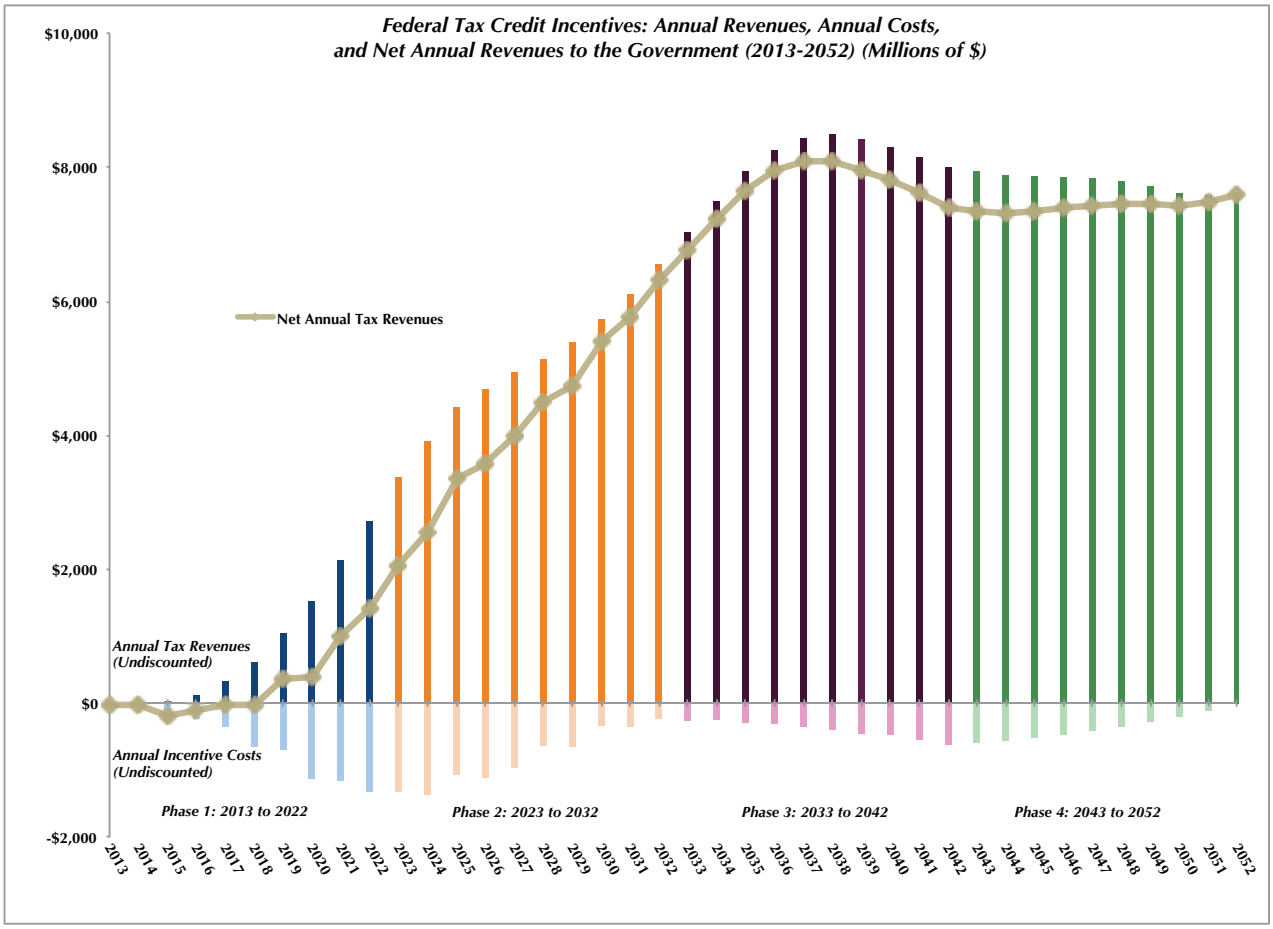
A. OVERVIEW OF THE PROPOSED FEDERAL PRODUCTION TAX CREDIT FOR CO_2 CAPTURE AND TRANSPORT

U.S. federal policy has long encouraged the capture and geologic storage of CO_2 emissions, or CCS, from power plants and other industrial facilities. This support has been consistently bi-partisan and extended across several Presidential Administrations. Grants, loan guarantees, and federal assistance from agencies such as the U.S. Department of Energy (DOE) have played a vital role in advancing research, development, and demonstration of key CO_2 capture technologies.

The commercial and operational experience of the CO_2-EOR industry in capturing, transporting, and injecting CO_2 for oil production has greatly informed and contributed to the federal CCS effort. Indeed, DOE has increasingly come to view commercial EOR as a key pathway to facilitating CCS deployment.

Thanks to the efforts of private industry and DOE, many CO_2 capture technologies are already commercially proven, and only a modest incentive is needed to help close the gap between the market price of CO_2 and what it costs to capture and transport that CO_2. In the case of emerging technologies, companies need a larger incentive to help shoulder the additional financial and operational risk of deploying new, pioneer capture projects for

Figure 1: Federal CO_2 Production Tax Credit Program Revenues and Costs: Core Scenario



the first time in a commercial setting.

Therefore, NEORI participants recommend a carefully targeted and fiscally disciplined production tax credit program to be administered by the U.S. Department of the Treasury. Performance-based and competitively awarded, the program is designed to provide just enough incremental financial support, and nothing more, to enable important CO_2 capture and pipeline projects to come into commercial operation and begin supplying CO_2 to the EOR industry.

The tax credit includes the following key features designed to foster the commercial deployment of anthropogenic CO_2 capture and pipeline projects, while ensuring project performance and a revenue- positive outcome for American taxpayers. It would be:

- Provided to owners of CO_2 capture equipment, installed on a broad range of industrial processes, with the potential to supply significant volumes of CO_2 to the EOR industry;
- Limited to covering the additional incremental costs of CO_2 capture, compression, and transport at new and existing industrial facilities and power plants;
- Allocated through competitive bidding in pioneer project, electric power and industrial tranches (so that like technologies with similar costs bid against each other);
- Awarded to qualifying projects over a ten-year period based on performance (the credit can only be claimed upon demonstrating the capture and oil field storage of the CO_2);
- Designed with transparent registration, credit allocation, certification, and public disclosure (to provide project developers and private investors the financial

certainty they need to move forward with projects);

- Created with no limits on project scale or on the aggregation of different CO_2 sources into a single project (to enable smaller industrial CO_2 suppliers to participate effectively);
- Measured to ensure that the program achieves ongoing technology innovation, CO_2 emission reductions, and cost reductions for CO_2 capture, compression, and transport; and
- Designed with explicit safeguards to penalize noncompliant projects, limit taxpayer expenditure, and modify the program to ensure net positive federal revenues (within the ten-year Congressional budget scoring window and over the long term).

A section-by-section analysis of the proposed federal production tax credit can be found in Appendix A and the detailed policy design recommendations are in Appendix B.

B. ANALYSIS OF REVENUE-POSITIVE IMPACTS OF THE PROPOSED FEDERAL PRODUCTION TAX CREDIT

C2ES and GPI conducted an analysis, with extensive input from NEORI participants, to inform the recommendations for a federal CO_2-EOR tax credit. In particular, the analysis explored the implications of NEORI's recommendations for CO_2 supply, oil production, and federal revenue. After consulting with NEORI participants and other industry experts and reviewing available literature, C2ES and GPI developed inputs and a spreadsheet model to reflect real-world production and market conditions. A core scenario was developed based on "best guess" inputs, and several sensitivity analyses were conducted.

The analysis demonstrates that a program can be designed that will become "revenue positive" within ten years after initial tax credits are awarded (revenue positive defined as federal revenues from additional new oil production exceeding the cost of a production tax credit program after applying a discount rate to both costs and revenues). Sensitivity analysis reveals that the program remains revenue positive using a realistic range of likely assumptions. In addition, NEORI's incentive recommendation contains provisions to allow the Secretary of the Treasury discretion to prevent cost overruns that would keep the program from becoming revenue positive within its first ten years.

The analysis suggests that the following benefits will occur by implementing NEORI's proposed federal CO_2-EOR tax credit for an extended period of time:

- Under the core scenario, the program pays for itself within the first decade, becoming revenue positive within ten years after the first incentive payment.
- The program becomes increasingly revenue positive, and more benefits accrue, the longer the program is in place:
    - After one decade, the program would have a net present value of $2 billion, and result in cumulative new oil production of nearly 400 million barrels of oil.
    - After two decades, the program would have a net present value of $31 billion and result in cumulative new oil production of 2.5 billion barrels of oil.
    - After three decades, the program would have a net present value of $73 billion and result in cumulative new oil production of 6 billion barrels of oil.
    - After four decades, the program would have a net present value of $105 billion and result in cumulative new oil production of 9 billion barrels of oil.
    - Because of the long lifespan of CO_2 and EOR projects, benefits would continue to accrue for two more decades, even if government incentives cease. These additional benefits are not quantified.
- If a program remains in place for several decades, it will enable a build-out of projects at sufficient scale to result in significant cost reductions in CO_2 capture costs from currently more expensive sources. These cost reductions will allow many technologies to supply CO_2 to EOR projects without an incentive in later phases and after the program ends.

A full description of the analysis can be found in Appendix D.

C. OVERVIEW OF MODEL STATE INCENTIVES FOR CO_2-EOR DEPLOYMENT TO COMPLEMENT FEDERAL SUPPORT

Several states have incentives to encourage CO_2 capture and transport from power plants and industrial facilities, which complement federal grants, tax credits, and other

support mechanisms. States with these incentives have provided critical support for projects to advance toward deployment. Furthermore, as with the new federal tax credit recommended in this report, state incentives for commercial CO_2 capture and pipeline projects have the potential to be revenue positive, stimulate local oil production, and spur economic activity at a time when most states face profound fiscal challenges.

NEORI recommends consideration, adoption or adaptation of the following state policies to complement federal policy and encourage commercial deployment of CO_2 capture and transport technologies.

Severance tax reduction and/or extension of existing severance tax reduction for oil produced with CO_2 from anthropogenic sources. This policy provides a percentage reduction in the severance tax for oil production, if the taxpayer uses CO_2-EOR techniques and/or uses anthropogenic CO_2 for EOR. It creates an incentive to pursue CO_2-EOR and use CO_2 from man-made sources, although it would only work for states with a production or severance tax.

Cost recovery approval for regulated entities. This policy enables regulatory approval by public utility commissions for a utility to recover certain costs associated with CO_2 capture through rates paid by customers. Cost recovery approval provides significant financial certainty to attract the private investment necessary for a project to proceed to construction and commercial operation.

Off-take agreements. This policy enables projects to enter into long-term contracts for supply of a project's output (e.g., electricity). Long-term off-take agreements provide significant financial certainty, similar to regulatory cost recovery.

Tax credits, exemptions, or abatements. This policy provides credits, exemptions, and abatements for taxes that would otherwise be incurred, such as property tax abatement, franchise tax credits, and sales tax exemption for sale of captured CO_2. Such tax policies reduce the incremental capital cost of capture, compression, infrastructure, and purchase of manmade CO_2.

State-level bonding of CO_2 pipeline projects and/or capture and compression facilities. This policy supports project financing, development, and planning of infrastructure or facilities deemed to be in the public interest. Public infrastructure authorities commonly may issue bonds, make grants/loans, plan/coordinate infrastructure, or participate in infrastructure build-out (e.g., own, construct, maintain, and operate a facility).

Inclusion in Portfolio Standards. This policy requires that a certain percentage of all electricity generated in a state must come from specific sources, such as power plants with CCS. Portfolio standards that include CCS are an effective tool to establish financial certainty through state policy requirements, by allowing for regulatory cost recovery of investments made to meet statutory obligations.

A more detailed description of model state policies can be found in Appendix C, including state-by-state links to specific policies to serve as a resource to state policy-makers.

III. ENERGY SECURITY, ECONOMIC, AND ENVIRONMENTAL BENEFITS OF CO_2-EOR

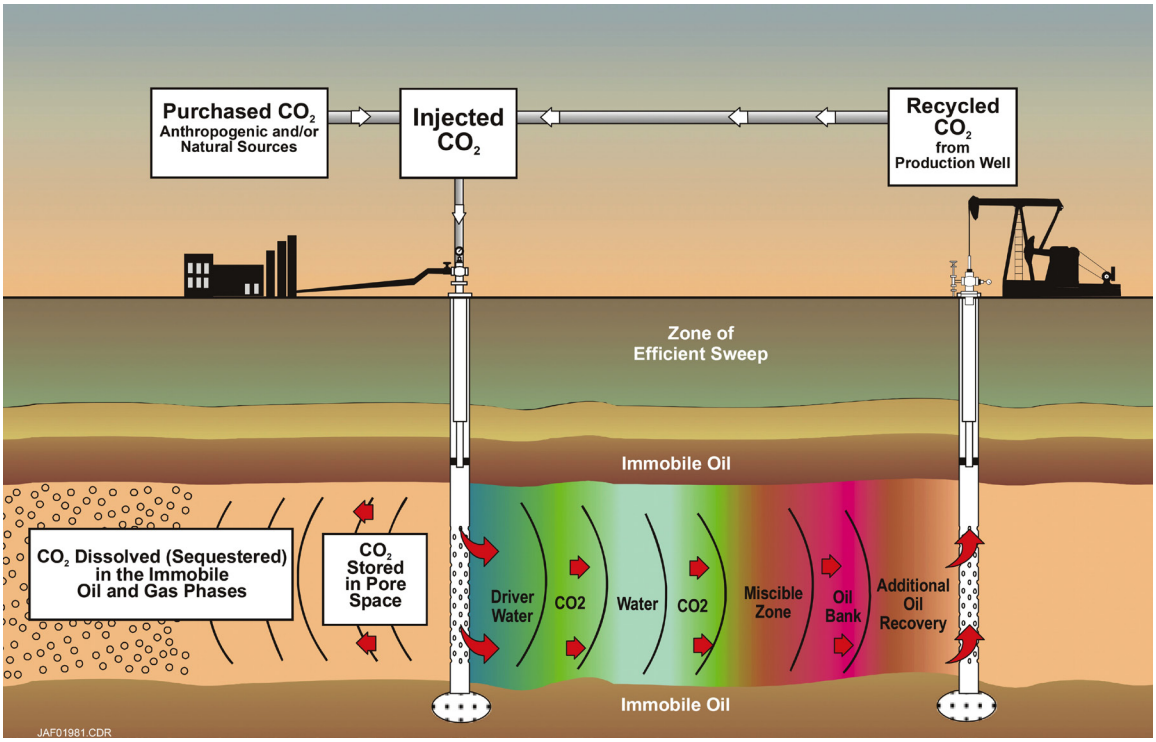
CO_2-EOR has the potential to significantly expand domestic oil supplies, increase job growth, and protect the environment. It works by injecting CO_2 into already developed oil fields, where it mixes with and "releases" additional oil from the reservoir, thereby freeing it to move to production wells. CO_2 is separated from the produced oil in above-ground equipment and re-injected in a closed-loop system many times over the life of an EOR operation. Figure 2 provides an illustration of how CO_2-EOR works. Box 2 describes CO_2-EOR in relation to conventional oil production.

CO_2-EOR is not new. It was pioneered in the Permian Basin in West Texas in 1972, and the CO_2 for the first projects came from natural gas processing facilities.

Later, however, companies became aware that naturally occurring CO_2 source fields could offer large quantities of CO_2. As demand grew, these underground formations in New Mexico, Colorado, and Mississippi came to dominate the CO_2 supply. Pipelines were constructed in the early 1980s to connect the CO_2 source fields with the oil fields in West Texas. This system led to more and more EOR projects and expansion to other U.S. regions, including the Rocky Mountains and Gulf Coast. Figure 3 shows the growth of EOR from 1986 to 2010.

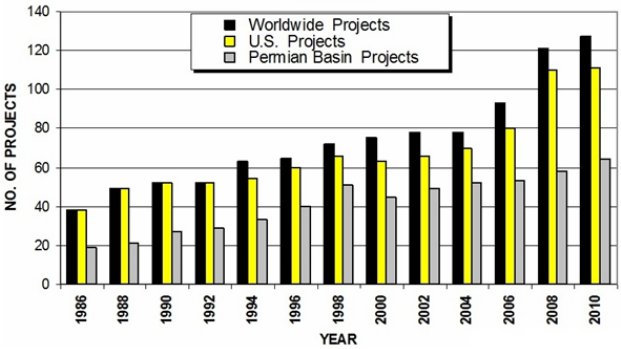
Today, over 110 EOR operations exist in the United States (ARI, 2011) with more than 3,900 miles of CO_2 pipeline (Dooley, et al., 2009). Furthermore, new CO_2 pipelines are being constructed in the Gulf Coastal and

Figure 2: How CO_2-EOR Works



Source: Advanced Resources International and Melzer Consulting, Optimization of CO_2 Storage in CO_2 Enhanced Oil Recovery Projects, prepared for UK Department of Energy & Climate Change, November 2010.

Figure 3: History of U.S. and Global CO_2-EOR Oil Production Projects



Source: Melzer, 2012.

Mid-continental regions and in the Rockies, promising to dramatically increase CO_2-EOR activity (Melzer, 2012). Figure 4 shows the CO_2-EOR infrastructure in the United States.

A. OPPORTUNITY TO INCREASE DOMESTIC OIL SUPPLY FROM EOR

Reliance on oil imports directly affects the security and stability of the U.S. energy system. The United States consumed 19.1 million barrels of oil per day in 2010 (almost 7 billion barrels per year) primarily to fuel the transportation sector. Yet the United States produced only 5.5 million barrels per day – importing the remaining two-thirds, in some case from hostile regions (Energy Information Administration (EIA), 2011).

Today, EOR quietly accounts for 281,000 barrels per day, or six percent of U.S. oil production (ARI, 2011). However, EOR has the potential to significantly increase domestic oil supplies. Over the past 40 years the EOR industry has grown to include over twenty companies that deploy new technologies and practices to improve understanding of the subsurface and to locate hard-to-find oil pockets, as well as boost oil production efficiency (NETL, 2010).

Using existing state-of-the-art practices, EOR has the potential to deliver to the U.S economy 26-61 billion barrels of additional oil (ARI, 2011). This supply potential significantly expands oil resources above current levels. Companies in the EOR business currently book around 1 billion barrels as proven reserves; and over the past 25 years EOR has produced a total of 1.5 billion barrels of oil (NETL, 2010).

Moreover, "next generation" EOR technology could yield substantially greater gains, potentially increasing recoverable domestic oil to 67-137 billion barrels (ARI, 2011). With a supply potential of almost 10-14 years of

Box 2: Phases of Oil Production

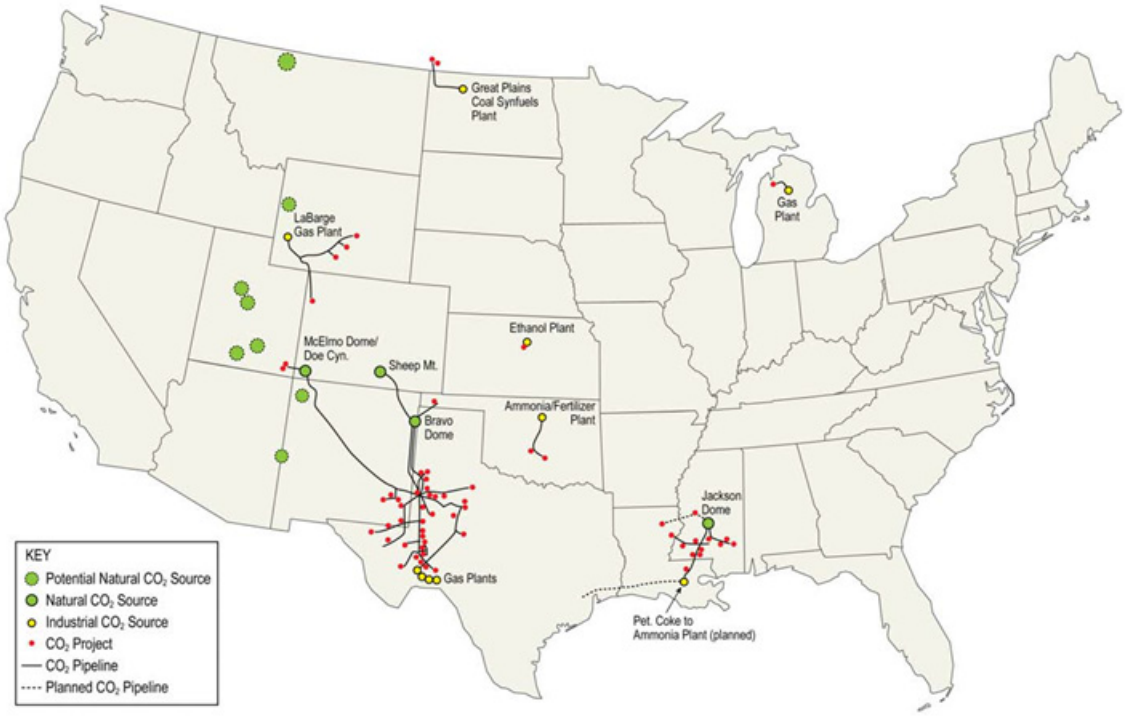
Primary Production refers to a new oil field discovery where production wells are drilled into a geological formation and oil or gas is produced using the pent-up energy of the fluids in the reservoir. At the end of primary production a considerable amount of the oil remains in place, with sometimes as much as 80-90 percent still "trapped" in the pore spaces of the reservoir (Melzer, 2012).

If an oil field is not abandoned after primary production, it moves into a secondary production phase wherein a substance (usually water) is injected to repressurize the formation. New injection wells are drilled or converted from producing wells, and the injected fluid sweeps oil to the remaining producing wells. Secondary production could yield up to an equal or greater amount of oil from primary production. But this has the potential to ultimately leave 50-70 percent of the original oil remaining in the reservoir since much of the oil is bypassed by the water that does not mix with the oil (Melzer, 2012).

Primary and secondary production are sometimes referred to as "conventional" oil production practices.

During tertiary production, oil field operators use an injectant (usually CO_2) to react with the oil to change its properties and allow it to flow more freely within the reservoir. Almost pure CO_2 (>95 percent of the overall composition) has the property of mixing with oil to swell it, make it lighter, detach it from the rock surfaces, and cause the oil to flow more freely within the reservoir to producer wells. In a closed loop system, CO_2 mixed with recovered oil is separated in above-ground equipment for reinjection. CO_2-EOR typically produces between 4-15 percent of the original oil in place (ARI, 2010).

Figure 4: EOR Projects, CO_2 Sources and Pipelines



Source: ARI, 2010 (Note: CO_2 Project refers to a CO_2-EOR project, not a CO_2 source).

annual consumption, a fully developed national EOR program could dramatically alleviate our dependence on foreign oil.

However, EOR development is constrained by insufficient supply of CO_2. Without significantly expanding the volume of CO_2 available for use in EOR, the production of vital domestic oil will fall short of its potential. Natural sources of CO_2 do not have the capacity to satisfy all the demand from EOR (ARI, 2010). Therefore, the only way to increase oil production from EOR is to boost supplies of CO_2 from man-made sources in a manner suitably calibrated to the full potential of EOR.

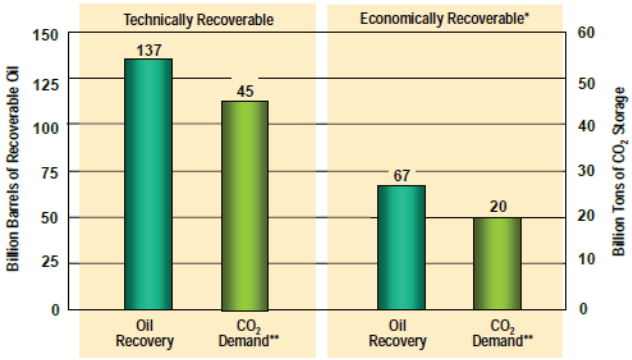
B. OPPORTUNITY TO INCREASE JOBS, IMPROVE THE HEALTH OF OUR ECONOMY, AND REDUCE CO_2 EMISSIONS FROM EOR

Increasing domestic oil supplies through EOR will not only improve energy security, it will reduce trade deficits, strengthen the overall health of our economy and help reduce CO_2 emissions. It will also benefit local and regional economies and creates thousands of jobs. Workers will be needed across the full CO_2-EOR value chain: from building and operating new CO_2 capture systems at power plants and other industrial facilities, to constructing new pipeline networks to transport CO_2, to retrofitting and giving new life to existing oil fields.

For example, the Kemper Integrated Gasification Combined Cycle (IGCC) plant in Mississippi, a cutting-edge demonstration plant jointly funded by the U.S. Department of Energy's Clean Coal Power Initiative and Mississippi Power (a subsidiary of Southern Company), will create approximately 300 permanent jobs from power plant and supply chain operations. Employment during construction is expected to peak at 1,150 and average 500 jobs over a 3.5-year construction period (DOE, 2010).

In another example, the Wyoming Grieve Field project, a small-scale CO_2-EOR project that has been approved for construction, will generate more than 50 construction jobs to revitalize and return an aging oil field to service. It will also add five to ten operations jobs and produce 12 to 24 million barrels of additional oil that will inject millions of dollars into Wyoming's economy through taxes, royalties, and local purchasing (Casper

Figure 5: Domestic Oil Supplies and CO_2 Demand (Storage) Volumes from "Next Generation" CO_2-EOR Technology**



*At an oil price of $85/B, a CO_2 market price of $40/mt and a 20% ROR, before tax.

**Includes 2,300 million metric tons of CO_2 provided from natural sources and 2.6 billion barrels already produced or being developed with miscible CO_2-EOR.

Source: ARI, 2011

Journal, 2011).

Increasing CO_2-EOR also stimulates the economy more broadly. Recent estimates show that expanded CO_2-EOR could provide up to $12 trillion in economic benefits to the U.S. over the next three decades, based on the "multiplier effects" of oil production on economic activities (Carter, 2011). In fact, a report by the University of Texas Bureau of Economic Geology's (TBEG) Gulf Coast Carbon Center quantifies the total economic activity of oil production for Texas to be 2.9 times the value of the oil produced. In other words, almost two dollars of additional economic activity is created for every dollar of oil produced. Moreover, TBEG estimates 19 jobs for every $1 million of oil produced annually (TBEG, 2004).

An increase in oil production from EOR has the potential to reduce net crude oil imports by half and provide up to $210 billion in increased state and federal revenues by 2030. Under a robust policy, EOR could reduce the U.S. foreign trade deficit by $11-$15 billion dollars (2007 dollars) in 2020 and $120-$150 billion by 2030. Cumulatively, this reduction in oil imports would keep $600 billion here at home, generating additional economic activity, jobs and revenues, rather than flowing out of the U.S. economy to other countries (ARI, 2010).

Regarding the benefits of EOR for reducing CO_2 emissions, using CO_2 captured from industrial sources to produce oil has the potential to help the United States reduce the CO_2 intensity of the industrial and power generation sectors. Over the life of a project, for every 2.5 barrels of oil produced, it is estimated that EOR can safely prevent one metric ton of CO_2 from entering the atmosphere.[1]

Current CO_2 use for EOR ranges between 65 million tonnes per year (Melzer, 2012) to 72 million tonnes per year (ARI, 2011). ARI states that 55 million tonnes of CO_2 come from natural sources and 17 million tonnes come from anthropogenic sources. But the potential for EOR to contribute to CO_2 reduction goals is great. The volume of CO_2 that could be captured and sequestered from industrial facilities and power plants to support "next generation" EOR could be 20- 45 billion metric tons (ARI, 2011).This is equal to the total U.S. CO_2 production from fossil fuel electricity generation for 10 to 20 years (EPA, 2011). Figure 5 illustrates the oil production potential and CO_2 demand — i.e., CO_2 stored through EOR — from "next generation" EOR technologies.

Properly managed EOR projects have demonstrated that injecting CO_2 into producing oil fields can safely store CO_2 in geologic formations without leaking to groundwater resources or escaping to the atmosphere. EOR is governed by federal regulations that require the protection of underground sources of drinking water, under the U.S. Environmental Protection Agency's (EPA's) Underground Injection Control (UIC) program. Many states have obtained authority from EPA to administer the UIC program and have laws that meet or go further than EPA's requirements. Permits issued by the EPA or states require that EOR operators manage their site in a manner that will prevent CO_2 (and other formation fluids) from migrating out of the subsurface confining formation and into drinking water aquifers (Code of Federal Regulations (CFR) 40 CFR §144).

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APPENDIX A: SECTION-BY-SECTION ANALYSIS OF PROPOSED FEDERAL PRODUCTION TAX CREDIT FOR CO_2 CAPTURE AND TRANSPORT

(a) FINDINGS.

The findings are that enhanced oil recovery (EOR) using anthropogenic carbon dioxide (CO_2) can provide significant domestic economic and job benefits, environmental benefits, and increased energy security through:

- The capture of CO_2 from power plants and industrial facilities and the advancement of carbon capture technologies;
- The use of the captured CO_2 for EOR, resulting in increased domestic oil production; and
- The disposal of the captured CO_2 in secure geological storage.

(b) PURPOSE.

The purpose of this text is to establish a production tax credit with competitive bidding that is fiscally responsible, transparent, and effective in achieving the following:

- A significant increase in domestic oil production through expanded EOR using anthropogenic CO_2 while reducing CO_2 emissions;
- A reduction of the incremental cost of carbon capture, compression, and transport;
- An acceleration of the deployment and advancement of technologies that capture CO_2; and
- Being revenue-positive over a reasonable period of time.

(c) ESTABLISHMENT.

This section establishes a 10-year, production tax credit for carbon dioxide (CO_2) capture and transport allocated through a competitive bidding process.

(d) COMPETITIVE BIDDING STRUCTURE AND REQUIREMENTS.

This section sets out the organization of the competitive bidding process into tranches and sub-tranches, and the bidding qualifications for each tranches and sub-tranches.

These tranches and sub-tranches group similar technologies to compete for the credits. The minimum requirement for a taxpayer to qualify for any tranche is that the captured, qualified CO_2 must be used as an injectant in a qualified EOR project, and disposed of or contracted for disposal in secure geological storage. Projects must be a new build capture project, a retrofit of carbon capture on an existing project, or an upgrade to an existing carbon capture facility that is significantly expanding CO_2 capture capacity. In determining a bid, taxpayers may include the cost of constructing the pipeline(s) that will transport the qualified CO_2. Taxpayers may also submit a bid for a tranche or sub-tranche that includes an aggregation of more than one source of qualified CO_2.

Subsection (d)(1)(D) sets out the three tranches and corresponding sub-tranches within which bidding shall occur:

- *Pioneer commercial-sale projects tranche.* This tranche includes projects that are 'first-mover' commercial-scale projects that will only move forward with sufficient government support to offset the technical and financial risk of integrating electricity generation or industrial production with CO_2 capture, compression, and transport. Taxpayers must meet the requirements of the pioneer tranche and following sub-tranches:
- Electric power sub-tranche (including polygeneration projects); and
- Industrial sub-tranche.

Review of pioneer tranche. The Secretary shall have the discretion to modify the pioneer tranche over time based on regular review and evaluation of the program's effectiveness in addressing first-in-kind commercial technology deployment, perceived scalability and commercial

risk of particular technologies, potential for further cost reductions, and how the other tranches and sub-tranches are performing.

- *Electric power tranche (including polygeneration projects).* Establishes qualifications for the electric power tranche, including nameplate, emissions, and energy output requirements.
- *Industrial tranche.* Establishes qualifications for the industrial tranche and two corresponding sub-tranches grouped by industrial processes with similar CO_2 capture costs.

(e) REQUIREMENTS FOR BIDDING PROCESS.

This section sets out the process of bid solicitations for the Secretary of the Treasury (Secretary); the requirements for the bidding process for taxpayers; and sets out the registration, allocation, and certification process that shall be administered by the Internal Revenue Service (Service) for taxpayers to bid and claim credits. The competitive bidding process occurs within a single tranche or sub-tranche and does not occur across tranches or sub-tranches. Registrants may only bid within a single tranche or sub-tranche for each qualified project and, if not selected, may bid in a subsequent solicitation.

Solicitation. Directs the Secretary of Treasury to solicit bids on an annual basis from taxpayers who are registered for the bidding process. This provision also directs the Secretary to establish dollar-per-ton bidding limits per tranche that constrain the tax credit to the incremental costs of carbon capture, compression, and transport.

Registration. Directs the Service to establish a registration process to determine eligibility for the bidding process and for each tranche and/or sub-tranche. Taxpayers register the project for the tranche or sub-tranche in which they will bid and must meet the following registration requirements, including a signed, legal representation, subject to verification by the Service, that the project meets registration requirements. The representation also must attest that the project meets the requirements for the tranche or sub-tranche within which the registrant shall bid.

Bid submission. Bid submissions must indicate the level of incentive sought per ton of CO_2 and the estimated amount of CO_2 that the project will capture, deliver for EOR and dispose of over a period of up to 10 years.

Bid selection, certification of taxpayer and credit allocation. Sets out the process and requirements for bid selection, credit allocation, and taxpayer certification. This provision directs the Secretary to select bids within each tranche and/or sub-tranche and to allocate credits until all credits within each tranche and sub-tranche have been allocated. The Secretary is directed to begin with the bid in each tranche or sub-tranche that has the lowest incentive level on a per-ton basis and that meets other requirements the Secretary may specify. The Secretary will certify taxpayers for the amount of tax credit allocated in selected bids. Certified taxpayers must meet specific project time requirements for beginning construction and commercial operation and notify the Service when they have met such requirements.

Penalties. This provision establishes the penalty of de-certification for failure to meet requirements and for making materially inaccurate representations. If a project is de-certified due to failure to meet construction requirements, such taxpayer may not bid again for the qualified project until commercial operation has begun. It also gives the Secretary discretion to provide up to two 180-day extensions if a taxpayer does not meet the time requirements for commercial operation and if significant progress has been made on construction. Notification requirements are established to notify the Secretary within specific timeframes that an extension is being sought.

(f) TRANSFERABILITY.

This section allows a registered taxpayer to transfer credit(s) to the entity that is responsible for disposing of the qualified CO_2 in secure geological storage.

(g) DEFINITIONS

- *Secretary.* The term "Secretary" means the Secretary of the Treasury.
- *Registered taxpayer.* The 'registered taxpayer' is the taxpayer responsible for capturing the CO_2 at a qualified project.
- *Qualified projects.* The term 'qualified projects' means the projects as defined under each of the three tranches and corresponding sub-tranches.
- *Energy output.* Energy output is the total of the chemical and/or thermal energy generated by the conversion of the feedstock(s).
- *Beginning of Construction.* Construction begins when physical work of a significant nature begins. Work

performed by the taxpayer and by other persons under a written binding contract is taken into account in determining whether construction has begun. Both on-site and off-site work may be taken into account for purposes of demonstrating that physical work of a significant nature has begun. Physical work of a significant nature does not include preliminary activities such as planning or designing, securing financing, exploring, researching, clearing a site, test drilling to determine soil condition, or excavation to change the contour of the land (as distinguished from excavation for footings and foundations).

(h) MANDATORY PROGRAM REVIEW.

This directs the Secretary to establish an external review process of the program. The review shall be conducted by a panel of diverse, independent experts who will make recommendations for potential changes. The program review is intended to ensure that the bidding process is transparent, effective, and efficient and to ensure that the program purposes are achieved over time.

(i) DISCRETION OF SECRETARY.

This section gives the Secretary discretion to make modifications based on program operations and outcomes and to address the recommendations that result from the mandatory program review. The Secretary has authority to modify the following: the bidding process, the dollar-per-ton bidding limits per tranche, the allocation of credits between tranches, and the number of available credits. The Secretary also has the authority to modify and make additions to qualified projects and qualified sources of CO_2 as is necessary to achieve the purpose of the program.

(j) PUBLIC DISCLOSURE.

This section requires the Service to provide public notification and to disclose: a description of each taxpayer's selected project(s); the location of each taxpayer's relevant project(s); the value of the bid on a per-ton basis; and the amount of credit allocated with respect to each bid. The Service will also provide real-time public notification of taxpayer registration, certification, de- certification and credits claimed through annual taxpayer reporting. The Service must continuously update this information on the IRS website and issue an annual report summarizing key information, including credits allocated and claimed during the previous year, and credits available for allocation by tranche in the subsequent year's round of bidding.

APPENDIX B: DETAILED POLICY DESIGN RECOMMENDATION FOR FEDERAL PRODUCTION TAX CREDIT FOR CO_2 CAPTURE AND TRANSPORT

(a) Findings. Enhanced oil recovery (EOR) using anthropogenic carbon dioxide (CO_2) can provide significant domestic economic and job benefits, environmental benefits and increased energy security through –

(1) The capture of CO_2 from power plants and industrial facilities and advancement of carbon capture technologies;

(2) Use of the captured CO_2 for EOR, resulting in increased domestic oil production; and

(3) Disposal of the captured CO_2 in secure geological storage.

(b) Purpose. This establishes an incentive program with competitive bidding that is fiscally responsible, transparent and effective in achieving the following –

(1) Significant increase in domestic oil production through expanded EOR using anthropogenic CO_2 while reducing CO_2 emissions;

(2) Reduction of the incremental cost of carbon capture, compression, and transport;

(3) Acceleration of the deployment and advancement of technologies that capture CO_2; and

(4) Being revenue-positive to the Treasury over a reasonable period of time.

(c) Establishment. Establish a 10-year, production tax credit for CO_2 capture and transport that is allocated through a competitive bidding process.

(d) Competitive bidding structure and requirements.

(1) Organization of bidding process into tranches and sub-tranches. The competitive bidding process shall occur within three tranches and/or corresponding sub-tranches of qualified projects.

(A) In general, registered taxpayers –

(i) Must use or contract to use the captured qualified CO_2 as an injectant in a qualified EOR project;

(ii) Must dispose of the CO_2 or contract to dispose of the captured CO_2 in secure geological storage;

(iii) May aggregate more than one source of qualified CO_2 within a single tranche; and

(iv) May include the cost of pipeline construction in determining a bid.

(B) In general, qualified projects must be –

(i) New projects that capture qualified CO_2 including new builds or retrofits; or

(ii) Upgrades to existing projects that capture qualified CO_2 that significantly expand carbon capture capacity.

(C) In general, qualified sources of CO_2 include the following industrial and other processes –

(i) Electric power generation; chemical production; industrial gas production plants; hydrogen production; gasification of coal, petroleum residuals, biomass and waste streams; natural gas processing; fermentation; clinker production; fluidized catalytic cracking and other refinery pro-

cesses; steel and aluminum production; and mining and manufacturing.[1]

(D) Tranches.

(i) Pioneer commercial-scale (first mover) projects. In general, pioneer commercial-scale projects must be of "first mover" commercial scale that can only be initiated by the private sector with sufficient government support to offset the technical and financial risk of integrating electricity generation or industrial production with CO_2 capture, compression, and transport. The pioneer tranche shall be limited to 100 million metric tons of annual CO_2 capture capacity and be determined by the total capture capacity of certified taxpayers' projects. This tranche will be available for bidding, on an annual basis, until the Secretary has determined that the total capture capacity of certified taxpayers' projects has reached 100 million metric tons.

(I) Pioneer commercial-scale projects shall –

(a) Support commercial-scale demonstration of carbon capture technology capable of advancing those technologies to commercial readiness;

(b) Use a range of different feedstocks, including various coal types, petroleum residuals, natural gas, and biomass;

(c) Be geographically diverse; and

(d) Employ a range of capture technologies suitable for new or retrofit technologies.

(II) Sub-tranches. The pioneer tranche is divided into electric power and industrial sub-tranches.

(a) Electric power sub-tranche. For the electric power generation sub-tranche, projects shall –

(1) Capture and deliver at least one million tons of CO_2 on an annual basis for use in EOR and disposal in secure geological storage;

(2) Feature a power block with nameplate capacity of 200MW or greater; and

(3) For polygeneration projects, at least 150 MW of power must be supplied to a power distribution system for sale, and over 50 percent of the energy output of the gasification process must be devoted to the power block.

(b) Industrial sub-tranche. For industrial sub-tranche, projects –

(1) Must not have electric power output that is greater than 50 percent of energy output; and

(2) There is no minimum required level of carbon capture to qualify.

(III) Review of pioneer tranche. The Secretary shall have the discretion to modify the pioneer tranche over time based on regular review and evaluation of the program's effectiveness in addressing first-in-kind commercial technology deployment, perceived scalability and commercial risk of particular technologies, potential for further cost reductions, and based on how

1 It is noted that the Natural Resources Defense Council does not support the inclusion of processes whose products contain significant quantities of carbon that will be released to the atmosphere, for example coal-to-liquid fuel or coal-to-methane projects, as qualified sources of CO_2 eligible to receive credits under this program

the other tranches and sub-tranches are performing.

(ii) Electric power (including polygeneration) projects. Requirements for qualifying within the electric power tranche.

(I) Power block of 200 MW nameplate capacity or greater; and

(a) For projects using coal and/or petroleum residuals as fuel, qualifying projects must have a post-capture equivalent emissions rate of 780 lb/MWhr or less for a given power block under normal operating conditions; or

(b) For projects using primarily natural gas as fuel, qualifying projects must have a post-capture equivalent emissions rate of 400 lbs/MWhr or less under normal operating conditions.

(II) These emission rates shall be reduced by 15 percent every five years for subsequent projects, unless the Secretary determines that this is not technologically or economically feasible.

(III) For polygeneration projects, at least 150 MW of power must be supplied to a power distribution system for sale and over 50 percent of the energy output of the gasification process must be devoted to the power block.

(iii) Industrial projects. Requirements for qualifying within the industrial tranche.

(I) In general, industrial projects –

(a) Must not have electric power output that is greater than 50 percent of energy output; and

(b) There is no minimum required level of carbon capture to qualify.

(II) Sub-tranches. The industrial tranche is divided, by industrial process, into two sub-tranches –

(a) Industrial sub-tranche 1 – Natural gas processing, fermentation, ammonia production and existing gasification of coal, petroleum residuals, biomass, and waste streams.

(b) Industrial sub-tranche 2 – New build gasification of coal, petroleum residuals, biomass and waste streams, refinery, cement, steel, and iron production, and hydrogen production.

(e) Requirements for bidding process.

(1) Solicitation. The Secretary shall –

(A) Solicit bids from registered taxpayers, on an annual basis, for the production tax credit within each tranche and/or corresponding sub-tranche; and

(B) The Secretary shall establish dollar-per-ton limits to bids in each tranche to constrain program expenditure to the incremental costs of CO_2 capture, compression, and transport.

(2) Registered taxpayer. The registered taxpayer is the taxpayer responsible for capturing the CO_2 at a qualified project.

(3) Registration. The Internal Revenue Service (Service) shall establish a registration process to determine eligibility for the bidding process and for the tranche in which the registered taxpayer shall submit a bid. Taxpayers shall register with the Service the project(s) for which they are seeking the tax credit. Only taxpayers who meet the requirements shall qualify for registration.

(A) Registration requirements. The taxpayer shall –

(i) Submit the name, address, and taxpayer identification number of the expected reporting taxpayer;

(ii) Submit the name and location of the qualified project that will capture the CO_2 and a brief description of the project that includes the capture capacity based on the design of the qualified project;

(iii) Designate the tranche and/or sub-tranche for which the project is proposed for qualification; and

(iv) Execute a signed representation, subject to verification by the Service, that the project meets registration requirements, including that the project meets the requirements for the tranche within which the registrant shall bid.

(4) Competitive bidding shall occur within each tranche and/or sub-tranche and not between tranches or sub-tranches.

(5) Registrants are limited to bidding in one tranche only, per qualified project.

(6) Registrants that are not selected in a bidding process may bid in subsequent processes.

(7) Bid submission. Registered taxpayers shall submit a bid within their designated tranche and/or sub-tranche, specifying –

(A) The level of incentive sought per ton of qualified CO_2 captured and delivered to an EOR operator(s) and disposed of in secure geological storage; and

(B) The estimated quantity of qualified CO_2 that the project will capture, deliver, and dispose over a period up to 10 years.

(8) Bid selection, certification of taxpayer and credit allocation.

(A) Bid selection and credit allocation. The Secretary shall select bids and allocate credits within each tranche or sub-tranche, beginning with the bid at the lowest incentive level on a per-ton basis and meeting other requirements the Secretary may specify, until the amount of tax credit available within each tranche or sub-tranche is committed.

(B) Certification. The Secretary shall certify taxpayers for the amount of tax credit allocated in selected bids. Time requirements for projects included in selected bids.

(i) Project construction must begin within two years of certification. Certified taxpayers must notify the Service of the date of beginning of construction and demonstrate that construction has begun.

(ii) Commercial operation must begin –

(I) Within five years of certification for new builds. Certified taxpayers must notify the Service within five years of certification that commercial operation has begun.

(II) Within three years of certification for retrofits. Certified taxpayers must notify the Service within three years of certification that commercial operation has begun.

(C) Penalties.

(i) Certified taxpayers shall be automatically de-certified if –

(I) They do not meet requirements or if a taxpayer makes materially inaccurate representations; and

(II) For projects that do not meet construction time requirements, the taxpayer cannot bid again for the qualified project(s) until commercial operation has commenced.

(ii) Extension. The Secretary has discretion to grant 180-day extensions, and up to two extensions, if a taxpayer does not meet the time requirements for commercial operation and if significant progress has been made on construction. Taxpayers that seek an extension must notify the Secretary within 90 days before the end of the commercial operation timeline requirements and may request a 180 day extension. Taxpayers may also notify the Secretary within 90 days of the end of the extension that they seek a second 180-day extension.

(9) Annual reporting requirements for competitive bidding process.

(A) Taxpayers must submit annual reports for each taxable year for which credits are claimed. Each annual report shall include –

(i) The name, address, and taxpayer identification number of the reporting taxpayer, and all parties:

(I) That use or are contracted to use the captured CO_2 for EOR;

(II) With which the taxpayer contractually ensures the disposal of CO_2 in secure geological storage (if a different person than the taxpayer);

(ii) The name and location of the qualified facilities at which the CO_2 was captured;

(iii) The amounts (in metric tons) of qualified CO_2 for the taxable year that has been taken into account for purposes of claiming the tax credit; and

(iv) Any changes in information included in prior annual reports submitted, including adjustments to the amount (in metric tons) of qualified CO_2 taken into account for purposes of the tax credit in prior taxable years.

(f) Transferability. Transferability within CO_2 chain of custody.

(1) A certified taxpayer may transfer the credit to the person responsible for disposing of the qualified CO_2 in secure geological storage. Such transfer shall only be effective if the taxpayer submits to the Secretary, at such time and in such manner as the Secretary prescribes, a statement concerning the transfer which contains –

(A) The name, address, and the taxpayer identification number of the taxpayer transferring the credit;

(B) The name, address, and taxpayer identification number of the taxpayer receiving the transfer; and

(C) Such other information as the Secretary may require relating to such transfer.

(g) Definitions.

(1) Secretary. The term 'Secretary' means the Secretary of the Treasury.

(2) Secure geological storage. The term 'secure geological storage' has the same meaning as when used in §45Q of the Internal Revenue Code.

(3) Qualified projects. The term 'qualified projects' means the projects as defined under each of the three tranches and corresponding sub-tranches.

(4) Energy output. The term 'energy output' means the total of the chemical and/or thermal energy generated by the conversion of the feedstock(s).

(5) Primarily. The term 'primarily' means more than 50 percent.

(6) Beginning of Construction. The term 'beginning of construction' means that physical work of a significant nature has begun. Work performed by the taxpayer and by other persons under a written binding contract is taken into account in determining whether construction has begun. Both on-site and off-site work may be taken into account for purposes of demonstrating that physical work of a significant nature has begun. Physical work of a significant nature does not include preliminary activities such as planning or designing, securing financing, exploring, researching, clearing a site, test drilling to determine soil condition, or excavation to change the contour of the land (as distinguished from excavation for footings and foundations).

(h) Mandatory Program Review. The Secretary shall require an external review of the program undertaken by a panel of diverse, independent experts who will make recommendations regarding potential changes to the program to ensure transparent, effective, and efficient functioning of the bidding process and to ensure that the purpose of program is achieved over time. The review shall be initiated after the second annual round of bidding and completed within 180 days prior to commencement of the fourth annual round of bidding. Additional reviews shall be undertaken every three years, with subsequent reviews also evaluating impacts on incremental oil production and federal revenues.

(i) Discretion of Secretary. The Secretary shall have the authority to modify the bidding process, to modify dollar-per-ton bidding limits per tranche and sub-tranche, the allocation of credits between tranches and sub-tranches, and the number of available credits based on program operations and outcomes and in response to recommendations resulting from the independent program review. The Secretary shall have the authority to modify and make additions to qualified projects and qualified sources of CO_2 as necessary to achieve the purpose of the program.

(j) Public disclosure. Nature and frequency of disclosure and successful bids by the Service.

(1) Public notification and disclosure. The Service shall publicly disclose –

(A) A project description(s) for each selected bid;

(B) The location of each taxpayer's relevant project or projects;

(C) The value of the bid on a per ton of CO2 basis; and

(D) The amount of the credit allocated with respect to that bid.

(2) The Service shall also provide real-time public notification of taxpayer registration, certification, de-certification, and credits claimed through annual taxpayer reporting. The Service shall continuously update this information on the Agency's website and issue an annual report summarizing key information, including credits allocated and credits claimed during the previous year and credits available for allocation by tranche and sub-tranche in the subsequent year's round of bidding.

APPENDIX C: MODEL STATE INCENTIVE POLICIES FOR CO_2-EOR DEPLOYMENT

STATE INCENTIVES FOR CO_2-EOR DEPLOYMENT TO COMPLEMENT FEDERAL SUPPORT

Some states' support for deployment of specific CO_2 capture projects exceeds that of the federal government in terms of dollar value over the life of a project. Indeed, commercial capture projects now under construction or nearing construction are located in states that have significant incentive policies in place to complement available federal grants, tax credits and other support.

As with the new federal tax credit recommended in this report, state anthropogenic CO_2-EOR incentives for commercial CO_2 capture and pipeline projects have the potential be revenue positive at a time when most states face profound fiscal challenges. These incentive policies can stimulate production and economic activity that would not otherwise occur by making available new CO_2 supplies to produce additional oil from already developed fields that would otherwise not be produced using conventional technologies.

While implementation of a more robust federal tax credit is critical to reach much greater EOR deployment levels, a number of states with EOR potential still lack adequate incentives to complement federal policy and encourage commercial project development. They now have the opportunity to build on the experience of states that have pioneered incentives and to spur CO_2-EOR expansion by adopting or modifying those states' existing policies to meet their specific needs.

Toward that end, the Initiative has identified and recommends the following state policies for consideration and adoption by other states, based on their likely effectiveness in helping critical projects get across the commercial finish line:

A. Severance tax reduction and/or extension of existing severance tax reduction for oil produced with CO_2 from anthropogenic sources.

- *How the incentive works:* Provides a percentage reduction in the severance tax for oil production, if the taxpayer uses CO_2-EOR techniques and/or uses anthropogenic CO_2 for EOR. This incentive provides an incentive to pursue CO_2-EOR and for EOR projects to use CO_2 from manmade sources. The incentive also reduces the cost of using manmade CO_2. This incentive would only work for states that have a production or severance tax.
- *Examples:*
  - **North Dakota, Wyoming and Oklahoma** provide an exemption for incremental oil from a qualified tertiary recovery project that uses CO_2 (S.B. 2034 – ND; § 39-14-204 - WY; §68-1001(D)(4) - OK).
  - **Texas** extended its current 80% severance tax reduction for EOR projects that use manmade CO_2 from a 7-year period to 30 years (H.B. 469).

B. Cost recovery (Mississippi - Kemper IGCC project).

- *How the incentive works.* Regulatory approval for cost recovery enables a utility to recover certain costs through rates paid by customers. Cost recovery approval provides significant financial certainty to attract the private investment necessary for a project to proceed to construction and commercial operation.
- *Example:*
  - **Mississippi's** Public Service Commission (PSC) approved cost recovery for Mississippi Power's Kemper County IGCC project for up to $2.88 billion in total project costs. This project will provide CO_2 to EOR projects in Mississippi (Mississippi PSC report).

C. Long-term off-take agreements

- *How the incentive works.* Allows projects to enter into long-term contracts for supply of a project's output in states that need legislative approval to do so. Long-term off-take agreements provide significant financial certainty, similar to regulatory cost recovery.
- *Examples:*
  - **Indiana's** Utility Regulatory Commission approved a 30-yr. contract for the Indiana Finance Authority to purchase substitute natural gas (SNG) for 30 years from the Indiana Gasification project at a formula price that includes protections against price fluctuations for natural gas (Indiana press release). Indiana Gasifica-

tion has an off-take agreement with Denbury Resources to provide CO_2 for Denbury's EOR operations.

- **Illinois**' Clean Coal Portfolio Standard guarantees that the initial clean coal facility in Illinois with a final air permit may enter into 30-year contracts with utilities and other retail suppliers. Clean coal facilities must capture and sequester at least 50% of CO_2 emissions, if the facility is in operation before 2016 with CCS requirements ramping up to 90% for facilities that commence operation from 2017 onward (S.B. 1987). Such a facility would provide a large-scale, long-term source of industrial CO_2 for use in EOR.

D. Tax credits, exemptions or abatements.

- *How the incentive works.* Provides tax credits, exemptions and abatements for taxes that would otherwise be incurred, such as property tax abatement, franchise tax credits, and sales tax exemption for sale of captured CO_2. These tax policies reduce the incremental capital cost of capture, compression, infrastructure and purchase of manmade CO_2.
- *Examples:*
  - **Texas** provides a franchise tax credit capped at the lesser of $100 million or 10% of total capital costs for the first three 'clean energy projects' built in Texas. A qualifying project, defined as a 'clean energy project,' must capture and be capable of supplying CO_2 for EOR and storing a minimum of 70% of the CO_2 emissions. In Texas, a franchise tax is akin to a tax on gross receipts for corporations (H.B. 469).
  - **Texas** provides local property tax deferral for periods that are consistent with the timeframe of large-scale clean energy projects (H.B. 3896).
  - **Mississippi** provides for a reduced tax rate of 1.5% on the sale of CO_2 used in EOR or for geologic storage (H.B. 1459).
  - **Montana** provides a reduced tax rate of 3% tax rate on equipment used for carbon capture, transport and sequestration (H.B. 3).

E. State-level bonding of CO_2 pipeline projects and/or capture and compression facilities at anthropogenic source locations.

- *How the incentive works.* Infrastructure authorities commonly may issue bonds, make grants/loans, plan/coordinate infrastructure, or participate in infrastructure build-out (e.g., own, construct, maintain, operate a facility). Supports project financing, development and planning of infrastructure or facilities deemed to be in the public interest.
- *Examples:*
  - **North Dakota & Wyoming** have pipeline authorities that may participate in the development of CO_2 pipelines, including providing grants, loans and bonding authority (North Dakota Pipeline Authority; Wyoming Pipeline Authority).

F. Inclusion in Portfolio Standards.

- **How the incentive works.** Requires that a certain percentage of all electricity generated in a state must come from specific sources, such as CCS projects. Portfolio standards that include CCS are an effective tool to establish financial certainty in state policy requirements, by allowing for regulatory cost recovery of investments made to meet statutory obligations.
- *Examples:*
  - **Ohio's** Alternative Energy Portfolio Standard (AEPS) provides that 12.5% of the 25% alternative energy standard come from sources such as clean coal technology that is designed to prevent and control CO_2 emissions (S.B. 221).
  - **Illinois'** Clean Coal Portfolio Standard requires utilities and other retail suppliers to purchase up to 5% of electricity from clean coal facilities. The states goal is that cost-effective clean coal facilities will generate 25% of electricity consumed by 2025 (SB 1987).

APPENDIX D: DESCRIPTION OF ANALYSIS OF THE IMPLICATIONS OF A FEDERAL PRODUCTION TAX CREDIT FOR CO_2 SUPPLY, OIL PRODUCTION, AND FEDERAL REVENUE

NEORI ASSUMPTIONS & METHODOLOGY

The Center for Climate and Energy Solutions (C2ES) and the Great Plains Institute (GPI) conducted an analysis, with extensive input from NEORI participants, to inform the recommendations for a federal CO_2-EOR tax credit. In particular, C2ES and GPI explored the implications of NEORI's recommendations for CO_2 supply, oil production, and federal revenue.

C2ES and GPI compared the likely cost of a federal tax credit for greater CO_2 supply with the expected federal revenues from applying existing tax rates to the resulting incremental oil production. C2ES and GPI quantified two key relationships for CO_2-EOR development and a related tax credit program:

1) The cost gap – the difference between CO_2 suppliers' cost to capture and transport CO_2 and EOR operators' willingness to pay for CO_2. The goal of the tax credit is to bridge the cost gap. Thus, the cost gap determines the expected level of the tax credit in a proposed competitive-bidding process.

2) Revenue neutrality – the federal government will bear the cost of a CO_2-EOR tax credit program, yet it will enjoy increased revenues from the expansion of CO_2-EOR oil production when existing tax rates are applied to the additional production. C2ES and GPI analyzed when the net present value of expected revenues would exceed the net present value of program costs.

C2ES and GPI calculated the tax credit required to bridge the cost gap, and the cost and revenue implications. C2ES and GPI developed input assumptions based on real-world physical and market conditions after consulting with NEORI participants and other industry experts and reviewing available literature. C2ES and GPI developed a core scenario based on "best guess" inputs and conducted several sensitivity analyses of key inputs. (See Figure D1.) C2ES and GPI demonstrated that a program can be designed that will become "revenue positive" (defined as when the federal revenues from additional new oil production exceed the cost of a carbon capture tax credit program after applying a discount rate to both costs and revenues) within ten years after tax credits are awarded. Sensitivity analysis reveals that the program remains revenue positive using a realistic range of likely assumptions.

CO_2 Capture and Transportation Costs

CO_2 capture and transportation cost is one of the most important variables in determining the size of a federal tax credit program. The recommended tax credit program divides CO_2 sources into tranches and sub-tranches with similar capture costs. In addition to technological factors, cost estimates must reflect the cost of transporting CO_2 to an EOR site and an amortization schedule for CO_2 suppliers investing in capture equipment and pipeline infrastructure. Finally, capture costs are unlikely to remain static over time. They are likely to fall as capture technology matures and CO_2 suppliers learn from building multiple facilities of a given type. Publicly available studies and insight from industry experts helped to establish a range and best estimate of likely capture and transportation costs. Sensitivity analysis was conducted to assure that revenue neutrality would still occur within a reasonable timeframe if capture and transportation costs are higher than expected.

CO_2 capture and transportation costs are not the only determining factor for whether a man-made CO_2 source enters the EOR market. Naturally occurring CO_2 composes a major share of current CO_2 supplies, but its reserves are rapidly diminishing. The loss of this supply will have an important effect on available CO_2 quantity and market price. In addition, many of the lower-cost man-made sources are not much more expensive than the willingness-to-pay price for CO_2 at current oil prices. However, because the lower-cost sources also tend to be small in volume, it is impractical to construct dedicated pipelines to serve only lower-cost sources except in some niche applications. It is assumed that if an incentive were available at a sufficient level to bring on larger-volume, higher-cost sources, it would become possible to aggregate the lower-cost, smaller-volume industrial sources to bring them to market.

Figure D1: Assumptions regarding carbon capture and transportation costs for different technology tranches

	TRANSPORTATION COST	CORE SCENARIO CAPTURE COST	CORE SCENARIO + TRANSP. COSTS (A)	CO_2 MARKET PRICE (*STARTING 2013, WILLINGNESS TO PAY) (B)	REPRESENTATIVE EOR INCENTIVE (FOR ILLUSTRATION PURPOSE) (VARIES BY YEAR) (A-B)
POWER PLANT TRANCHE	**($/TONNE)**	**($/TONNE)**	**($/TONNE)**	**($/TONNE)**	**($/TONNE)**
		(30-year Payback)			
Pioneer - First of a Kind Projects	$10	$60	$70	$33	$37
Projects #2-#5	$10	$50	$60	$33	$27
Nth of a Kind (Projects #6-onward)	$10	$45	$55	$33	$22
INDUSTRIAL - LOW COST TRANCHE	**($/TONNE)**	**($/TONNE)**	**($/TONNE)**	**($/TONNE)**	**($/TONNE)**
		(15-Year Payback)			
Pioneer- First of a Kind Projects	$10	$28	$38	$33	$5
Projects #2-#5	$10	$28	$38	$33	$5
Nth of a Kind (Projects #6-onward)	$10	$28	$38	$33	$5
INDUSTRIAL - HIGH COST TRANCHE	**($/TONNE)**	**($/TONNE)**	**($/TONNE)**	**($/TONNE)**	**($/TONNE)**
		(15-Year Payback)			
Pioneer- First of a Kind Projects	$10	$55	$65	$33	$32
Projects #2-#5	$10	$45	$55	$33	$22
Nth of a Kind (Projects #6-onward)	$10	$35	$45	$33	$12

CO_2 Supply over Time

Projecting likely CO_2 supply over time is important for projecting the size of an overall federal tax credit program. The availability of CO_2 is constrained by capture technology, time, and overall CO_2 potential. C2ES and GPI, with extensive input from NEORI participants, developed a realistic supply expansion scenario. In terms of capture technology, power plants, low-cost industrial sources, and high-cost industrial sources have different time horizons for development and deployment. For example, capture technology for low-cost industrial sources is closer to deployment than capture technologies for power plant and high-cost industrial sources. In terms of time, CO_2 supply growth is constrained on an annual basis, at least in the early years of the incentive program. Power plants and industrial facilities take time and resources - material and financial - to complete, and,

given current market conditions, it is unlikely for more than a few power plants or industrial facilities to go into operation in a given year during the early years of the program. Over the longer term, capture technology for existing and new facilities is likely to become available more broadly and at lower costs. CO_2 supplies are projected to rapidly expand after an initial deployment phase and approach the total available supply for a given resource.

Oil Supply & Production

C2ES and GPI projected the incremental EOR oil production that results from incentivizing and expanding the supply of anthropogenic CO_2. Assumptions for oil supply and production resulting from new incremental CO_2 supply were based on research by the Natural Resources Defense Council and reviewed by Initiative participants. The analysis accounts for the multiple phases of EOR production to project when the federal government is likely to realize revenues from incremental EOR production. As indicated in the assumptions list below, a CO_2-EOR project's annual oil production will vary over its lifetime and reflect different development phases: initial injection, increasing production, plateau production, and declining production.

Key Assumptions:

- Oil production:
  - After initial CO_2 injection, 1 year lag before oil production commences;
  - 5 year ramp-up in oil production volume follows;
  - 5 year plateau in oil production follows;
  - 20 year decline in oil production follows; and
  - After 30 years, oil production ceases.
- CO_2 purchase use:
  - Purchased CO_2 injected for first 10 years at 100% (maximum level)
  - Purchased CO_2 injections decline at 20% per year after peak oil production
  - Purchased CO_2 continues to be injected at 10% for remainder of EOR project
  - CO_2 injections cease at the end of 30 years
- As volumes of purchased CO_2 injection decline for an EOR project, the CO_2 becomes available for new EOR projects.

Federal Revenue

A federal tax credit program for CO_2-EOR will generate additional tax revenue as the new CO_2 supply enables additional oil production that is taxed at existing tax rates (the analysis assumes no changes to taxes other than the tax credit for CO_2 capture and transportation for EOR). Over time this new revenue exceeds the cost of the tax credits provided for CO_2-EOR. C2ES and GPI estimated federal revenue from CO_2-EOR production by calculating the total value of oil sales and calculating the expected percentage of the value of a barrel of oil that the federal government collects in revenue. The federal government collects approximately 20% of the sales value of a barrel of oil on average, in the form of corporate income taxes, royalties on oil produced on public lands, and taxes on private royalties (ARI, 2011 and Industry Sources).

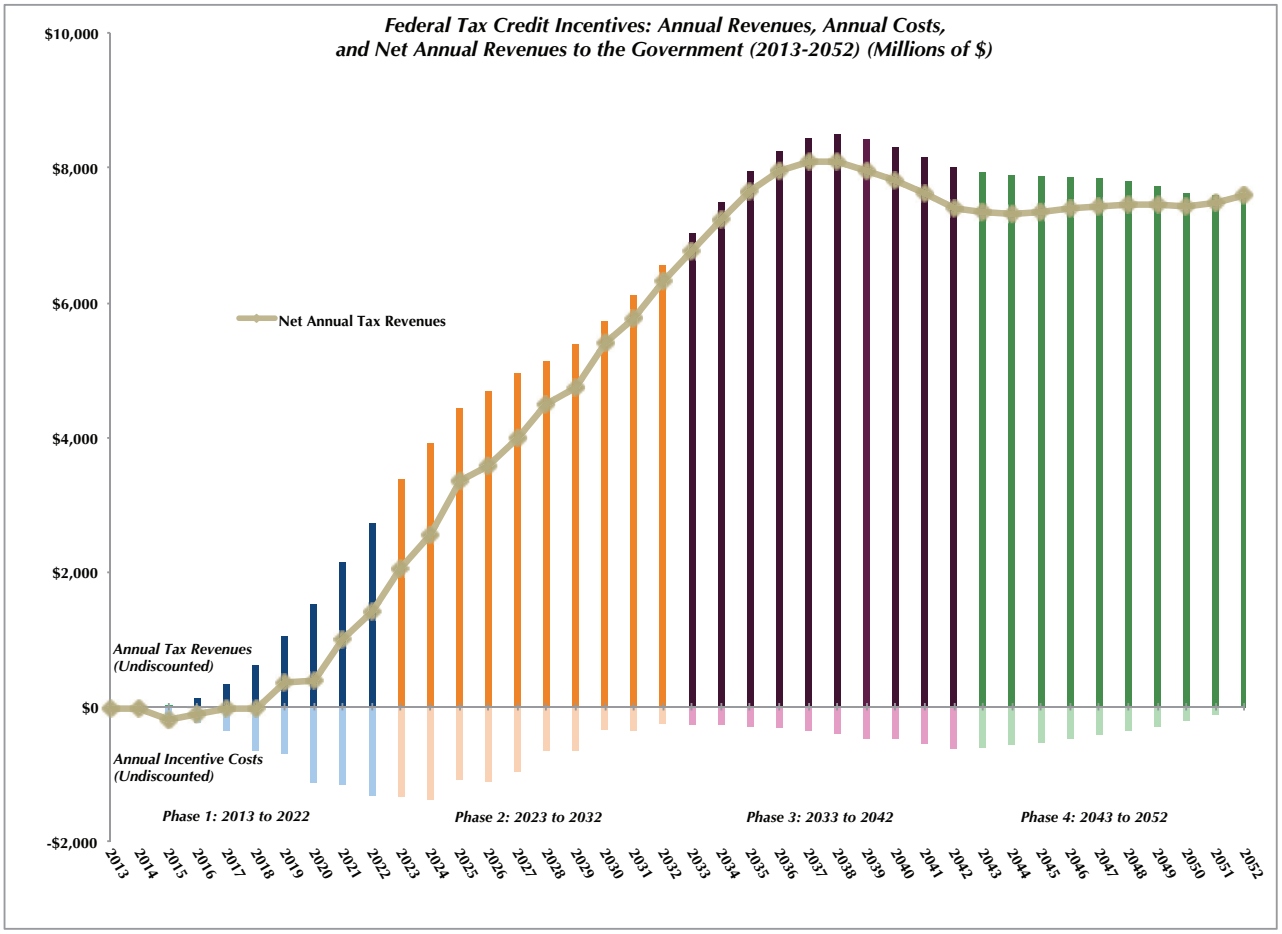
RESULTS OF THE CORE CASE SCENARIO AND SENSITIVITY ANALYSIS

Analysis by C2ES and GPI demonstrates that a federal CO_2-EOR tax credit program can be structured in a way that generates more revenue than costs within ten years of the program's inception. GPI and C2ES analyzed a program in ten-year increments over 40 years. Over time, the revenues from a CO_2-EOR program become much greater than the costs of the tax credits, regardless of how long the program remains in place (beyond the first decade). The tax credit cost rises over the first ten years and beyond, but the revenues rise faster. Over time, the net program costs fall as initial tax credits for relatively more expensive first-of-a-kind capture projects are phased out and capture costs decrease as a result of learning. Figure D2 shows annual program revenue and costs over 40 years. Figure D3 illustrates annual revenue and costs relative to cumulative net benefits.

Phase 1: 2013-2022

During this phase, the federal program awards tax credits to first-of-a-kind projects in each tranche and additional projects in the lower cost industrial tranche. By 2020, the net present value (NPV) of the revenues exceeds the NPV of the program costs, and the program meets its goal of being revenue-positive within a ten-year time period. At the end of 2022, oil production due to the program reaches 120 million barrels annually and 394 million barrels cumulatively. The NPV of the program (NPV[Revenues] – NPV [costs]) for the first ten years is approximately $2 billion dollars.

Figure D2: Federal CO_2 Production Tax Credit Program Revenue and Costs: Core Scenario



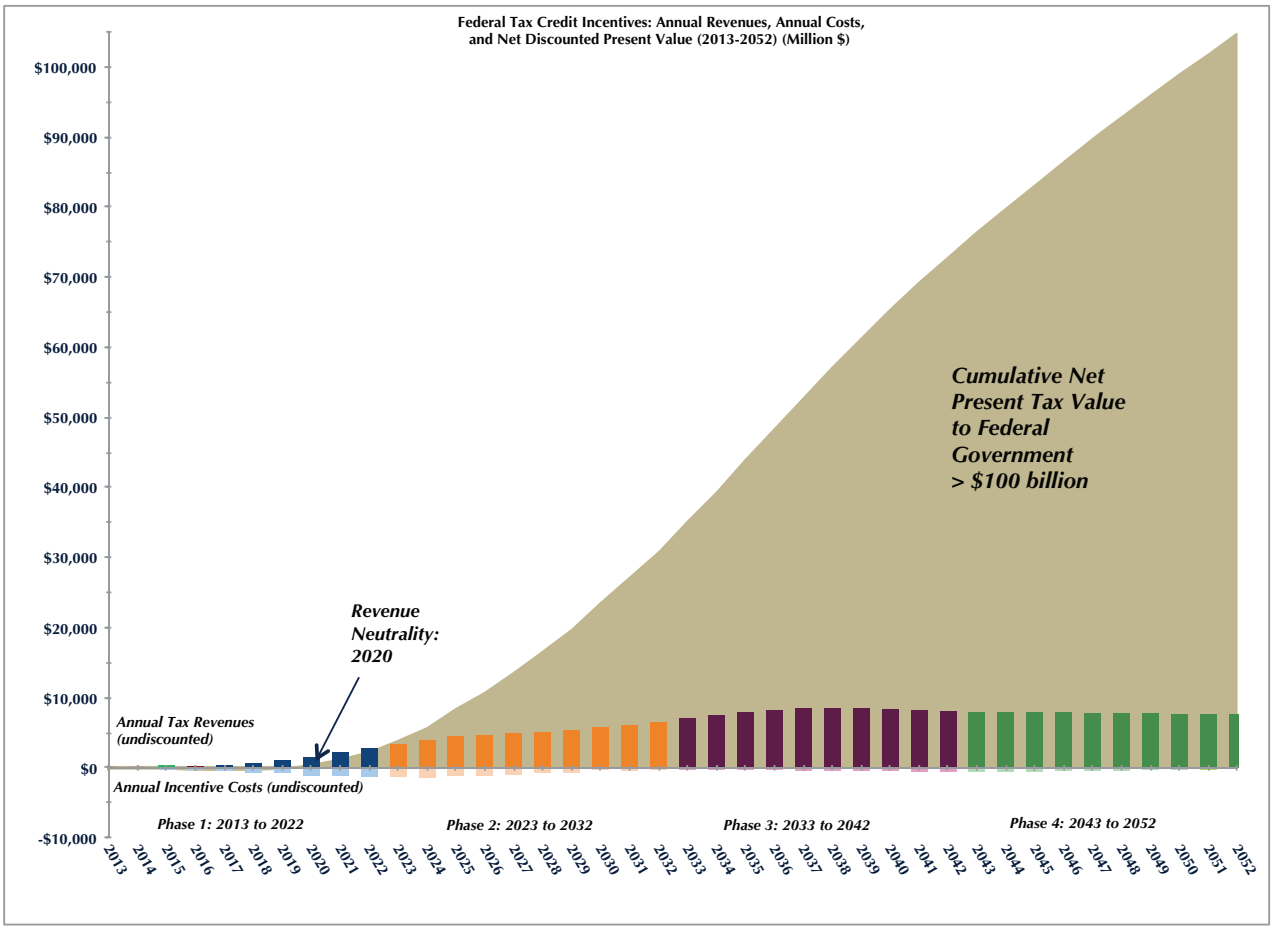
Phase 2: 2023-2032

During this phase, tax credits end for Phase 1 projects, and a new stream of projects is awarded tax credits. In the power plant and high-cost industrial tranches, next-of-a-kind projects are incentivized in the early years, while the rapid expansion of high-cost CO_2 supply begins in the later years. Low-cost industrial CO_2 supply begins rapid expansion after the completion of first-of-a-kind and next-of-a-kind projects. The size of the federal tax credit program reaches its highest level at $1.37 billion dollars in 2024, but annual expenditure falls in 2025 with the termination of tax credits for some Phase 1 projects. By 2032, the federal government receives approximately $6.5 billion in annual revenue. At the end of 2032, oil production due to the program has reached 264 million barrels annually and 2.48 billion barrels cumulatively. The NPV of the program by the end of Phase 2 is approximately $31 billion.

Phase 3: 2033-2042

Throughout this phase, overall CO_2 supply continues to grow. High-cost industrial and power plant CO_2 sources adopt technologically and commercially mature capture technologies, and the CO_2 supply from power plants grows rapidly. The federal tax credit program continues to incentivize numerous Phase 2 projects, but tax credits are slowly phased out by the end of the period. Capture projects in Phase 3 are eligible for tax credits, but due to reductions in capture cost, the overall size of the tax credits program averages $360 million. In 2038, EOR oil production reaches its highest annual production level of 339 million barrels as a result of the cumulative supply

Figure D3: Cumulative Revenue and Costs: Core Scenario



of recycled CO_2 from previous periods. By 2042, the federal government receives approximately $8 billion in annual revenue. At the end of 2042, oil production due to the program has reached 321 million barrels annually and almost 6 billion barrels cumulatively. The NPV of the program by the end of Phase 3 is approximately $73 billion.

Phase 4: 2043-2052

Throughout this phase, tax credits awarded in Phase 3 are slowly phased out and no new tax credits are offered for projects. At the end of 2052, oil production due to the program drops slightly to 303 million barrels annually but reaches almost 9 billion barrels cumulatively. In 2052, the federal government still receives $7 billion in annual revenue due to the program. The NPV of the program by the end of Phase 4 is approximately $105 billion.

Beyond Phase 4

Because of the long life of CO_2 and EOR projects, benefits continue to accrue to the federal government beyond the end of the incentives program. In practice, the NPV of a program would be higher than is reflected in this analysis as the government would continue to collect tax revenue from oil produced due to the program even when no further incentives were being allocated.

Incremental EOR Production

The C2ES-GPI analysis indicates that a tax credit program will greatly expand current oil production via CO_2-EOR. Annual production via CO_2-EOR is currently approximately 100 million barrels per year, which equals 6 percent of total U.S. annual oil production (ARI, 2011). Following the inception of a tax credit program, analysis of the core scenario shows that annual oil production via

CO_2-EOR doubles within twenty years. Between 2033 and 2052, current annual production is tripled. (See Figure D4.)

Cumulative EOR production resulting from a tax credit program enables the extraction of a considerable percentage of "economically recoverable" CO_2-EOR reserves. (See Figure D5.)

SENSITIVITY ANALYSIS

Sensitivity analysis varied the key inputs to the CO_2-EOR model. C2ES and GPI identified likely ranges for these inputs and used the CO_2-EOR model to determine whether the tax credit program's payback window still fell within a ten year period. These sensitivity scenarios revealed that certain variables have a larger impact than others. The outer ranges of some variables suggest that the tax credit program may not experience payback within a ten year window under some scenarios, but rather within 11-13 years. Using more favorable assumptions, the payback window may be as short as five years. Overall, these sensitivities suggest that allowing the Secretary of the Treasury to have discretion to impose annual caps on a tax credit program, as NEORI recommends, will enable it to maintain a ten-year payback period. (See Figure D6.)

Oil Price (2013-2028, 20% Increase, 20% Decrease)

SENSITIVITY CHANGE	SENSITIVITY BREAKEVEN YEAR
Increase Oil Prices by 20%	2018
Decrease Oil Prices by 20%	2025

Varying the oil price ($/barrel) for the first fifteen years of the program has a significant effect on the projected breakeven years of the tax credit program. If oil prices are 20% lower than projected in the EIA's Annual Energy Outlook 2011 Reference case (EIA, 2011), the estimated breakeven year goes from 2020 to 2025. This reflects EOR operators' lower willingness to pay for CO_2, thus increasing the size of cost gap and needed tax credit for CO_2 suppliers. If the expected oil price rises by 20%, the payback period will be shortened to 2018. This is due to

Figure D4: Current Annual CO_2-EOR Production vs. Average Projected Annual Incremental Production by Program Decade

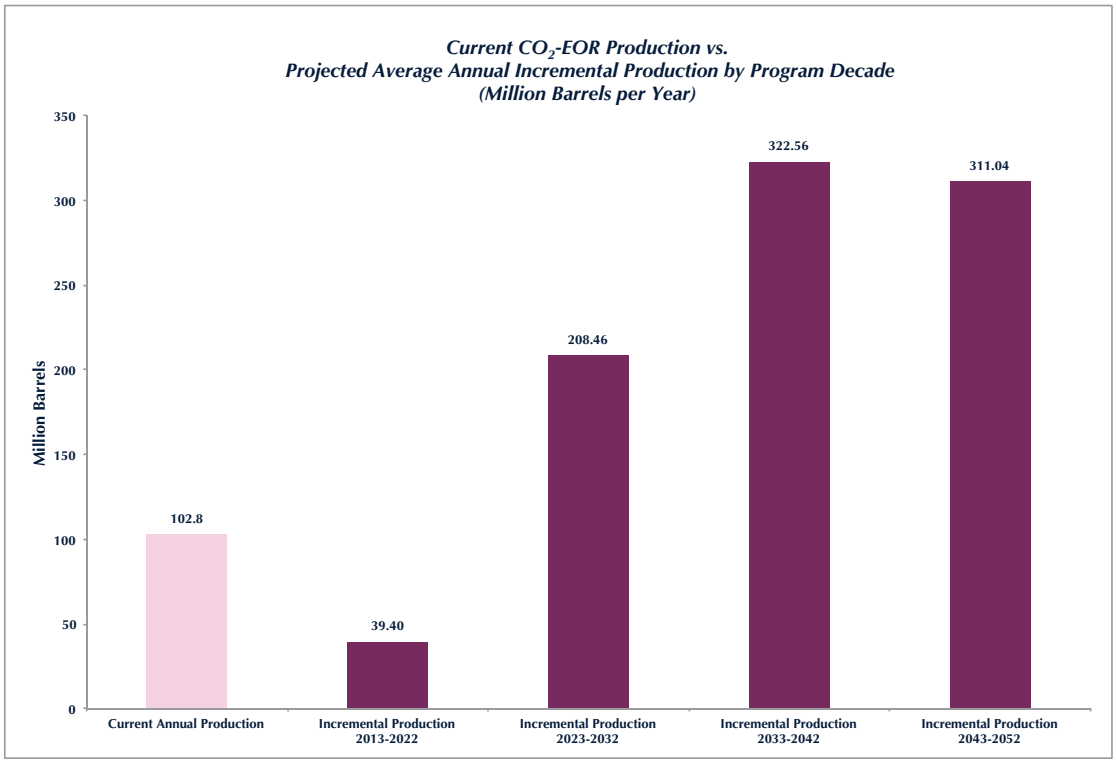


Figure D5: Cumulative Incremental CO_2-EOR Oil Production (2013-2052) vs. Total Reserves Estimates

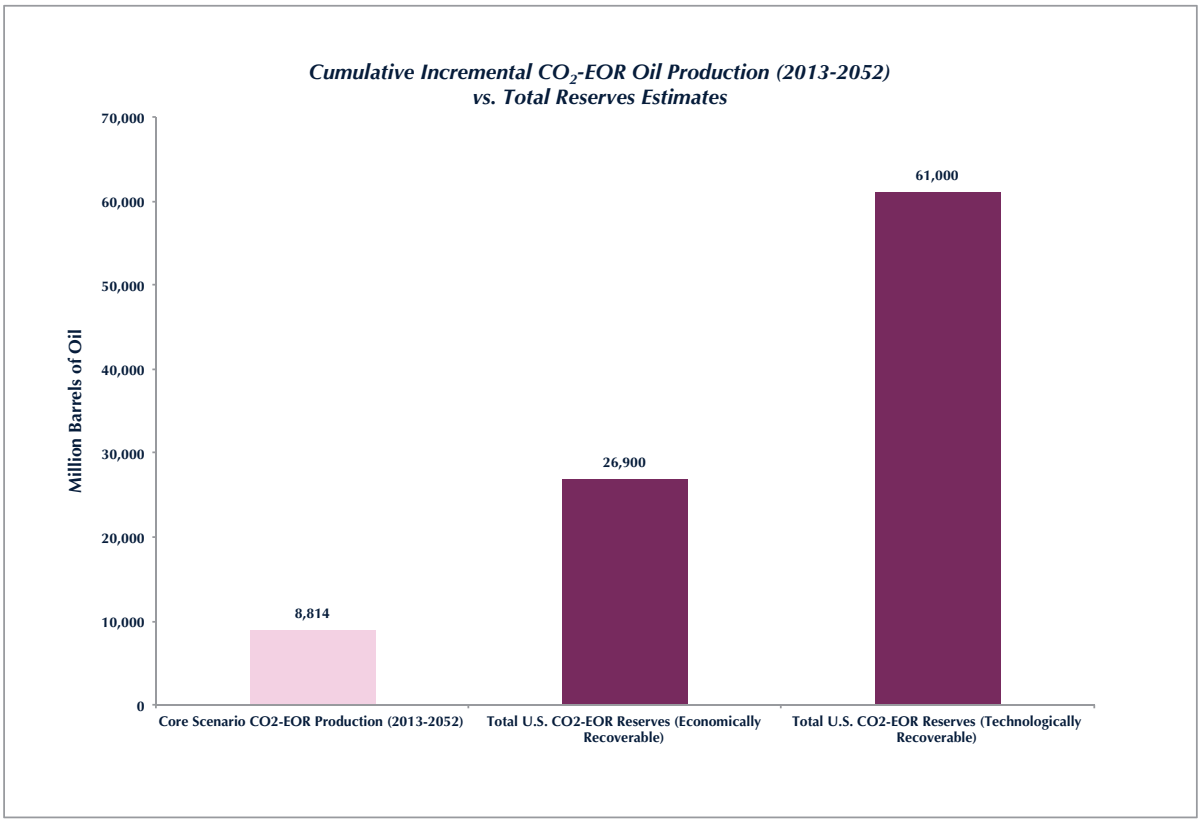
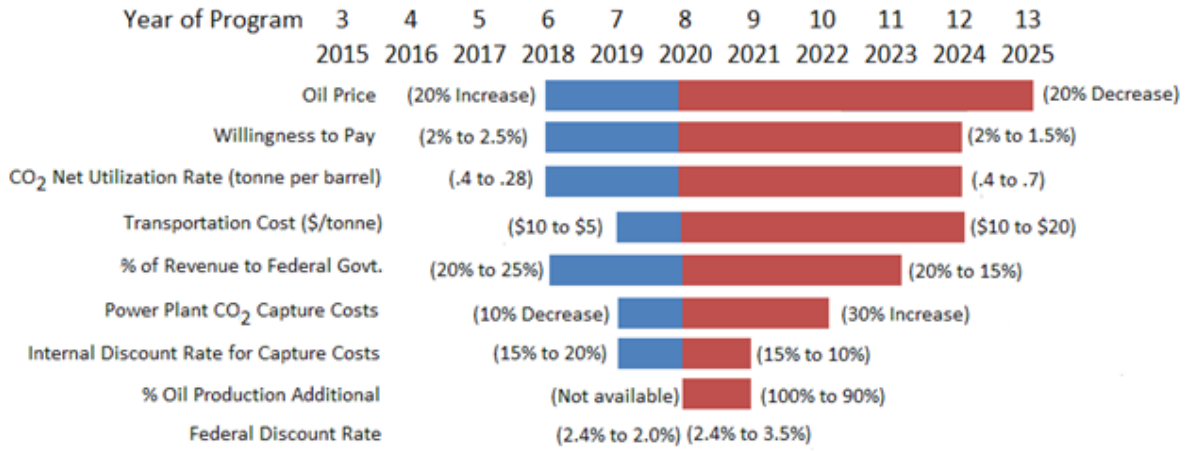


Figure D6: Results of a sensitivity analysis determining number of years to revenue neutrality using a range of assumptions.



a higher willingness to pay for CO_2, thus decreasing the size of the cost gap and needed tax credit for CO_2 suppliers. Lowering the oil price extends the payback period by five years, whereas raising the oil price shortens the payback period by two years. This three-year sensitivity difference is explained by the fact that there is a limit to how fast the program can break even. From 2013 to 2015, the program bears the costs of tax credits, but revenue from oil sales is minimal or relatively low compared to future periods as oil production from incentivized CO_2 gradually comes online.

Willingness to Pay as a % of the Price of Oil (Core: 2.0%, Range 1.5-2.5%)

SENSITIVITY CHANGE	SENSITIVITY BREAKEVEN YEAR
Increase from 2.0% to 2.5%	2018
Decrease from 2.0% to 1.5%	2024

Varying the EOR operators' willingness to pay for CO_2 has a significant effect on the projected breakeven years of the tax credit program. If the willingness to pay falls to 1.5%, the estimated breakeven year goes from 2020 to 2024. A lower willingness to pay for CO_2 increases the size of cost gap and needed tax credit for CO_2 suppliers. If the willingness to pay is 2.5%, the payback period will be shortened to 2018. A higher willingness to pay for CO_2 decreases the size of the cost gap and needed tax credit for CO_2 suppliers. Increasing the willingness to pay reduces the payback period by two years, while lowering the willingness to pay extends the payback period by four years. The difference in sensitivity reflects a limit to faster payback due to the fact that there are upfront costs for carbon capture before revenues are generated by EOR production.

CO_2 Net Utilization Rate (Core: 0.4, Range 0.28 - 0.7)

SENSITIVITY CHANGE	SENSITIVITY BREAKEVEN YEAR
Decrease from 0.4 to 0.27	2018
Increase from 0.4 to 0.7	2024

Varying the CO_2 net utilization rate (tonnes/barrel) has a significant effect on the projected breakeven years of the tax credit program. If the CO_2 net utilization rises to 0.7, the estimated breakeven year goes from 2020 to 2024. A 0.7 net utilization rate means more CO_2 is consumed per barrel of oil. This means CO_2-EOR operations produce less oil, which lowers projected federal revenues. A 0.7 net utilization rate is the upper end of the range of possible utilization rates from projects observed around the country. A 0.28 net utilization rate represents a likely minimum needed to sustain EOR operations.

Transportation Costs (Core: $10, Range $5 - $20)

SENSITIVITY CHANGE	SENSITIVITY BREAKEVEN YEAR
Decrease from $10 to $5	2019
Increase from $10 to $20	2024

Varying CO_2 transportation costs (dollars/tonne) has a significant effect on the projected breakeven years of the tax credit program. If transportation costs are doubled from $10 to $20, the size of the cost gap and needed tax credit rises for CO_2 suppliers. Reducing the transportation cost from $10 to $5 reduces the size of the cost gap and needed tax credit, thus shortening the payback period to 2019.

Percentage of Revenue to the Federal Government (Core: 20%, Range 15% - 25%)

SENSITIVITY CHANGE	SENSITIVITY BREAKEVEN YEAR
Increase from 20% to 25%	2018
Decrease from 20% to 15%	2023

Varying the federal government's expected share of revenues from incremental oil production has a moderate effect on the projected breakeven years of the tax credit program. If the expected share falls from 20% to 15%, the estimated breakeven year goes from 2020 to 2023, reflecting lower revenues for the federal government in all years. Increasing the expected share to 25% raises revenues in all years and shortens the payback period by two years to 2018. Reducing the percentage changes the payback period by 3 years, while raising the percentage by an equal amount changes the payback period by only two years. This one year sensitivity difference is explained by the fact that there is a limit to how fast the program can break even. From 2013 to 2015, the program bears the costs of tax credits, but revenue from oil sales is minimal or relatively low compared to future periods as oil production from incentivized CO_2 gradually comes online.

Power Plant CO_2 Capture Costs (Increase by 30%, Decrease by 10%)

SENSITIVITY CHANGE	SENSITIVITY BREAKEVEN YEAR
Decrease by 10%	2019
Increase by 30%	2022

Varying power plant CO_2 costs (dollars/tonne) has a limited effect on the projected breakeven years of the tax credit program. Higher capture costs increase the cost of the tax credit program, but the effect on the break-even year is limited by the fact that many power plant projects begin operations after the federal government begins to receive EOR revenues. Lowering the expected power plant capture costs by 10% has a limited effect on the breakeven year, increasing the time to break-even by one year. A larger decrease in cost is outside the range of what is likely.

Internal Discount Rate for CO_2 Capture Costs (Core 15%, Range 10% – 20%)

SENSITIVITY CHANGE	SENSITIVITY BREAKEVEN YEAR
Increase from 15% to 20%	2019
Decrease from 15% to 10%	2021

Varying the internal discount rate for CO_2 capture costs has a limited effect on the projected breakeven years of the tax credit program. An internal discount rate is applied because ten years of incentives must account for 30 years of capture operations. However, receiving incentives upfront is preferred to receiving incentives in the future, thus allowing for a discounting of future incentives that are received in the present. Increasing or decreasing the internal discount rate by 5 percent does not equate to a large dollar per tonne change in the production tax credit predicted in the core scenario.

Additionality of CO_2-EOR Oil Production

SENSITIVITY CHANGE	SENSITIVITY BREAKEVEN YEAR
Decrease from 100% to 90%	2021

Varying the percentage of CO_2-EOR oil that is expected to be additional as a result of a federal tax credit program has a minimal effect on the projected breakeven year. This sensitivity was considered because it is possible that some of the lower-cost industrial CO_2 sources would come online and provide CO_2 for EOR in the absence of a new federal tax credit. In the core scenario, 100% of the oil production is directly attributable to the tax credit. In the sensitivity case, this assumption was reduced to 90%.

The additionality concern only exists for lower-cost industrial sources, which constitute only 23% of the total cumulative CO_2 supplied over the life of the program. Although the comparison between willingness-to-pay for CO_2 at current oil prices and the capture cost for lower-cost industrial sources suggests that some of these sources are close to entering the marketplace, the relative economics are not the only determinant of whether a CO_2 source enters the marketplace. The sources with lower capture costs also tend to be relatively small-volume sources that are prohibitively expensive or impractical to be served by dedicated pipeline infrastructure, with the exception of niche applications where a source is particularly close to an EOR resource. Individual small-volume sources are unlikely to justify investment in long-distance pipelines by themselves. Industry interviews indicate that the most likely scenario for bringing the smaller-volume, lower-cost industrial sources into the market is to aggregate them with larger-volume, more expensive sources into larger-volume pipeline projects. This is unlikely to occur without a new policy such as a new tax credit for CO_2-EOR.

Federal Discount Rate (Core 2.4%, Range 2 – 3.5%)

SENSITIVITY CHANGE	SENSITIVITY BREAKEVEN YEAR
Decrease from 2.4% to 2.0%	2020
Increase from 2.4% to 3.5%	2020

Varying the federal government's discount rate does not impact the time-to breakeven sufficiently to change the projected breakeven years. This is because the magnitude and timing of program costs and revenues are similar enough in the early years of the program to balance out the relative impact of a change in discount rate on costs and revenues.

REFERENCES

ARI (2011). Improving Domestic Energy Security and Lowering CO_2 Emissions with "Next Generation" CO_2-Enhanced Oil Recovery (CO_2-EOR).

EIA (2011). Annual Energy Outlook 2011.

This report presents the National Enhanced Oil Recovery Initiative (NEORI) participants' consensus recommendations for targeted federal and state incentives to expand CO_2-EOR. NEORI was formed to help realize CO_2-EOR's full potential as a national energy security, economic and environmental strategy.

National Enhanced Oil Recovery Initiative

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