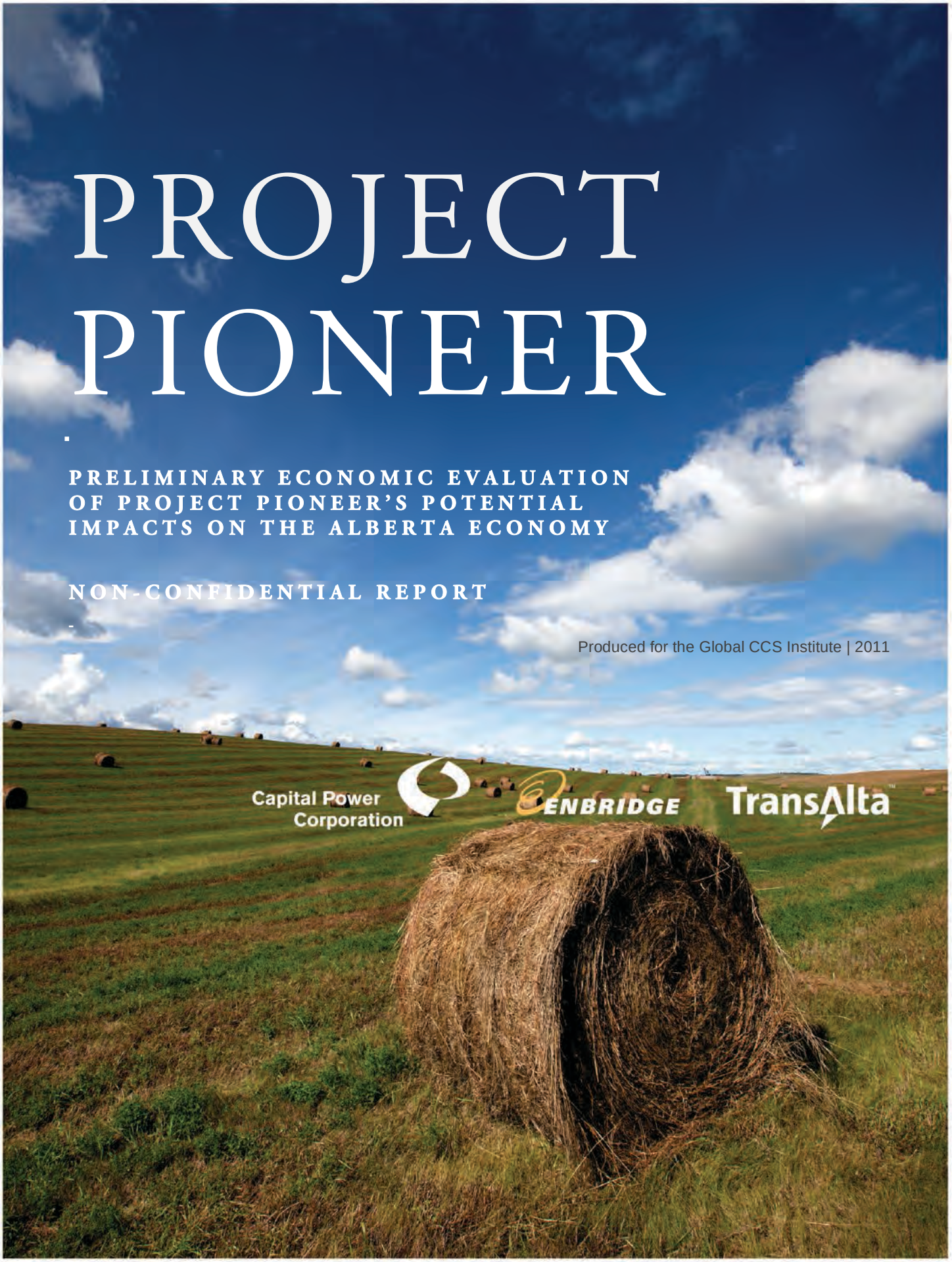
PROJECT PIONEER

PRELIMINARY ECONOMIC EVALUATION OF PROJECT PIONEER'S POTENTIAL IMPACTS ON THE ALBERTA ECONOMY

NON-CONFIDENTIAL REPORT

Produced for the Global CCS Institute | 2011



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ABSTRACT OF THE PROJECT

Project Pioneer will be one of the first carbon capture and storage (CCS) projects to utilize an integrated approach for CCS, and is expected to serve as a prototype for the long-term, commercial-scale application and integration of CCS technologies to achieve reductions in greenhouse gas emissions. The partners in Project Pioneer are TransAlta Corporation (TransAlta), Capital Power L.P. (CPLP), Enbridge Inc. (Enbridge), the Alberta provincial and Canadian federal governments, and the Global CCS Institute as a Knowledge Sharing Partner.

Project Pioneer is being proposed to capture 1 million tonnes of carbon dioxide (CO_2) annually from a coal fired power plant and transport the CO_2 by pipeline to a sequestration field or to be utilized for enhanced oil recovery (EOR) in a depleted oil field.

The key components of Project Pioneer are:

- Carbon capture facility (CCF)
- Pipeline from the CCF to the Sequestration Field
- Pipeline from the CCF to the EOR site
- Saline formation sequestration field

The Carbon Capture Facility (CCF) portion of Project Pioneer will be retrofitted onto the Keephills 3 coal-fired power plant. Keephills 3 is located approximately 70 km west of Edmonton, Alberta and is jointly owned by TransAlta and Capital Power.

The CCF will treat approximately one third of the flue gas from Keephills 3 and will capture approximately 1 million tonnes of CO_2 annually. The CO_2 will be compressed and transported by pipeline to a sequestration site to be injected approximately 2 km underground into a saline formation known as the Nisku Formation. A pipeline will also be built to transport the CO_2 to the primary EOR target, the Pembina oilfield, where the CO_2 will be injected and used for enhanced oil recovery and stored permanently underground. The Pembina oilfield is approximately 80 kms southwest of the Keephills 3 facility.

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1.0

EXECUTIVE SUMMARY

Introduction to the Project

Project Pioneer represents a major step toward advancing the reduction of a key greenhouse gas (GHG) emission – carbon dioxide (CO_2).

TransAlta and its project partners believe that maintaining the long-term viability of fossil-fired generation is a global necessity. Through economic carbon capture and storage (CCS) we can keep coal and natural gas as fuel options while addressing climate change concerns. Much of the world, including Canada, is fortunate to have huge, reliable reserves of low-cost coal – more coal than oil, in fact. Within the global electricity generation mix, coal is vital and often the only practical fuel for some regions. With billions of dollars of energy infrastructure already built (and billions more to come) carbon capture and storage (CCS) may be the only way to minimize the long-term impact these facilities will have on the environment over the course of their lifespan.

Project Pioneer will demonstrate a post-combustion, retrofit CCS process that can be attached to existing energy infrastructure.

Introduction to the Economic Evaluation

This is a preliminary evaluation of the economic impacts of Project Pioneer on the province of Alberta, done in 2009, at the very inception of the project. **Pioneer is currently conducting a follow-up economic evaluation through Q4/2011 and Q1/2012.**

In this report, we will also estimate the economic impacts that might accrue if the technology and refinements from Project Pioneer were successful and more broadly applied to other sectors.

Methodology

The analysis employs an input output framework to measure the direct and indirect impacts arising from the capital and operating expenditures associated with Project Pioneer. These include the expenditures related to the capture of approximately one megatonne (MT) of carbon dioxide (CO_2) annually and the associated compression, transportation, use in enhanced oil recovery (EOR) projects and ultimate sequestration. The focus is on the implications for provincial output, income, employment and government revenues. This analysis measures the impacts on these variables and, unlike cost benefit analysis for example, does not address efficiency issues.

This economic analysis was conducted based on preliminary investment economics for Project Pioneer.

Economic Impacts of Project Pioneer

The overall construction plus operating period impacts over the period 2010-2023 associated with Project Pioneer are shown in the table and graph below. As indicated, the project is expected to generate between $2 billion and $3 billion in Alberta GDP (depending on future oil prices) over this fourteen year period. The increases in Labour Income are expected to be about $700 million and combined provincial and municipal revenues are estimated to grow by between $225 million and $850 million.[1] The estimated impact on federal government revenue is between $260 and $330 million while total employment is expected to be approximately 8800 person years. These impacts assume that 90 per cent of the CO_2 captured by Project Pioneer is used in EOR projects.

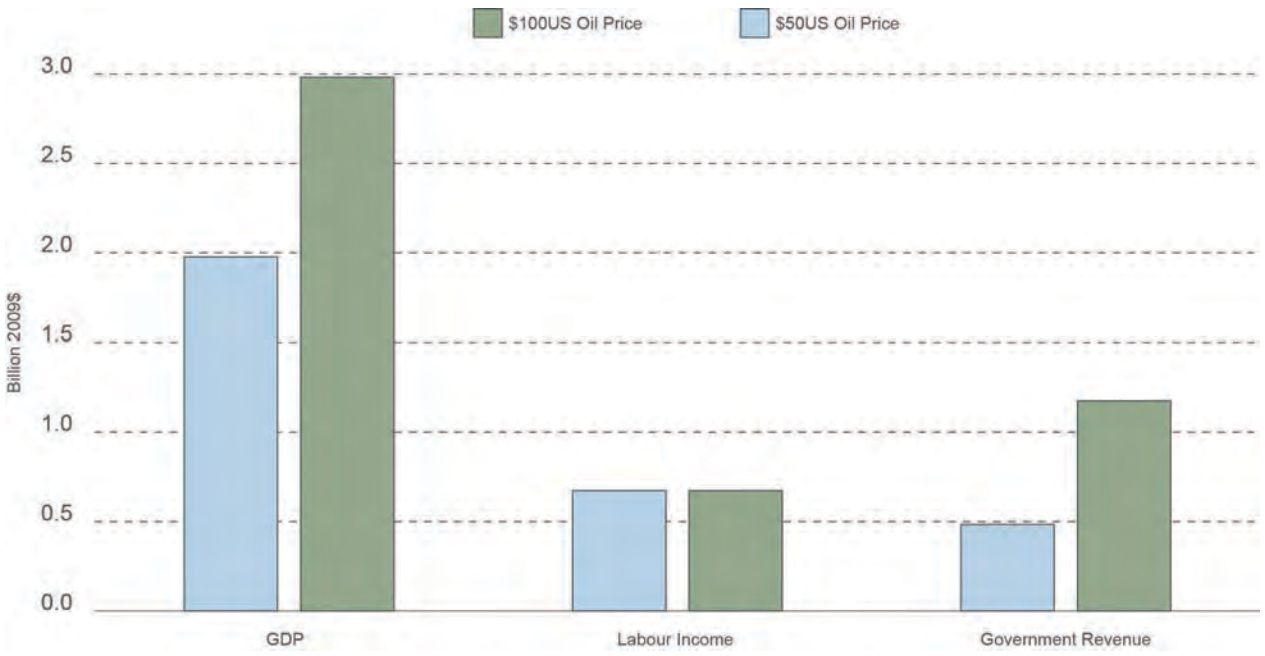
[1] Note that the increases in revenue do not take into account any increases in government transfers or tax expenditures that may be required to achieve the assumed EOR activity if oil prices are at or below those shown for the $50 US/bbl case.

fig. 1.0

SUMMARY OF PROJECT PIONEER IMPACTS, 2010-2023

(values are in millions of 2009 Cdn $ unless otherwise noted)

	$50 US Oil Price	$100 US Oil Price
GDP	1,977	2,982
Labour Income	673	673
Provincial/Local Government Revenue	225	848
Federal Government Revenue	259	327
Total Government Revenue	484	1,175
Employment (in person years)	8,769	8,769



It is important to note that these estimates do not include an economic value for the net reductions in CO_2 emissions of 7.7 Mt over ten years.[2] If total Alberta CO_2 emissions were at some cap, it can be argued that the value of the Project Pioneer CO_2 emission reductions would be the value of economic activity that would otherwise have to be reduced. If that activity was oil sands production, for example, then the impacts shown above would be substantially underestimated. In general, the impacts under those circumstances would be approximately double those shown above (See Table 3.3 for estimates of these additional impacts).

Potential Impacts Associated with the Broader Adoption of Project Pioneer Technology

TransAlta has estimated the potential applicability of scaled-up, retrofit Project Pioneer technology to other coal-fired electricity generation and to oil and gas plants.

Based on these estimates (and including those for Project Pioneer), capital spending by the various parties would generate about $4.5 billion in GDP, $3.4 billion in labour income and create about 44,000 person years of employment. The operations of EOR facilities that used captured CO_2 would produce between $4.1 billion and $7.2 billion in revenues under the alternative oil price assumptions ($50US/barrel and $100US/barrel) and would generate between $0.6 billion and $2.5 billion in provincial government revenues.

[2] The net reduction takes into account the incremental emissions from parasitic losses on electricity production associated with additional energy required to capture the CO_2 from the flue stream.

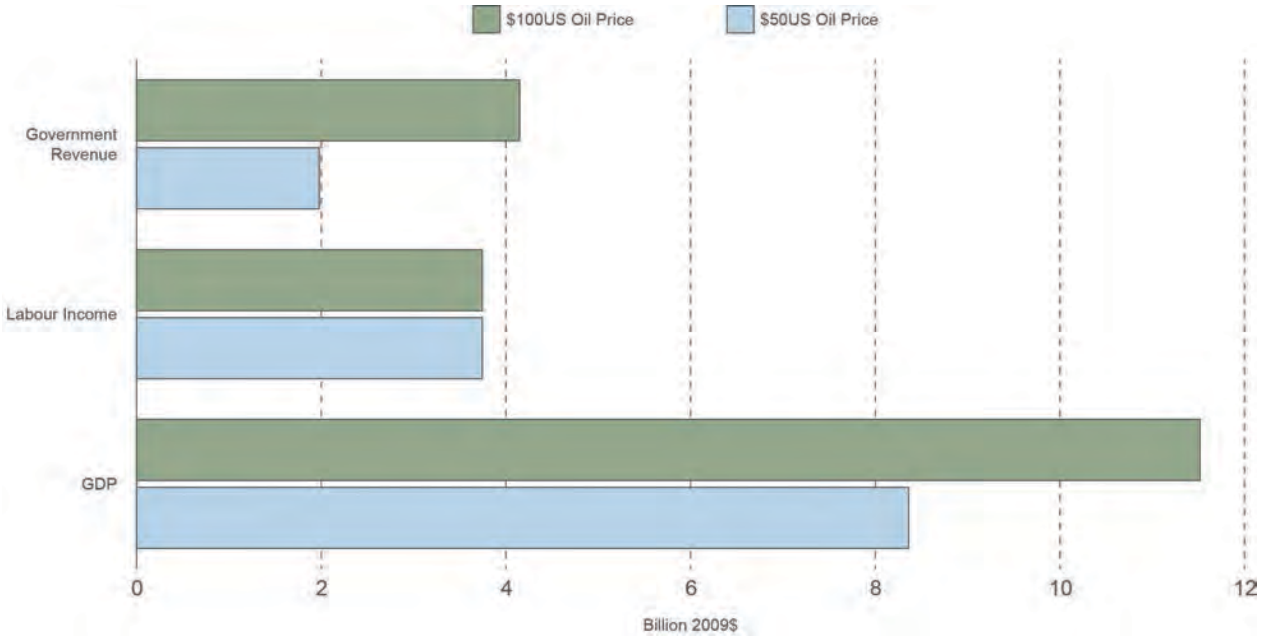
The overall construction and operating phase impacts (with the latter for just the first 10 years of operations) are shown in the table and graph below.

fig. 2.0

ECONOMIC IMPACTS WITH BROADER IMPLEMENTATION, 2016-2025

(values are in millions of 2009 Cdn $ unless otherwise noted)

	Capital Spending			Operations	
	Coal	Oil & Gas	EOR	$50US	$100US
Capital Expenditure/Oil Revenue	3,764	2,990	1,849	4,057	7,213
GDP	1,801	1,431	1,222	3,909	7,064
Labour Income	1,364	1083	908	389	389
Provincial/Local Government Revenue	104	83	75	567	2,523
Federal Government Revenue	281	223	191	451	666
Total Government Revenue	385	306	267	1018	3,190
Employment (in person years)	17,876	14,201	11,999	4,839	4,839



It is important to note that in the case of a binding CO_2 emission cap, the impacts can be expected to be much larger and likely about twice as large. That is, in such circumstances other activity such as unconventional oil production or other industrial production may have to be reduced in the absence of CCS to avoid exceeding the cap. The impact of this avoided reduction in activity would then represent the economic impact value of the CO_2 emissions reductions arising through CCS implementation based on the Project Pioneer pilot.

Unlike the results shown in Section 4 for the Project Pioneer, no estimates are made here for this value of reduced emissions. However, based on the results in that Section (see Table 4.3), incorporation of the associated impacts would lead to an approximate doubling of the size of the impacts shown in the table and graph on the previous page.

Although the results above are sensitive to various assumptions and factors, it is clear that widespread implementation of carbon capture and use of captured CO_2 in EOR schemes could be expected to produce very substantial economic gains.[3]

2.0

INTRODUCTION

Background

TransAlta, with its partners, is proposing to construct and operate a large-scale carbon capture and storage (CCS) pilot project. Project Pioneer involves retrofitting a power plant to capture and store approximately one megatonne (Mt) of CO_2 annually. The captured CO_2 will have access to nearby sites for permanent storage in deep saline aquifers and for use in enhanced oil recovery (EOR).

This project is expected to significantly advance the commercial implementation of CCS in Alberta and elsewhere in Canada. With one of the largest, diversified, and secure hydrocarbon resource bases, the province has the potential to become a significantly larger energy supplier to a world with growing energy demands. The associated economic gains would be a critical element of sustainable prosperity for Alberta and Canada.

[3] Note that this analysis does not take into account the cost of any government spending or tax expenditures that might be required to achieve the assumed adoption of the Project Pioneer CCS technology.

There are numerous environmental challenges in translating this huge potential into a reality. Most of these can be managed. However, the real Achilles' heel is carbon emissions. In this context, CCS takes on great importance for Alberta and Canada. By successfully demonstrating an effective and efficient CCS alternative, Project Pioneer has the potential to relax a key constraint on future prosperity and growth in Alberta and other regions.

Study Objective

The first objective in this study is to estimate key impacts on the Alberta economy arising from the successful development and operation of Project Pioneer. This includes the direct and indirect impacts on incomes, employment, investment and government revenues for Alberta resulting from the capital and operating expenditures associated with the carbon capture, transportation, EOR and sequestration. These impacts are estimated for a fourteen-year period under several scenarios to capture the main uncertainties, especially with respect to future oil prices.

A second objective is to estimate the likely impacts for Alberta associated with the broader application of the CCS technology embodied in Project Pioneer. These impacts are estimated by scaling the impact results for Project Pioneer under a scenario where Project Pioneer technology is applied to other coal-fired electricity generation and to some oil and gas operations.

Approach and Qualifications

The analysis in this report is referred to as Impact Analysis. That is, it is focused on measuring the impact on selected economic measures (such as output, income, employment and government revenues) taking into account the 'multiplier' effects. For example, a given expenditure on construction in the province will involve an increase in purchases of labour, lumber, concrete and so on. These are referred to as Direct impacts. However, this expenditure will also cause those industries or sectors providing the increased inputs to the construction project to increase their purchases from other industries or sectors. These Indirect impacts will be more significant the greater the backward and forward linkages in the economy. Direct and indirect impacts are typically estimated using an Input-Output Model.[4]

The analysis used in this report involves the use of the latest Statistics Canada Interprovincial Input Output Model (the I/O Model). For the first objective, detailed annual commodity (goods and services) requirements and sourcing associated with all dimensions of the construction and operation of Project Pioneer are tabulated. As noted previously, there will be several such arrays, each associated with a different energy price scenario covering a construction period of 4 years and an operating horizon of 10 years. These are then fed into the I/O Model to estimate the overall impacts on various dimensions of the provincial economy. Some additional spreadsheet modeling is undertaken to estimate the impacts on royalty revenues.

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[4] The standard method of measuring the net impacts after all complex actions and reactions are complete involves the use of an interregional input-output model. An input-output model simulates the effect on the economy when overall output of an industry changes in a specific region or when final demand for a particular commodity changes in a specific region (these changes are referred to as shocks). It can be noted there will also be *Induced* impacts as the larger labour income translates into increases in consumer expenditures and as additional government revenues translate into increased expenditures by government on goods and services. In this analysis, the induced impacts have not been included in the estimates.

There are several important assumptions concerning this methodology that should be noted.

First, it assumes that there is some additional capacity in the economy that can be tapped without generating significantly higher prices. To the extent the project resulted in higher prices (i.e., inflation) the impact on real output or income would be overestimated.

Second, production technologies are assumed fixed. In other words, each industry is assumed to use the same proportions of inputs to produce its output regardless of the quantity of outputs produced. Consequently, any impacts calculated will reflect the average effect in a region, in contrast to the marginal effect of a particular project which quite possibly could differ.

Third, the input-output model is by nature a static model with all of the relationships estimated for a specific, past time period. To the extent there have been significant changes in the relationships in the economy since the estimation period (such as major changes in production technologies) the model results may not provide the most accurate representation of what would actually happen in the current or future environment.

Fourth, it is important to note that an impact analysis is focused on measuring the impacts of a given change such as an increase in investment in a particular policy or project. However, it does not measure the efficiency or overall return associated with that project or policy. Such efficiency measures fall with the realm of Cost Benefit Analysis. Given this distinction, it can be noted that the impact analysis presented in this study does not address any questions concerning the overall social return of the project relative to other alternatives or any expenditures of public funds required to support the project.

Finally, Project Pioneer involves breaking new ground. For example, at this point it remains unclear exactly how carbon will be priced in the future or what particular combination of emissions caps, pricing, and tax/royalty provisions will be required to make CCS economically viable. Consequently, while the various assumptions about such things as the price EOR operators would pay for CO_2 are believed to be reasonable, they could prove to be unrealistic as the policy and regulatory structure for CCS is developed.

3.0

KEY DIMENSIONS OF PROJECT PIONEER

Overview

This project involves construction and operation of facilities:

- to capture, process and compress approximately one megatonne (Mt) of CO_2 per year from the flue stream of the Keephills 3 coal-fired power plant.
- to transport the captured CO_2 to nearby oil pools, such as Pembina Cardium, where it will be cycled within enhanced oil recovery (EOR) projects.
- and, to transport CO_2 directly to nearby permanent sequestration sites in the Wabumum area or indirectly to these sites from EOR cycling schemes once they are completed.

Carbon capture will involve some parasitic power losses at Keephills 3 and these will have to be made up by other generation. The economic impact of this makeup generation and the impact on CO_2 emissions must be taken into account. For the purposes of the analysis in this report it is assumed that the power losses would be made up by other nearby power plants and would not require additional capital expenditures.

The evaluation of economic impacts was conducted over the period 2010 to 2024, representing a construction phase from 2010-2013 (with major construction expenditures in 2010 and completion in 2013), followed by a 10-year operating phase. As of publication of this report, the construction phase is rescheduled to begin in 2013 with a completion date in 2015, with operations beginning the end of Q4/2015.

Construction Expenditures

TransAlta estimates that the capital costs of the carbon capture facilities at Keephills 3 would be $638 million 2009 Cdn$ (all $ values in this report are expressed in 2009 Cdn$ unless otherwise noted). In addition, the pipeline facilities that would be used to transport CO_2 to various EOR projects would cost an additional $79 million. The total capital expenditures of $717 million would be incurred over the period from 2010-2013.

The operators of EOR projects that would utilize the CO_2 will also need to incur significant capital costs. It is assumed that 90% of the CO_2 captured by Project Pioneer (or roughly 8.7Mt) would be available to various EOR projects.[5] Using information provided by TransAlta regarding a recent application for a CO_2-based EOR project, it is estimated that $589 million in capital expenditures would be incurred by EOR producers that would use Project Pioneer CO_2. Almost all of the capital spending is assumed to occur in 2012 and 2013.

[5] Ultimately after EOR requirements for new (vs. recycled CO_2) are met, the CO_2 streams will be diverted to permanent sequestration in depleted reservoirs and/or deep saline aquifers.

Operating Revenues and Expenditures

Once Project Pioneer is operational, streams of revenues and operating expenditures can be expected to occur over an indefinite time frame. However, in this analysis, economic impacts are assessed over just a ten year operating period.

In terms of economic impact, the main operating revenue that would be generated as a result of the Pioneer project is the revenue associated with incremental oil production in the EOR projects.[6] Both the value of the CO_2 that Transalta would sell to EOR producers and the cost of transporting the CO_2 to the EOR sites are input costs in the ultimate production of more oil.

TransAlta has modeled the cost of transporting the Project Pioneer CO_2 and it is expected to amount to $128 million over 10 years. TransAlta also provided information regarding the operating costs associated with the carbon capture process at Keephills. In the analysis, it is assumed that EOR producers would pay $25/t (2009$) of CO_2 for the duration of the project. As a result, it is estimated that $247 million worth of CO_2 would be used as an input by the EOR producers over 10 years. Finally, there would also be other operating costs incurred by EOR producers over a 10 year span and these are estimated to be $52 million.

Based on preliminary information provided by TransAlta, incremental oil production resulting from the use of Pioneer project CO_2 in EOR schemes could amount to 20.8 million barrels over 10 years. This estimate is subject to additional future work to be conducted with specific EOR operators and fields. In order to value this production, two different pairs of assumptions are used regarding oil prices and exchange rates.

Oil prices of $50US/bbl and $100US/bbl are used to define a range of possible operating impacts. Given the significant sensitivity of the value of the Canadian dollar to oil prices in recent times, alternative exchange rates are assumed in the two scenarios: under $50US/bbl, the exchange rate is $0.80US/Cdn$; under $100/bbl, the exchange rate is $0.90US/Cdn$. Given these assumptions, the incremental oil revenue associated with the use of Pioneer project CO_2 in EOR schemes would range from $1.3 billion to $2.3 billion in the two scenarios.

It can be noted that the expected nominal after-tax rate of return in the EOR projects would range from 9% to 20% given the assumed prices and costs. It is debatable whether a rate of return at the low end of this range would provide enough of an incentive for many producers to engage in EOR development. However, it is reasonable to expect some combination of tax, royalty and/or CO_2 price adjustments to improve the economics of EOR activity may be necessary to meet GHG emissions targets.

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[6] The analysis does take into account the reductions in payments by large emitters to the Climate Change and Emissions Management Fund resulting from reduced emissions associated with Project Pioneer.

Aside from the significant impacts associated with incremental oil production, there would also be another very important consequence of Project Pioneer (or any other CCS project). A value should be attached to the reduction in CO_2 emissions that would result from the project. Although 9.6 Mt of CO_2 are expected to be captured over 10 years, the production of make-up power to offset the parasitic power losses at Keephills 3 could produce an additional 1.9 Mt of CO_2 assuming the replacement power was generated by coal-fired units. Consequently, the net emission reductions as a result of the project would amount to 7.7 Mt over 10 years.

There are a number of ways to value these emission reductions. One possibility is to attach a value to reduced emissions based on some deemed price or perhaps a price determined in a tradeable emissions market. This would then be used to calculate an avoided compliance cost. For example, assuming carbon price of $25/t, the avoided compliance cost would be $192 million.

An alternative valuation technique is to assume that the regional economy would, in the future, be operating at a level where CO_2 emissions were at a set limit or cap. In such a scenario, the reduction in emissions by one part of the economy (for example, coal-fired electricity production) could allow other activity to occur (for example, oil sands production) such that the total limit or cap was not violated. Alternatively, in a world where emission caps may be lowered over time, the reduction of emissions by one industry may avoid the requirement of reductions in the size of another industry.

Concern has been raised regarding the growth in CO_2 emissions in the oilsands industry in Alberta. In the event of more binding policies directed at reducing greenhouse gas emissions, growth in the oilsands would certainly be more likely to be negatively affected than growth in conventional oil and gas or other industries in Alberta.

Given these factors, an operating impact associated with an avoided reduction in oilsands production (and its resultant emissions) is estimated. Given the per barrel CO_2 emissions in integrated oilsands projects, the production of 57 million barrels of oil (or about 155,000 barrels per day over a 10 year period) would generate an equivalent amount of CO_2 to the reductions provided by the Pioneer Project over 10 years. With the price and exchange rate assumptions noted above, the revenue associated with this oil would range from $3.6 billion and $6.3 billion in the $50US/barrel and $100US/barrel price scenarios.

4.0

ECONOMIC IMPACTS OF PROJECT PIONEER

Construction Period Impacts

Construction period impacts in Alberta in terms of Gross Domestic Product (GDP), labour income, government revenues and employment are shown in Table 3.1. Impacts for the expenditures made by TransAlta and partners on Project Pioneer and those made by operators of EOR projects are shown separately along with the totals.

table 4.1

CONSTRUCTION PHASE IMPACTS ASSOCIATED WITH PROJECT PIONEER

(values are in millions of 2009 Cdn $ unless otherwise noted)

	Pioneer	Associated EOR Projects	Total
Capital Expenditures	717	589	1,306
GDP	343	389	732
Labour Income	260	289	549
Provincial/Local Government Revenue	20	24	44
Federal Government Revenue	54	61	115
Total Government Revenue	74	85	159
Employment (in person years)	3,822	3,406	7,228

The $1.3 billion in capital expenditures Project Pioneer and associated EOR projects that would use Project Pioneer CO_2 could be expected to generate $732 billion in GDP in Alberta over the period 2010-2013. Since a significant amount of the materials used, especially in the carbon capture and transportation components of the project, would be sourced from outside Alberta (roughly half from other parts of Canada and half from abroad), the GDP impact would be only about 55% of the capital spending.

However, the bulk of the GDP impact would involve increased labour income ($549 million). Government revenues would increase by $159 million, $44 million of which would go to provincial and local governments in Alberta. These impacts would be distributed over the period 2010-2013.

Expected employment impacts over 2010-2013 range between 3000 and 4000 person years for both the carbon capture/transportation and the EOR components, yielding a total employment impact of about 7200 person years.

Operating Period Impacts

The operating phase impacts associated with incremental oil production from the EOR schemes (over 10 years from 2014 to 2023) that would use Project Pioneer CO_2 are shown in Table 4.2. Note that the impact of the carbon capture and the transportation of the CO_2 to the EOR projects is incorporated in the values shown below. Also included are any effects related to the production of make-up power to offset parasitic load implications at Keephills. Results are presented for the $50US/barrel and $100US/barrel oil price scenarios.

table 4.2

PROJECT PIONEER TEN-YEAR OPERATING PHASE IMPACTS

(values are in millions of 2009 Cdn $ unless otherwise noted)

	$50 US Oil Price	$100 US Oil Price
Incremental Oil Production Revenue	1,292	2,297
GDP	1,245	2,250
Labour Income	124	124
Provincial/Local Government Revenue	181	804
Federal Government Revenue	144	212
Total Government Revenue	324	1,016
Employment (in person years)	1,541	1,541

Since there are very few leakages from Alberta during the operating phase of the project, GDP impacts are very close to the incremental oil revenue in both cases. GDP impacts range from $1.2 billion in the $50US/barrel case (or an annual average of about $120 million) to $2.3 billion in the $100US/barrel case (or an annual average of about $230 million).

Overall government revenue impacts range from $300 million (or about $30 million annually) to $1 billion (or about $100 million annually) in the two cases. The Alberta provincial government would collect substantially higher royalties under the $100US/barrel case than in the $50US/barrel case.

Labour income and employment impacts would be the same under the two price scenarios. Additional labour income of $124 million over the ten-year period would be generated and about 1500 person years of employment would be created.

Table 4.3 shows the impacts associated with the net emission reductions attributable to Project Pioneer that would correspond to additional activity or avoided reductions of oilsands activity (as discussed in Section 2 under Approach and Qualifications).

table 4.3

TEN-YEAR IMPACTS ASSOCIATED WITH EMISSION REDUCTIONS

(values are in millions of 2009 Cdn $ unless otherwise noted)

	$50 US Oil Price	$100 US Oil Price
Value of Activity Reduction Avoided	3,561	6,330
GDP	3,163	5,932
Labour Income	576	576
Provincial/Local Government Revenue	180	1,161
Federal Government Revenue	156	298
Total Government Revenue	336	1,459

GDP impacts would range from $3.2 billion and $5.9 billion under the alternative oil price assumptions. Total government revenue impacts would be between $300 million and $1.5 billion. Provincial government revenues would be very different under the two scenarios since the effective royalty rate would be substantially higher in the $100US barrel scenario. In contrast, labour income and employment impacts would be identical under either price case and would be roughly $600 million and 8200 person years respectively.

Overall Impacts

The overall construction plus operating period impacts over the period 2010-2023 associated with Project Pioneer are shown in Table 4.4. As indicated, the project is expected to generate between $2 billion and $3 billion in Alberta GDP over this fourteen year period. The increases in Labour Income are expected to be about $700 million and combined provincial and municipal revenues are estimated to grow by between $225 million and $850 million.[7] The estimated impact on federal government revenue is between $260 and $330 million while total employment is expected to be approximately 8800 person years.

table 4.4

SUMMARY OF PROJECT PIONEER IMPACTS, 2010-2023

(values are in millions of 2009 Cdn $ unless otherwise noted)

	$50 US Oil Price	$100 US Oil Price
GDP	1,977	2,982
Labour Income	673	673
Provincial/Local Government Revenue	225	848
Federal Government Revenue	259	327
Total Government Revenue	484	1,175
Employment (in person years)	8,769	8,769

It is important to emphasize that these are very conservative estimates. As noted in Section 3 under Construction Expenditures, they do not include an economic value for the net reductions in CO_2 emissions. If total Alberta CO_2 emissions were at some cap, it can be argued that the value of the Project Pioneer CO_2 emission reductions would be the value of economic activity that would otherwise have to be reduced. If that activity was oil sands production, for example, then the impacts shown in Table 4.4 would be substantially underestimated. In that case the total impacts would be those shown in Table 4.4 plus those shown in Table 4.3. In general, this would amount to an approximate doubling of the overall impacts.

[7] Note that the increases in revenue do not take into account any increases in government transfers or tax expenditures that may be required to achieve the assumed EOR activity if oil prices are at or below those shown for the $50/bbl case.

5.0

IMPACTS OF ADOPTION BY OTHER SECTORS

Importance of CCS

Canada has one of largest concentrations of energy resources in the world. In Alberta alone this includes remaining potentially recoverable resources of about 50 billion barrels of conventional oil, over 170 billion barrels of unconventional oil, more than 600 billion tonnes of coal, 150 trillion cubic feet of conventional gas and perhaps as much as 1000 trillion cubic feet of unconventional gas. In a world where there will continue to be a growing demand for energy, this large resource base has the potential to be a cornerstone of comparative advantage and sustainable prosperity for the province and for Canada.

However there are major challenges to converting this potential into reality. Along with the growing technological challenges in producing lower quality and/or higher cost hydrocarbon resources, there are growing environmental constraints involving land use, water restrictions, resource access and greenhouse gas emissions. The latter, particularly in the form of CO_2, are likely to present the greatest challenges. Put differently, without a method to deal with these emissions from carbon intensive energy, the huge potential energy advantage for Canada cannot be realized.

In this context it is clear that the gains from advancing the commercial implementation of carbon capture and storage (CCS) can be very large. To the extent that Project Pioneer proves to be a successful pilot project and advances the economic and efficient implementation of CCS, it could generate large gains. The objective here is to provide some indication of the relative size of those potential gains.

Potential Impacts Associated with Implementation of Project Pioneer Technology

To provide an indication of these gains, it is assumed that 70% of the coal-fired electricity generation capacity in Alberta could be retrofitted with carbon capture facilities over a 10 year period starting in 2016. TransAlta has provided an estimate of capital costs of $3.8 billion associated with these retrofits, assuming a fully commercialized CCS technology with an estimated cost of about $700M per unit. In addition, TransAlta has estimated that another $3.0 billion could be spent by oil and gas producers on carbon capture facilities, assuming a CCS installation base of six oil & gas facilities with costs of approximately $500M per facility.

The carbon captured by coal plants and oil and gas producers could be used extensively in EOR schemes. However, with carbon capture on such a scale, it may be difficult to find sufficient suitable reservoirs to make use of all of the CO_2. It is impossible to predict exactly what proportion of the captured CO_2 would be used in EOR but, for illustrative purposes, 30% is assumed in this analysis.

The operators of the EOR schemes would also incur capital expenditures in this scenario. Ratios of capital spending to CO_2 usage taken from the Pioneer project suggest that the corresponding capital costs for the EOR producers in this scenario would amount to about $1.8 billion.

All of these capital expenditures would generate impacts on GDP, labour income, government revenues, and employment like those described in the previous section for just the Pioneer project. Table 5.1 illustrates these impacts along with the operating impacts that would result from running the associated EOR projects for 10 years. Unlike the results shown in Section 4 for the Pioneer project, no results are calculated here for potential impacts associated with the value of reduced emissions or, alternatively, the amount of economic activity foregone if, in the absence of application of CCS, reductions in industrial production are required to meet caps on CO_2 emissions.

table 5.1

ECONOMIC IMPACTS ASSOCIATED WITH BROADER IMPLEMENTATION, 2016-2025

(values are in millions of 2009 Cdn $ unless otherwise noted)

	Capital Spending			Operations	
	Coal	Oil & Gas	EOR	$50US	$100US
Capital Expenditure/Oil Revenue	3,764	2,990	1,849	4,057	7,213
GDP	1,801	1,431	1,222	3,909	7,064
Labour Income	1,364	1,083	908	389	389
Provincial/Local Government Revenue	104	83	75	567	2,523
Federal Government Revenue	281	223	191	451	666
Total Government Revenue	385	306	267	1,018	3,190
Employment (in person years)	17,876	14,201	11,999	4,839	4,839

Under the assumptions of this analysis, capital spending by the various parties would generate about $4.5 billion in GDP, $3.4 billion in labour income and create about 44,000 person years of employment. The operations of EOR facilities that used captured CO_2 would produce between $4.1 billion and $7.2 billion in revenues under the alternative oil price assumptions ($50US/barrel and $100US/barrel) and would generate between $0.6 billion and $2.5 billion in provincial government revenues.

It is important to note that in the case of a binding CO_2 emission cap, the impacts can be expected to be much larger and likely about twice as large. That is, in such circumstances other activity such as unconventional oil production or other industrial production may have to be reduced in the absence of CCS to avoid exceeding the cap. The impact of this avoided reduction in activity would then represent the economic impact value of the CO_2 emissions reductions arising through CCS implementation based on the Project Pioneer pilot.

Unlike the results shown in Section 4 for the Project Pioneer, no estimates are made here for this value of reduced emissions. However, based on the results in that Section (see Table 4.3), incorporation of the associated impacts would lead to an approximate doubling of the size of the impacts shown in the table and graph on the previous page.

Although the results above are very sensitive to numerous factors, it is clear that widespread implementation of carbon capture and use of captured CO_2 in EOR schemes could be expected to produce very substantial economic gains.[8]

6.0

CONCLUDING THOUGHTS

Based on preliminary economic analysis, Pioneer will create long-term, well-paying jobs, enhance oil recovery efforts, make the most of existing investments in energy infrastructure, and provide much needed revenue for vital government services. The project will also provide regional economic stimulus with the majority of new jobs concentrated in rural Alberta. It will also support the many Albertans employed in the oil, gas, coal and mining sectors, as well as the many industries that serve them.

Pioneer is ideally situated close to operating oil fields where the extracted CO_2 can be used for enhanced oil recovery (EOR). From this one facility, there is the potential to generate up to $850 million directly for the province through incremental royalties and taxes on this EOR activity alone.

Through Pioneer, Alberta can also develop a specialized and highly sought after expertise in carbon capture and storage (CCS). Most of the detailed engineering work for the capture and sequestration facilities will be completed in Alberta.

However, successful economic CCS will depend on visionary government policies and funding mechanisms, like other historic Canadian infrastructure projects such as the Canadian Pacific railway, the TransCanada natural gas pipeline, and the St. Lawrence Seaway. Alberta and Canada have the opportunity to be world-leaders in a technology that will ultimately result in increased revenue for the federal and provincial governments, as well as positive impacts on both the federal and provincial economies.

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[8] Note that this analysis does not take into account the cost of any government spending or tax expenditures that might be required to achieve the assumed adoption of the Project Pioneer CCS technology.

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