UNIVERSITY OF CALGARY

INSTITUTE *for* SUSTAINABLE ENERGY, ENVIRONMENT *and* ECONOMY

iseee

# Energy and the Alberta Economy: Past and Future Impacts and Implications


***Robert L. Mansell***
***Ron Schlenker***


***Paper No. 1 of the Alberta Energy Futures Project***

**December 15, 2006**

**Title:** Energy and the Alberta Economy: Past and Future Impacts and Implications

**Authors:** Dr. Robert L. Mansell and Mr. Ron C. Schlenker

**Affiliation:** Robert Mansell (PhD Econ) is Professor of Economics, Special Advisor to the President on Energy and Environment and Managing Director of the Institute for Sustainable Energy, Environment and Economy (ISEEE), all at the University of Calgary. Mr. Schlenker (B.Eng, MA Econ) is Instructor in the Department of Economics and Research Associate in ISEEE.



**The Institute for Sustainable Energy,**
**Environment and Economy**
**Room 220, CCIT Bldg.**
**University of Calgary**
**2500 University Drive NW, Calgary, AB T2N 1N4**
**Ph. 403-220-6100; Fx. 403-210-9770; info@iseee.ca**
**www.iseee.ca**

## ABOUT ISEEE

The Institute for Sustainable Energy, Environment and Economy (ISEEE) is a not-for-profit institute at the University of Calgary. It is an initiative of the President of the U of C, formed in 2003 and guided by a Leadership Board consisting of:



**ISEEE's Mission**: ***Investing in collaborative, multidisciplinary and mission-oriented research, education and innovation for secure competitive energy, a clean environment and a strong economy.***


**Funding:** ISEEE and associated researchers receive funding from the University of Calgary, from a wide range of provincial, national and international granting councils and organizations (including Alberta Ingenuity, the Alberta Energy Research Institute, the Canada Research Chairs program, Canada Foundation for Innovation, the Natural Sciences and Engineering Research Council and the National Science Foundation), from various federal and provincial government departments, and from a wide range of private and corporate donors (the latter include Direct Energy, Enbridge Inc., EnCana Corp., Nexen Inc., Shell International/Shell Canada, TransAlta and TransCanada Corp.).

**Funding for the Alberta Energy Futures Project through a grant from the Alberta Department of Energy is gratefully acknowledged.**

# PREFACE

The energy sector has been a dominant factor in Alberta's development and growth over the last half-century. The large capital investments and operating expenditures associated with finding and producing oil and gas have directly provided a major stimulus to the economy. But the indirect and induced impacts have been equally important. The development of many other industries supplying inputs to the energy sector, the generation of substantial export and government revenues, and the stimulus for large inflows of people have resulted in large 'multiplier' effects. In combination, these have also played a major role in shaping Alberta's 'character' which is generally distinguished by its highly educated, adjustable and entrepreneurial labour force, low unemployment and high labour force participation rates, strong work ethic and sense of self reliance, and its optimistic outlook.

In recent years the energy sector has become even more dominant and has increasingly made Alberta a key driver of the national economy. In a world with a rapidly growing demand for energy, having one of the largest concentrations of energy resources in the world might seem to translate into an assured, prosperous future. There is clearly huge potential associated with unconventional oil and gas, coal, remaining conventional resources and with alternative and renewable energy. However, translating this potential into reality will be daunting. Increasing constraints related to resource access, environmental impacts, infrastructure requirements, and availability of highly qualified people need to be addressed. Other challenges include the massive long-term investments in developing and implementing new technologies and making the right changes in the policy and regulatory framework. Indeed, the fact that relatively few nations have managed to convert resource wealth into high standards of societal welfare is a useful reminder of the magnitude of the challenges.

Alberta is in many respects at a crossroads. On the one hand complacency will almost certainly mean a dimming of the province's long-term prosperity. Declines in the conventional oil and gas sector will significantly dampen growth and prosperity. There are no other sectors of the province's economic base that could realistically expand sufficiently to offset significant declines in the dominant energy sector. On the other hand, visionary, strategic investments today can unlock non-conventional and other energy resources critical to securing a strong and prosperous long-term, sustainable future for the province.

It is in this context that ISEEE has undertaken a series of papers focused on Alberta's energy futures. The intent is to take a longer term look at the challenges, opportunities and choices and what they mean for Alberta's future. This first paper provides both a retrospective and a prospective overview of the impacts of the oil and gas sector. It is intended to frame and highlight the longer term issues and provide an anchor for more detailed analysis in subsequent papers.

# EXECUTIVE SUMMARY

***Objectives.*** The main objective is to provide an overview of the historical and future role of oil and gas in the development and performance of the Alberta economy. The main conclusions are summarized below.

***Alberta's Economic Performance.*** Over the period since the 1960s the Alberta economy has exhibited substantial variation but higher than average growth. On average over this period annual output (GDP), population and employment growth have been, respectively, 1.0, 0.8 and 1.0 percentage points above the national average. In recent years, output per capita has been between 20 and 30 percent above the national average and income per capita has increased to about 15 percent above that for Canada. On average, unemployment rates in the province have been 2 percentage points below the national rate. These factors have resulted in high levels of net in-migration which has had very significant positive effects on average age, education and skill levels.

***Oil, Gas and Development.*** Oil and gas can be classified as a 'key' or 'motor' industry. It has been a major factor in generating growth and prosperity in the province and transforming much of the structure and character of the economy. These effects can be easily seen in a comparison of the development of the Alberta and Saskatchewan economies. The oil and gas industry is the main reason why today the Alberta economy is about three times the size of Saskatchewan's even though the Saskatchewan economy was slightly larger than Alberta's prior to the Leduc discovery.

***Oil and Gas Industry Performance.*** While conventional oil production has been in decline for the past two decades, this has been offset by gains in production associated with the oil sands. After rapid growth, particularly over the 1988-1998 period, conventional natural gas production has now begun to decline. The ramifications of the this trend are huge, especially given that gas and gas liquids currently account for about 60 percent of the total value of oil and gas production and over two-thirds of total resource revenues paid to the provincial government.

The investment associated with the oil and gas industry has traditionally accounted for about 40 percent of total investment in Alberta. This, combined with the high production revenue and exports associated with oil and gas, has been the major driver of the Alberta economy. This investment is closely linked to total industry revenues with, on average, the industry reinvesting about two-thirds of net revenue (gross revenue minus operating costs and royalties).

***Cumulative Impacts of Oil and Gas – 1971-2004.*** Over this period the oil and gas industry accounted for over $1.5 trillion in GDP or value added (or an annual average of $45 billion) for the province, about $600 billion in labour income (or an annual average of $18 billion), about $280 billion in government revenues (or an annual average of $8.1 billion) and nearly 12 million person-years of employment (or an annual average of 375,000 person-years). All monetary values are expressed in terms of constant 2005 dollars.

***Impacts Relative to the Overall Economy.*** Without the oil and gas industry, the Alberta economy, measured in terms of GDP, would, on average over the 1971-2004 period, be about 42 percent smaller than with this industry. Or, using recent years or the 1975-1985 period, the economy would be about half the size. For example, without the oil and gas industry, provincial GDP would have been only 47 percent of what it actually was in 2004. As another example, it might be noted that in the absence of just the oil and gas royalty payments in 2004, all other things equal, it would require a provincial sales tax of about 16 percent to make up for the revenue.

These estimates of the impacts on GDP are no doubt significant underestimates. They take into account the direct and indirect impacts associated with the oil and gas industry but not the induced impacts. Consequently, the impacts associated with such things as the reserve additions from reinvestment by the industry, the additional government expenditures arising from the higher non-renewable resource revenues or the development of the petrochemical industry are not taken into account.

***Future Revenues.*** Economic impacts have been projected for the period to 2014 using an input-output model and projections for oil and gas production and prices. These suggest more or less constant revenues over the forecast period as rising oil sands production is offset by falling natural gas production. Without the growing natural gas revenues experienced over past decades, there will be considerable downward pressure on Alberta's economic performance. Non-renewable resource revenues accruing to the provincial government (primarily in the form of royalties) are projected to decline from the recent average of about $10 billion annually. Using a conservative energy price forecast, future non-renewable resource revenues could average about $5 billion annually. There is, however, the possibility of a smaller decline with higher sustained oil and gas prices.

***Macroeconomic Implications.*** The average annual contribution of the industry to provincial GDP is projected to be $87 billion per year and would comprise 40 percent of overall provincial GDP. This percentage is slightly lower than that observed in the historical period (42 percent) but remains substantial. The relative contribution of the sector to employment in the province is forecast to increase from 31 percent in the historical period to 37 percent in the forecast period. Roughly 740,000 jobs per year would be attributable to the oil and gas sector between 2005 and 2013. Annual contributions to provincial government revenues (resource revenues and tax revenues directly and indirectly generated by the industry) are expected to average $12 billion.

***Uncertainties, Challenges and Opportunities.*** It is clear that the oil and gas industry will remain the main engine of Alberta's economic growth and prosperity. There are no other sectors with the necessary comparative advantage, size and impact to replace energy as the key driver of Alberta's economy. Yet the relative impetus of this engine is uncertain. While there is the possibility of converting the province's huge energy potential into sustained, long-term prosperity, there are equally large challenges. Without a strong and sustained commitment to meet these challenges, Alberta's prospects will dim.

***Key Challenges.*** The inability of most regions in the world with an abundance of natural resources to successfully convert that advantage into sustainable growth and prosperity is referred to at the 'curse of natural resources.' While Alberta has avoided many elements of this curse (which include tendencies towards inefficiency, growing dependencies on rents to finance consumption {versus investment}, dislocations to other sectors arising from a booming resource sector, and instability), there are some signs that it is now being swayed by some of the more seductive elements.

Other fundamental challenges include gaining clarity on ultimate provincial goals and, specifically, the appropriate balance between extensive growth and development aimed at maximizing total output and income on the one hand and, on the other, intensive growth and development aimed at maximizing the levels and sustainability of average per capita living standards (including quality of life). Without this clarity there is the risk of focusing on means rather than on ends and on symptoms rather than causes.

Discussion is also warranted on the specific role of the provincial government in managing growth. It is suggested, for example, that there would be gains in moving to longer-term social and physical infrastructure planning and funding commitments and, in general, incorporation of more of an asset and risk management framework within the context of energy and environmental policy and regulation. The latter would include a greater emphasis on: preserving, developing and preparing for future options and on minimizing the likelihood of irreversible or very damaging outcomes; diversification, integration and balance in developing our energy technologies and potential; developing well-functioning integrated energy and environment market systems; and, most importantly; investing heavily in developing the human capital (education and skills) to provide assurance that, however the future unfolds, the challenges can be met and the opportunities can be unlocked.

A number of specific challenges were noted, including those related to labour and skills shortages, resource access and landscape issues, infrastructure shortfalls, water and carbon management, and escalating costs. These are discussed at length in other papers in this Series.

***Opportunities.*** Along with these quite daunting challenges there are large opportunities for energy-driven sustainable growth and prosperity. The demand for energy will continue to grow, and with its huge concentration of energy resources, there is the potential for the province to become a leader in clean, competitive, and secure energy. The one thing we can be certain about is that meeting the challenges and unlocking the opportunities will require a clear vision and long-term commitments to that vision. It will require major, sustained investments in the development of people, infrastructure, technologies and policies focused on cleaner and more efficient ways of recovering, using and upgrading our large fossil fuel base, systematic integration of energy and environmental systems and, in general, a shift in policy and regulatory frameworks to better embody asset and risk management strategies appropriate in an environment of risk and uncertainty.

# CONTENTS

# LIST OF FIGURES

# 1. INTRODUCTION

## 1.1 Overview

In many respects Alberta is today at a crossroads. Energy demand and prices are strong, investment in the sector is robust and energy revenues flowing to the provincial government have recently been near historical highs. This has all translated into a rapidly growing and prosperous economy.

However, there are substantial structural changes occurring in the energy sector and there is much uncertainty about what these will mean for Alberta's future. Conventional natural gas production, which accounts for by far the largest component of the province's energy revenues, has now begun to decline and this is on top of the secular decline in conventional oil production. These trends, combined with ever-increasing environmental constraints (from water restrictions to resource access and emissions) present major challenges for the Province. Consider, for example, the serious implications of declines in conventional gas production in terms of the effects on provincial government royalty revenue, on petrochemical feedstocks, on electricity production, on heat and hydrogen to recover and upgrade oil sands resources and on provincial exports.

At the same time there remains considerable potential for development of energy production and value added to offset these declines. The potential associated with unconventional oil (oil sands) and gas (particularly tight gas and coal bed methane) alone is much larger than that associated with the original in-place conventional oil and gas reserves. Added to this is the considerable potential associated with coal and alternative / renewable energy. Further, the prospects for continued growth in global energy demand relative to supply, the associated strong prices and the existing strengths of the oil and gas industry in Alberta would seem to provide a strong base for translating this potential into reality. With strong and visionary leadership, strategic investments in developing and implementing new and improved technologies and an appropriate economic and policy environment, there would seem to be the potential for the energy sector to be a major contributor to the development, growth and prosperity of the Alberta economy for many decades to come.

It is far from a given that the considerable challenges associated with converting this huge energy potential into sustained prosperity will be met. Indeed, the historical record suggests that more often than not resource-rich regions and nations have not been able to do this. The boom and bust cycles are difficult to tame and can easily distort the economy and impair the development of other sectors. Further, there is typically a tendency to take the energy resource rents for granted, and to use them to fund consumption activities without recognition of the need to reinvest a significant portion in order to achieve sustainability and stability.

## 1.2 Objectives

The main purpose in this study is to provide an overview of what these challenges and opportunities mean for the province. We begin by examining the historical role of the energy sector in the Alberta economy and the nature of the mechanisms through which it impacts the economy. With this we can gain a better understanding of what future changes and options for this sector will mean for the province and the nation. We also examine the future role and impacts of the energy sector given current projections for oil and gas production and prices. This provides a framework for evaluating alternatives – meeting challenges and seizing opportunities.

Specific objectives include:

(i) providing the necessary background to generally understand and assess the role and contributions of the oil and gas sector and the implications for Alberta

(ii) quantifying the impacts of this sector (and each of the main components) on the various dimensions of the Alberta economy (for example, value added (or GDP), employment, incomes and government revenues), and

(iii) outlining the main challenges and opportunities and their implications for Alberta's future growth and prosperity.

## 1.3 Important Notes

Throughout this study there are values (prices, revenues and so on) spread over numerous years. To allow meaningful comparisons across time it is necessary to remove the effects of inflation (i.e. the decline in purchasing power of a dollar over time as a result of general inflation). This involves converting all monetary values into real or constant dollar values. **Unless otherwise indicated, the monetary values in this study are all expressed in terms of constant 2005 Canadian dollars.**

Further, the focus in this study is on the oil and gas sector rather than the broader 'energy sector.' Oil and gas accounts for about 99 percent of Alberta's revenues from coal, oil and gas production. Nevertheless, coal and renewable/alternative energy may become significantly more important in the future. Given the time and budget constraints for this study, it was not possible to develop and incorporate quantitative estimates of the impacts of these other energy sources.

# 2. BACKGROUND

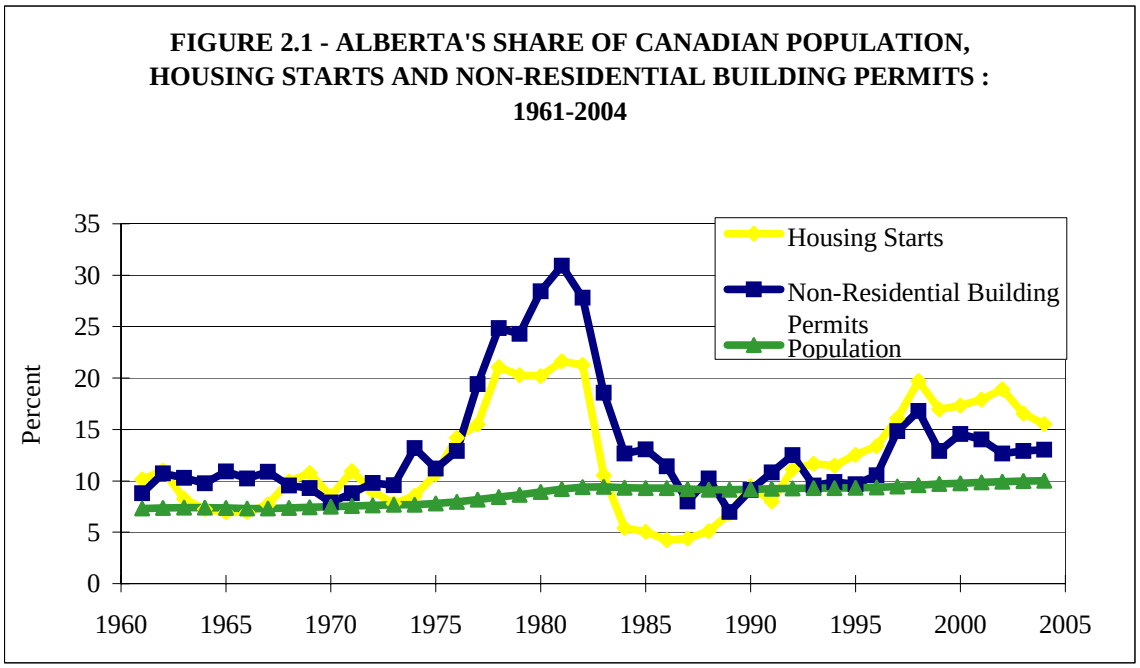
## 2.1 Alberta's Economic Performance

### *Main Phases.*

Although the focus in this section is primarily on the province's economic performance in more recent periods, it is useful at the outset to provide a longer-term context. This is done by breaking the past four decades or so into distinct phases.

These main phases can be identified by examining patterns for such variables as employment growth rates, migration, population, and investment. To illustrate, Alberta's share of total population, housing starts and non-residential building permits is shown in Figure 2.1.

Figure 2.1



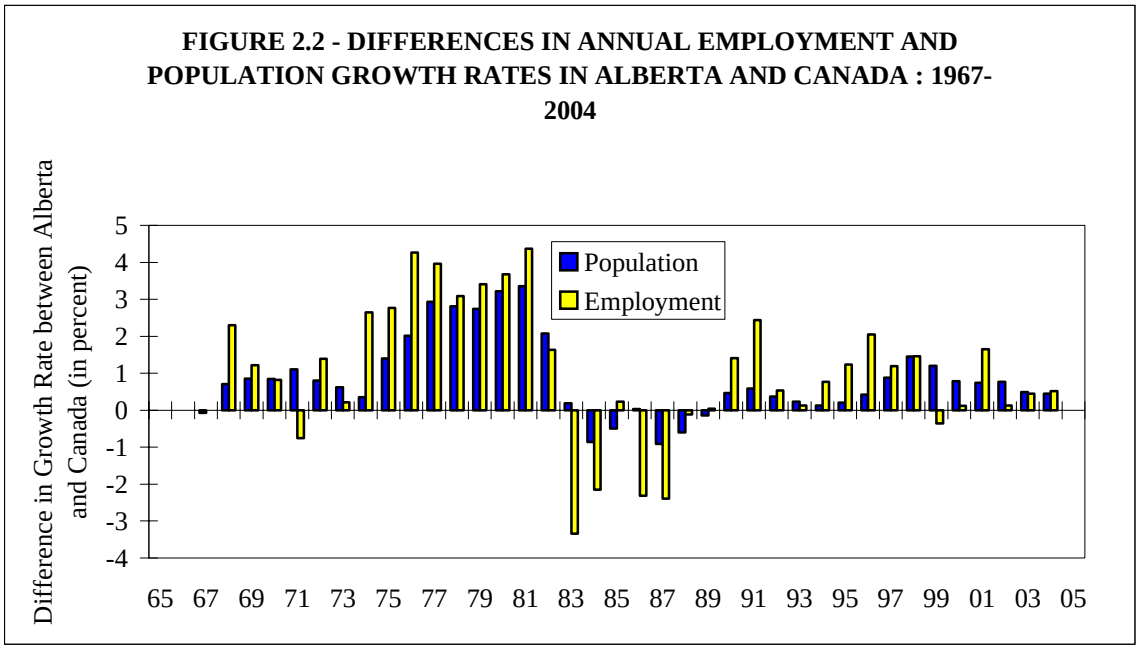

**Source: Data from Statistics Canada, CANSIM 260003, 270009, 51005**

Over most of the 1950s and 1960s the provincial economy generally performed at a level slightly above the national average. There were, however, some years, such as the mid-1960s, when Alberta's growth rates were significantly below those for the nation. During this period, the province's share of the national population remained fairly constant at about 7.5 percent.

A significant break in this pattern occurred in the early 1970s. The OPEC-induced rise in world oil prices during that time ushered in a phase of very strong growth. This evolved into a boom that peaked around 1980. During this period Alberta's relative position in terms of population (and employment) increased significantly.

The next major phase was the period starting in the early 1980s, when a combination of federal government policy (particularly the National Energy Program), high interest rates and unsustainable expectations with respect to asset prices resulted in a major bust.[1] The performance of the Alberta economy relative to that for the nation fell dramatically. As shown in Figure 2.2, annual growth rates in employment and population were much lower for Alberta over most of the period after 1982 until 1990.

Figure 2.2




**Source: Data from Statistics Canada, CANSIM 2820001, 510005**

Following the initial bust and after the first signs of a recovery, crude oil and grain prices collapsed in 1985 and the provincial economy was again pushed down to levels well below the national average. It would take until the late 1980s before the Alberta economy would recover to the point where employment growth was again near the national average.

Alberta avoided the national recession in 1991, and by the early 1990s was well on its way back to consistently outperforming the national economy. The most recent period of above-average performance began just after 1995. This has once again resulted in growth in Alberta's relative population, employment and income position. However, as evident in Figures 2.1 and 2.2, the growth of the economy over this period has been significantly less than that observed during the 1970s boom. Put differently, Alberta's strong performance during recent years would not be characterized as a full 'boom,' although at times it has approached boom conditions. Market conditions in some sectors such as construction have been very tight and there have been worrisome signs of overheating.

[1] For a more detailed discussion of these factors, see R. Mansell and M. Percy, *Strength in Adversity: A Study of the Alberta Economy*, Western Centre for Economic Research and C. D. Howe Institute, 1990.

However, there have not been the types of broad and rapid price increases, substantial increases in debt / equity ratios and unsustainable expectations seen in the boom during the 1970s.[2]

Over the period as a whole since the 1960s, annual population growth for Alberta has averaged 0.8 percentage points above that for Canada. In the case of employment, the growth rate in Alberta has on average been about 1.0 percentage points above that for the nation.

## *Dimensions of Economic Performance.*

Here the focus is on the period since the 1970s. Alberta's performance in terms of a variety of economic measures is summarized below.

### *Output*

One of the broadest measures of overall economic output is Gross Domestic Product (GDP).[3] Figure 2.3 shows annual growth rates for Alberta and Canadian 'real' (or constant dollar) GDP. Over the period, real GDP growth for Alberta has on average been over 1 percentage point above that for Canada. However, there has tended to be significantly higher levels of variability in Alberta's overall economic performance than for most other Canadian regions.[4]

### *Productivity*

Output per capita in the province has generally been well above (17 percent on average) that for the country as a whole – see Figure 2.4. In the late 1990s it was almost 30 percent above the Canadian average and it is currently about 20 percent higher (in 2003 it was approximately $42,000 compared to $35,000 nationally).

---

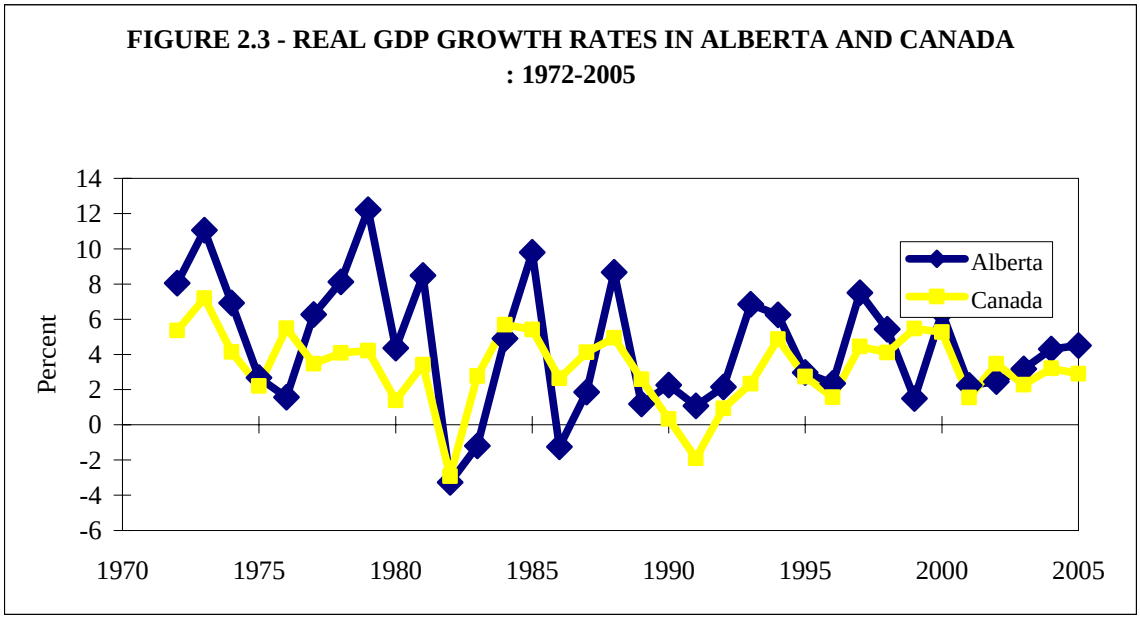
[2] Key elements of boom conditions, such as those experienced in the late 1970s and into 1980, include:

- Real energy prices at historical highs.
- Investment close to 40 percent of GDP versus an average of around 25 percent normally; rapid increases in imports as percentage of GDP
- Real GDP growth rates more than double the national average.
- Unemployment rate consistently at around 4 percent or lower.
- Increasing inflation rates, particularly for assets (e.g. housing) not tradable across regions.
- High net in-migration rates near historical highs (approximately 60,000 per year).
- High debt equity ratios.
- Extrapolative expectations for key prices (e.g. oil and gas); increase in speculation and asset trading versus asset development.
- Infrastructure shortfalls; all previous fiscal difficulties began in a period of rapid growth.

[3] GDP (Gross Domestic Product) is the total value-added or, alternatively, the sum of all final goods and services, currently produced within the geographical borders of the particular region or country.

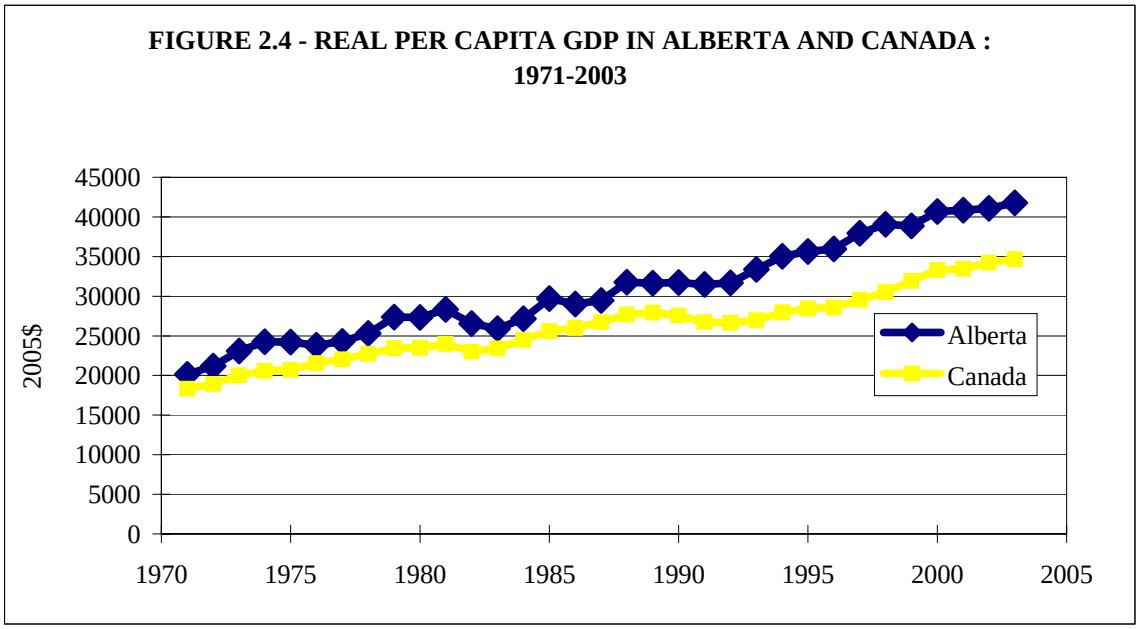
[4] For measures and comparisons of variability, see R. Mansell, 'The Alberta Economy: Changes and Challenges," in *Alberta's Fiscal Frontiers*, B. Dahlby ed., Institute for Public Economics, 2002.

Figure 2.3




**Source: Data from Alberta Treasury, *Alberta Economic Accounts* and Statistics Canada, CANSIM 3840002**

Figure 2.4

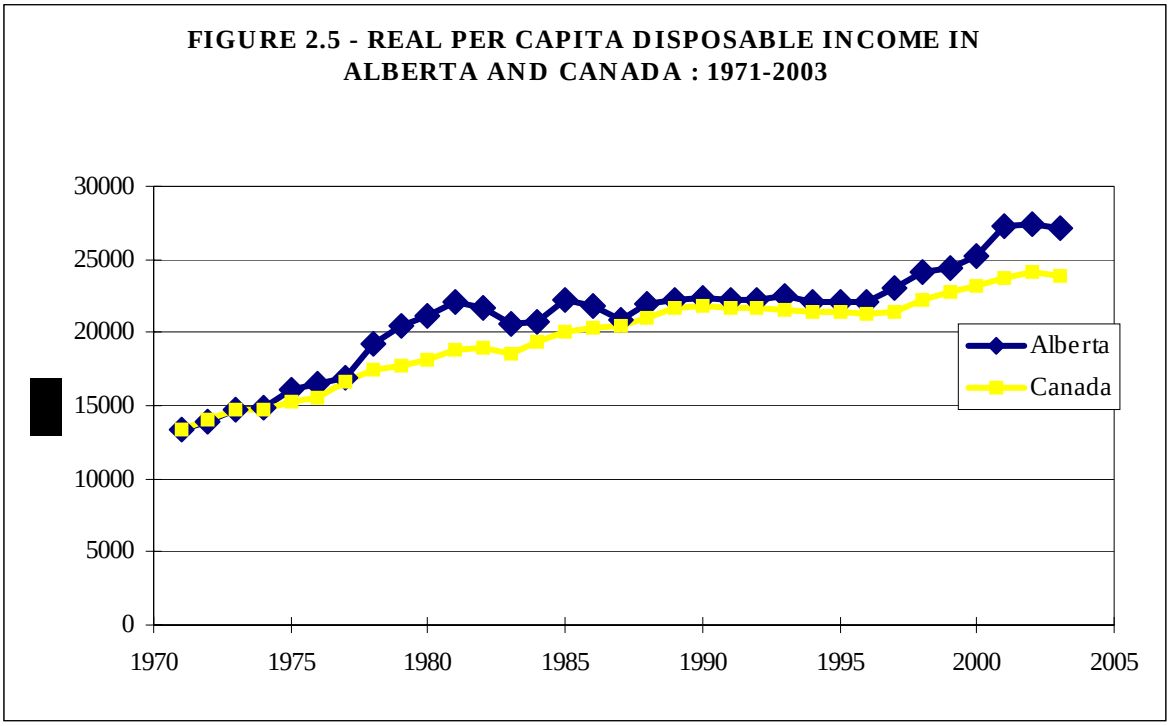



**Source: Data from Alberta Treasury, *Alberta Economic Accounts*) and Statistics Canada, CANSIM 510005, 3840002**

## *Incomes*

While GDP provides an indication of total output or value added, it does not measure incomes accruing to individuals. One standard measure of the latter is Personal Disposable Income.[5] This can be thought of as the amount of income available to individuals after all direct taxes have been paid. After adjusting to take account of inflation (that is, expressing the values in constant dollar or 'real' terms) and expressing the income figures on a per person basis, the trends are as shown in Figure 2.5. Over the entire period, real per capita disposable income in Alberta has on average been about 7 percent above that for the nation. This gap was significantly wider during the earlier 'boom' period and in more recent years. In both of these periods the gap is approximately 15 percent.

Figure 2.5




**Source: Data from Statistics Canada, CANSIM 510005, 3840012**

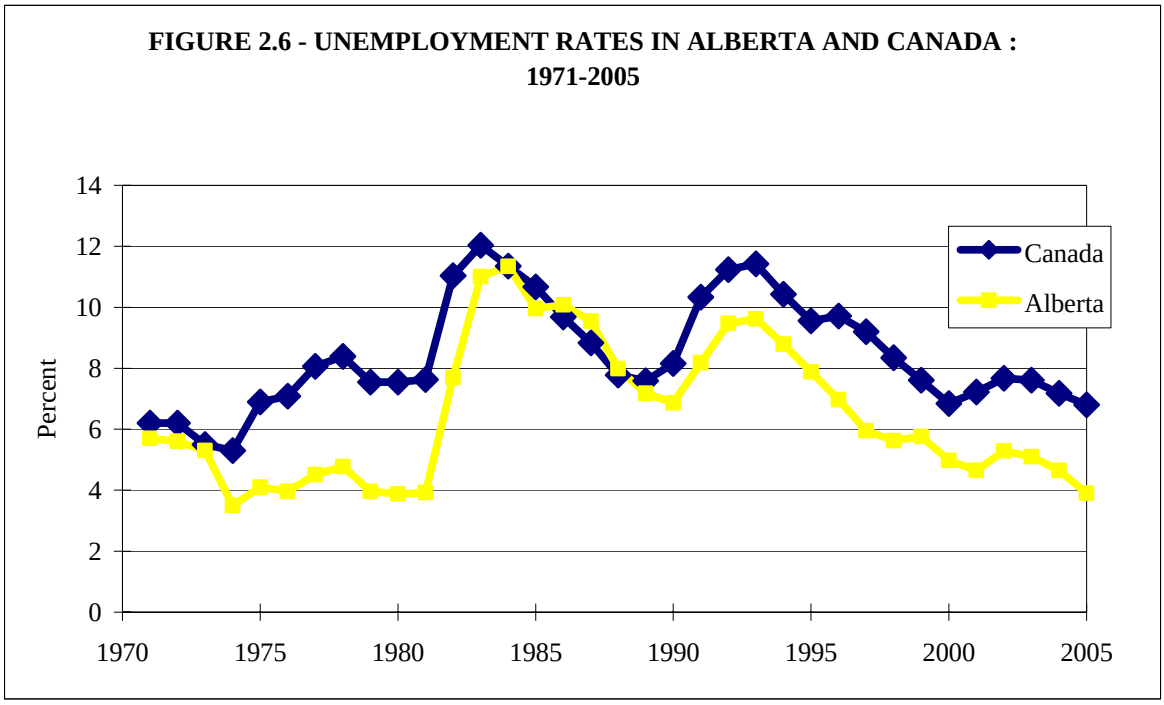
[5] Personal disposable income is the sum of all income received (wages, supplementary labour income, military pay and allowances, net income from unincorporated farming and other business enterprises, interest, dividends, and miscellaneous investment income, and all transfer payments (employment insurance benefits, government pensions etc), less all direct taxes and other transfers directly paid by individuals to governments.

It is useful to note that per capita income level is closely determined by four main factors: wages or income per worker, the labour force participation rate, the unemployment rate and the age structure of the population.[6] In the case of Alberta, the main reasons for higher than average per capita income are the significantly above average labour force participation rates and significantly below average unemployment rates (rather than, for example, salaries that are significantly above the national average).

## *Unemployment*

Over the period 1971 to 2005, unemployment rates in Alberta have, on average, been about 2 percentage points below the rates for Canada – see Figure 2.6.

Figure 2.6




**Source: Data from Statistics Canada, CANSIM 52820001**

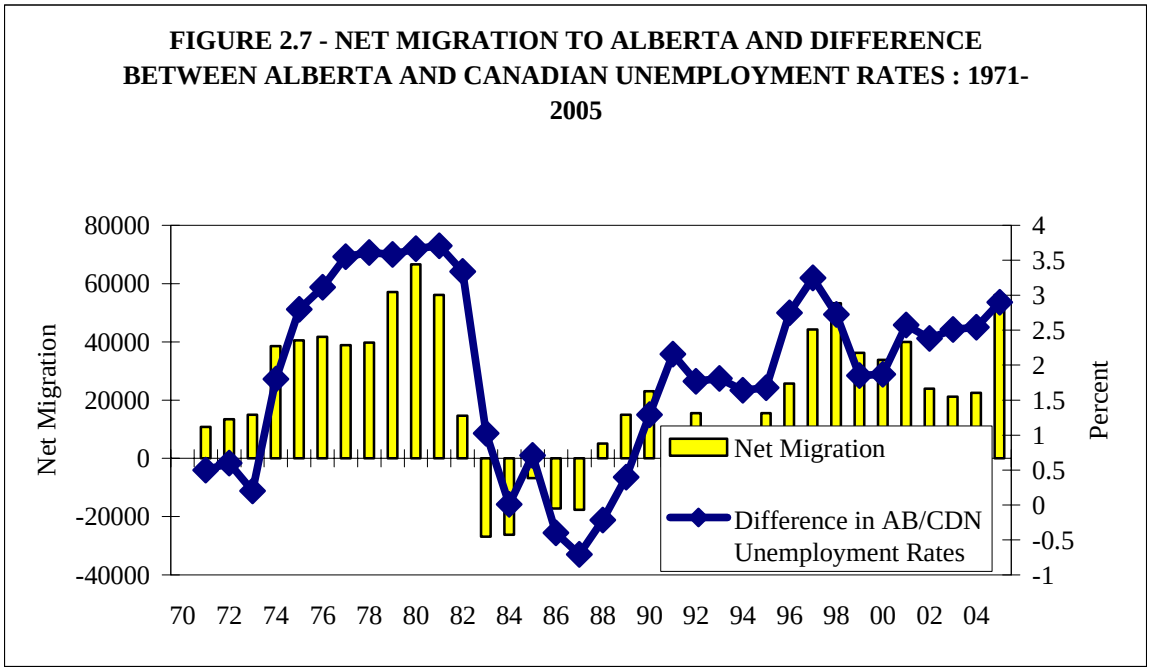
## *Population Growth and Structure*

Population change is a function of natural increase (births minus deaths) and net migration (in-migrants minus out-migrants). In general, the main factor behind the significant regional differences in population growth rates in Canada is differences in net migration rates.

[6] The participation rate is the percentage of the population aged 15 years and older participating in the labour force by being employed or being unemployed but actively seeking employment. The unemployment rate is the percentage of the labour force unemployed but actively seeking work. The age structure in this context primarily refers to the percentage of the population which is 15 years and over and not institutionalized.

As illustrated in Figure 2.7, Alberta has typically had fairly high rates of net in-migration (from other provinces and other countries).[7] Much of this pattern is related to relative performance in terms of income and employment opportunities. For example, net in-migration to the province increases when per capita incomes rise and unemployment rates fall relative to national averages.

Figure 2.7




**Source: Data from Statistics Canada, CANSIM 1110029, 2820001**

The main impacts from this net in-migration arise from the changes in both the size and structure of the population. The additional growth in population provides an economic boost through increasing consumer and infrastructure demand generally, as well as contributing to the labour force to accommodate higher rates of economic growth. At the same time, net inflows of people significantly reduce the average age of the population from what it would otherwise be and raise average education and skill levels. This occurs because migration is highly selective. Migrants tend to be disproportionately from younger age groups (predominately in the 20-35 age group) and tend to have higher education and skill levels. They also tend to be highly motivated to seek out new employment and income opportunities, more willing to take risks and more adaptable to changing economic conditions. These characteristics go a long way in explaining why Alberta has one of the youngest populations in Canada (for example, as measured by median age) and one of the most highly educated (in spite of the low participation rates in advanced education within the province).

[7] As a point of reference, for the period July 1, 2005 to June 30, 2006, net interprovincial migration was 57,105, net international migration was 14,458 and natural increase (births minus deaths) was 21,679. Statistics Canada, CANSIM Table 051-0004.

## 2.2 Oil, Gas and Economic Development

### *Early Development*

Many of the characteristics of Alberta's economic performance can be tied directly to the development of the oil and gas sector.

Although petroleum was discovered in the province before the turn of the 20th century, the major development occurred after 1947 with the discovery of Leduc field. This and subsequent finds set the stage for an investment-generated boom that represented a turning point for the Alberta economy. Prior to this time there was an increasing outflow of people from the province, primarily as a result of capital intensification which was displacing workers from the agricultural sector. By 1950, the population flow reversed and, with the exception of about 10 years in total (a few years in the mid-1960s, early 1970s and early-to-mid 1980s), net in-migration has remained positive and substantial.

### *Alberta and Saskatchewan*

It is interesting to compare the experience of Alberta and Saskatchewan over this period. Prior to the Leduc discovery the provinces were comparable in terms of population and income. For example, in 1945 the respective populations of Alberta and Saskatchewan were 808,000 and 896,000 and total personal income in Alberta was just slightly higher than that in Saskatchewan. By 1971, Alberta's population and income was approximately double that of Saskatchewan (e.g.1,628,000 vs 926,000 people in Saskatchewan) and in 2004, the ratio was more than 3 (e.g. 3,202,000 vs 995,000 people)[8].

While there are a number of factors behind this divergence,[9] there is no doubt that the dominant difference has been the development of the large oil and gas sector in Alberta. This highlights the very dramatic role this sector has played in transforming the Alberta economy and suggests that more than half of the economy can be attributed to the development of the energy sector.

As outlined elsewhere[10] the impacts of the oil and gas sector during this early period closely follow those predicted by the *staple* or *export base* theories of regional development and growth.[11] According to these, the discovery of a staple (petroleum) initially attracts capital and labour to the region. This, combined with subsequent exports of the staple, generates an income and population base which, over time, leads to the development of other industries dedicated to providing inputs to the staple industry and

---

[8] Population figures from Statistics Canada, CANSIM.

[9] For instance, the larger tourism sector and the more pro-development / investment policies in Alberta over time have no doubt been important.

[10] This section is largely quoted from R. Mansell, "Energy Policy, Prices and Rents: Implications for Regional Growth and Development" in W. Coffey and M. Polese (eds.), *Still Living Together: Recent Trends and Future Directions in Canadian Regional Development.* Montreal: Institute for Research on Public Policy, 1987.

[11] For an overview, see J. Richard, "The Staple Debates", in D. Cameron (ed.), *Explorations in Canadian Economic History: Essays in Honour of Irene M. Spry.* Ottawa: University of Ottawa Press, 1985.

serving local markets. The end result is an economy consisting of a large primary sector which exports most of its output, an underdeveloped manufacturing sector, a large service sector, and an industrial structure based on processing raw materials prior to export or on providing inputs to the extractive sector.

## *A Key or Motor Industry*

While this is a fairly accurate description of the Alberta economy as it existed in the late 1960s (and to some extent as it exists today), it overlooks many of the unique contributions of the petroleum industry to economic development in the province. Several of the more important are as follows.[12] First, because of its high capital intensity and the specialized and technological nature of its input requirements, this industry generated strong forward and backward linkages within the province (that is, through the development of businesses that refined or upgraded the product and businesses that provided inputs). The result was large interindustry multiplier effects. In fact, the coexistence of these strong linkages and the concentration of massive amounts of capital that is associated with this industry means it closely fits the classical definition of a "key" or "motor" industry for the purpose of regional development. Second, the high productivity and the requirements for a highly skilled labour force translated into above average wage levels in petroleum and related activities, the development of a skilled labour force in the region, and an impetus for urbanization. Finally, it made substantial contributions to government revenue, which facilitated the development of social infrastructure without the need for high regional taxes.

The emergence of the petroleum sector also played an important role in shaping the character of the Alberta economy. Like agriculture, this sector tends to be typified by capital-intensive production processes, a high degree of risk, externally determined prices, and a large number of independent producing units. Thus, as in the case of Texas, it did not generate a broad base for organized labour. Instead, it laid (or reinforced) the foundation for basically rural-conservative values characterized by rugged individualism, risk-taking, and entrepreneurial awareness. Further, the massive capital requirements involved ultimately meant a strong foreign presence in the province.

By speeding up the urbanization trend and providing the basis for the development of a large managerial/entrepreneurial class, the petroleum sector also played an important role in the political transformation of the province, marked by the election of the Conservatives in 1971.

The model of resource-based determinism represents a useful way of summarizing the role of the energy sector in the development of a small regional economy. Briefly stated, the main hypothesis embodied in this model is that the resource base determines, through the development of various linkages, the region's industrial structure and character; the

[12] These are outlined in E. Hanson, *Dynamic Decade: The Evolution and Effects of the Oil Industry in Alberta.* Toronto: McClelland and Stewart, 1958, and R. Mansell, "Texas and Alberta: A Comparison of Regional Economies," *Texas Business Review* 55, 6:241-246. 1981.

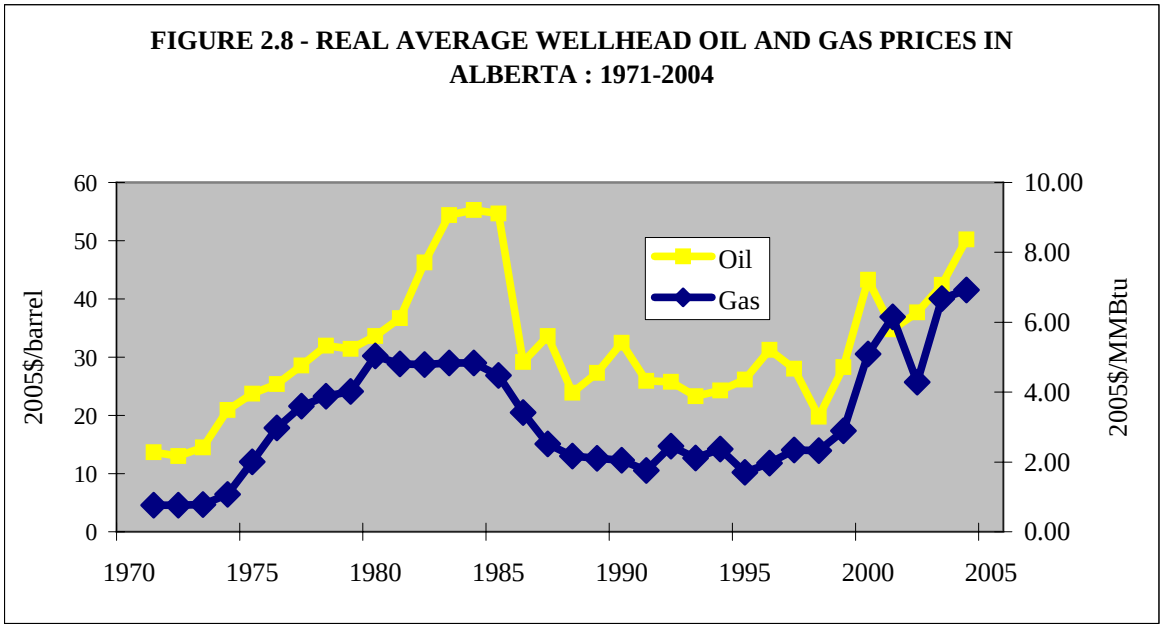
latter, given external events and policies, is a prime determinant of the overall performance of the regional economy.

## 2.3 Energy Industry Performance

### *Energy Prices*

Energy prices have been an important determinant of the performance of the energy sector and its impacts on the provincial economy. The patterns for average oil and gas prices at the Alberta wellhead and expressed in constant (2005) Canadian dollars are shown in Figure 2.8. It should be noted that these are affected by changes in national and international market prices, changes in the exchange rate and, in the period of price controls and the National Energy Program, mandated prices.

Figure 2.8




**Source: Data from Canadian Association of Petroleum Producers (CAPP), *Statistical Handbook***

Alberta's relative economic performance generally follows a pattern similar to that for real energy prices. The high variability in these prices is a significant part of the explanation for the high variability of the provincial economy. While it is possible that future prices could gravitate to the lower levels observed over the period from the late 1980s to late 1990s, there is a well-founded expectation that this will not occur. The decline in conventional oil production capacity in most major producing regions of the world, the decline in conventional gas production capacity in North America, and the longer term growth trends for oil and gas demand all suggest that future prices will generally be significantly above those during the 1990s.

It must be emphasized, however, that there is also a substantial increase in potential volatility. Further, while costs drive energy prices to a degree, it is also true that unit

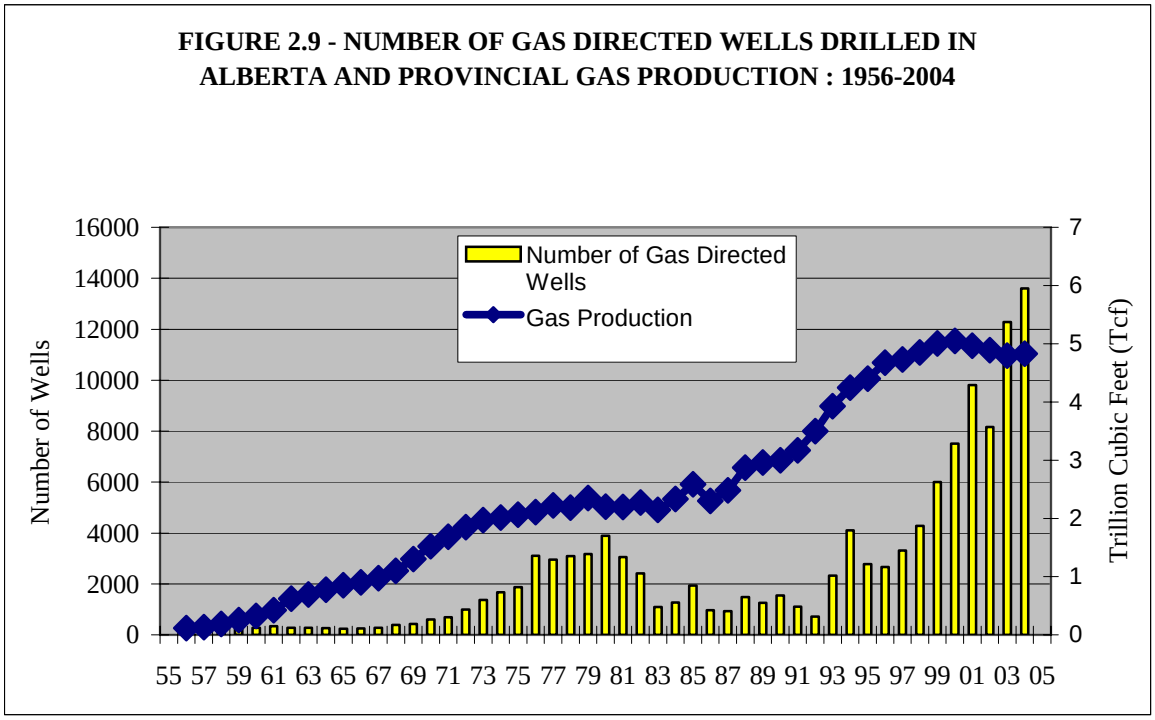
costs for the oil and gas sector are driven by prices. For instance, higher energy prices generally lead to greater activity in the oil and gas industry and, particularly in an economy already operating at close to capacity, this will drive up production costs. Combined with the reality that energy prices are more downwardly flexible than production costs, this means that the oil and gas industry can face substantial retrenchment with falling energy prices even if energy prices remain high relative to historical averages.

## *Oil and Gas Production*

The main impacts of the energy sector on the provincial economy depend on quantities of energy production as well as energy prices.

One of the single most important contributors to Alberta's economic growth, particularly since the late 1980s, has been the rapid increase in natural gas production (see Figure 2.9). For instance, in the period between 1988 and 1998 total gas production in the province doubled. This dramatic increase was possible because of the ramp-up in gas-directed drilling in the 1970s and the relaxation of the regulatory constraints, particularly those involving mandatory surplus tests for export applications. With the high ratio of gas reserves to production in the mid-1980s (or in other words, the high 'inventory' levels) it was possible to rapidly increase production without a concomitant increase in drilling activity.

Figure 2.9

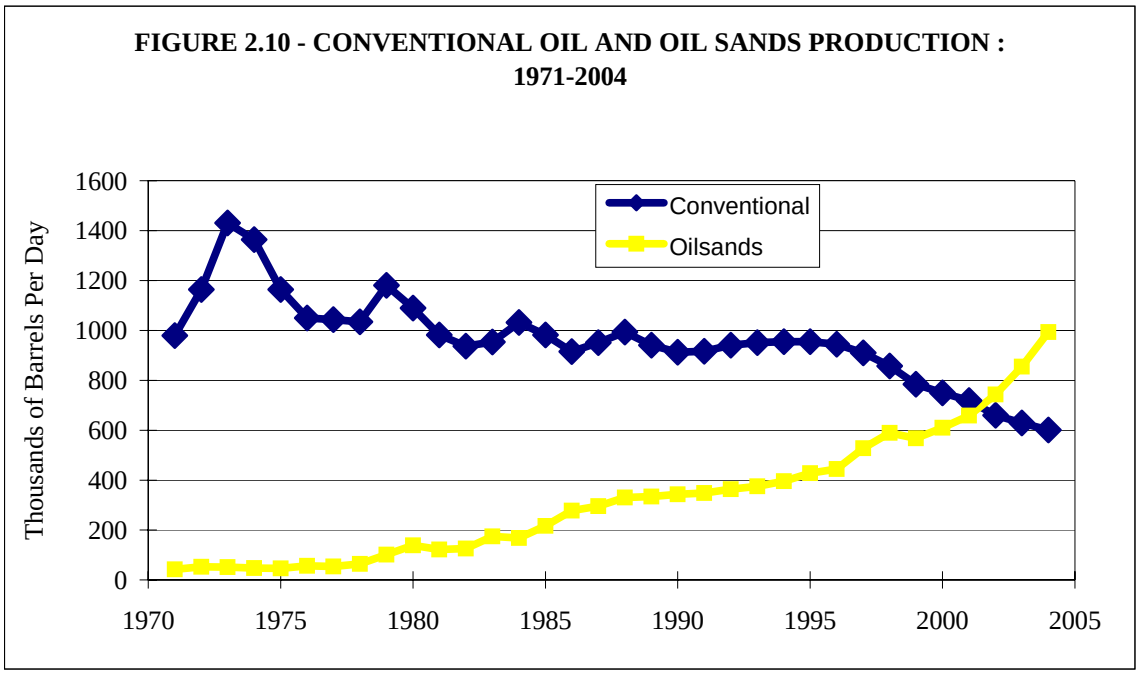



**Source: Data from Alberta Energy and Utilities Board (AEUB), website and Canadian Association of Petroleum Producers (CAPP), *Statistical Handbook*.**

This growth in production translated into substantial increases in exports from the province and in investment expenditures. These were not only associated with production facilities and transmission infrastructure, but also, especially in recent years, with increases in gas-directed drilling activity to record levels.[13] Further impacts over the period have been associated with the increase in gas production, including the expansion of the petrochemical industry as additional production of gas byproducts (primarily ethane) boosted feedstock supplies. Also, there have been rapid increases in royalty and related resource revenues paid to the provincial government. Royalty and related income from gas and gas liquids production now accounts for over two-thirds of total resource revenues collected by the government. As indicated in Figure 2.9, despite the substantial acceleration in drilling activity, production capacity has begun to decline.

The main trends in oil production since 1970 are shown in Figure 2.10.

Figure 2.10




**Source: Data from Alberta Energy and Utilities Board (AEUB) website and Canadian Association of Petroleum Producers (CAPP), *Statistical Handbook***

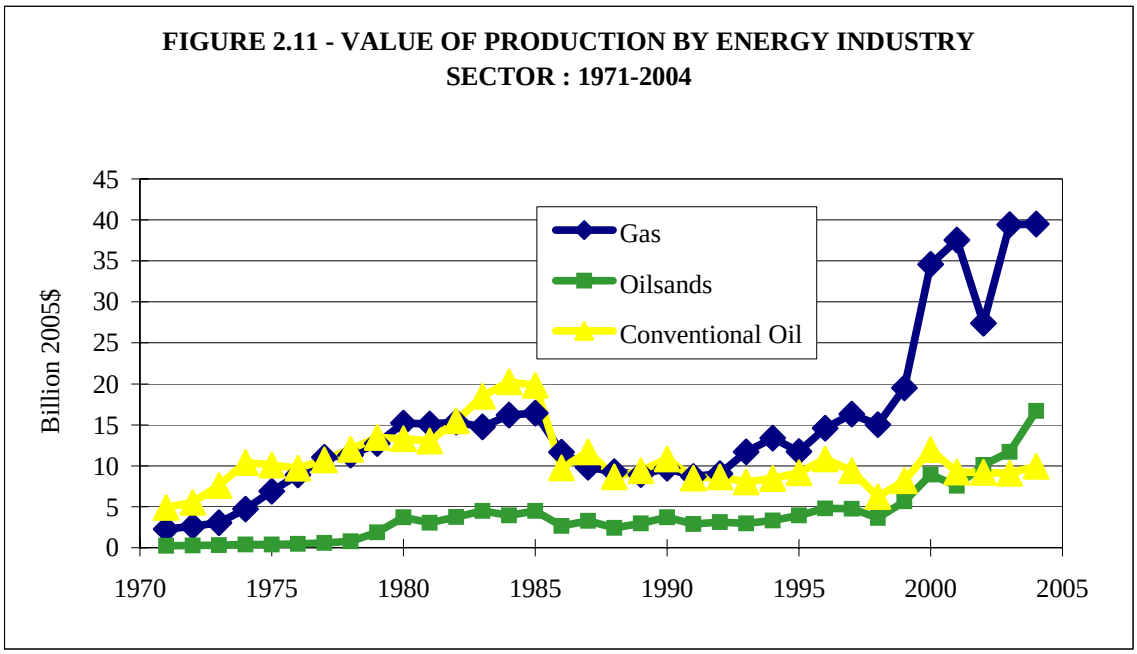
Conventional oil production has been in secular or long-term decline since the early 1970s. During part of the period, gains in heavy oil production were sufficient to offset the declines in light crude. However, since the mid-1990s, with both heavy and light production in decline, the overall decline in conventional oil production has been quite steep. At the same time, there has been steady growth in oil sands production and in 2002, oil sands production surpassed conventional oil production.

[13] It would appear that roughly the same number of gas wells have been drilled in the last seven years as in the previous 43 years. It should be noted, however, that the recent levels are in part a reflection of increased drilling in shallow gas areas of the province.

## *Value of Oil and Gas Production*

Taking into account the price and quantity of production, the total value of Alberta oil and gas production and sales is shown in Figure 2.11.

Figure 2.11



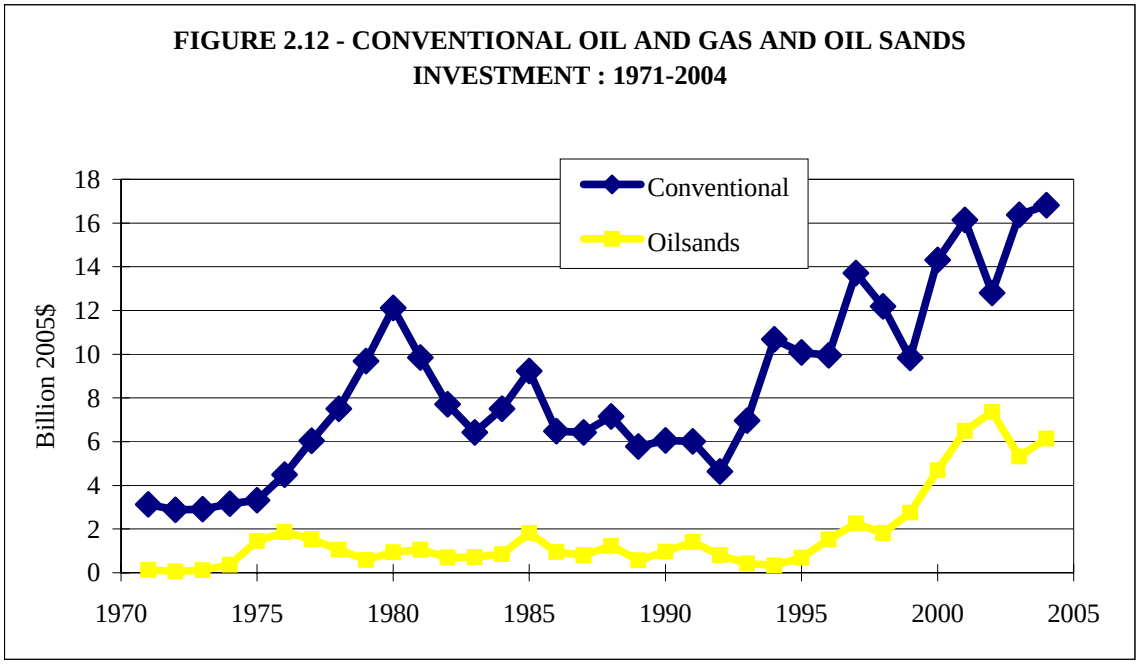

**Source: Data from Canadian Association of Petroleum Producers (CAPP), *Statistical Handbook***

In 2004, the total value was estimated to be $66 billion (measured in 2005 dollars). Natural gas and liquids accounted for $39 billion or almost 60 percent of the total. The respective amounts for oil sands and conventional oil were $17 billion (or approximately 25 percent of the total) and $10 billion (or 15 percent of the total value of production). While higher prices in recent years have helped compensate for the declines in the quantities of conventional oil and gas production, it seems unlikely that future price increases will be sufficient to prevent declines in the value of this production.

## *Oil and Gas Investment*

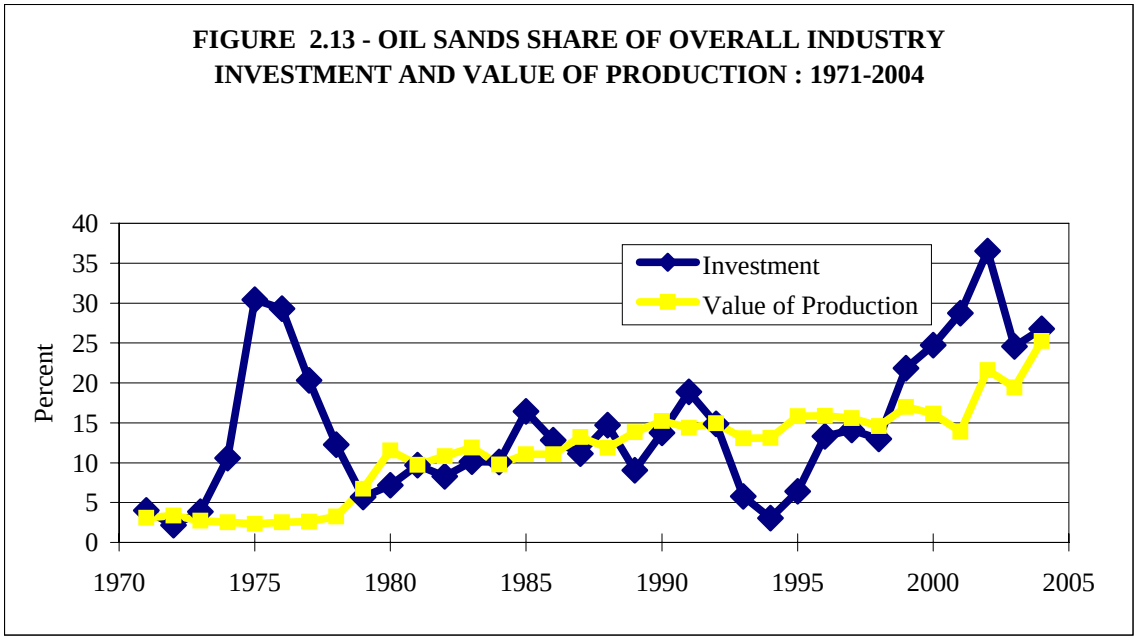
Given the capital-intensive nature of the industry, oil and gas investment is typically large and a major contributor to the overall performance of the provincial economy. This investment has risen dramatically in recent years and in 2004 amounted to $23 billion (see Figure 2.12). Of this total, 73 percent (or $16.8 billion) was accounted for by conventional oil and gas investment and 27 percent (or $6.2 billion) was investment associated with oil sands development. As shown in Figure 2.13, the oil sands share of total oil and gas investment, and value of production, has increased significantly since the late 1990s.

Figure 2.12




**Source: Data from Canadian Association of Petroleum Producers (CAPP), *Statistical Handbook***

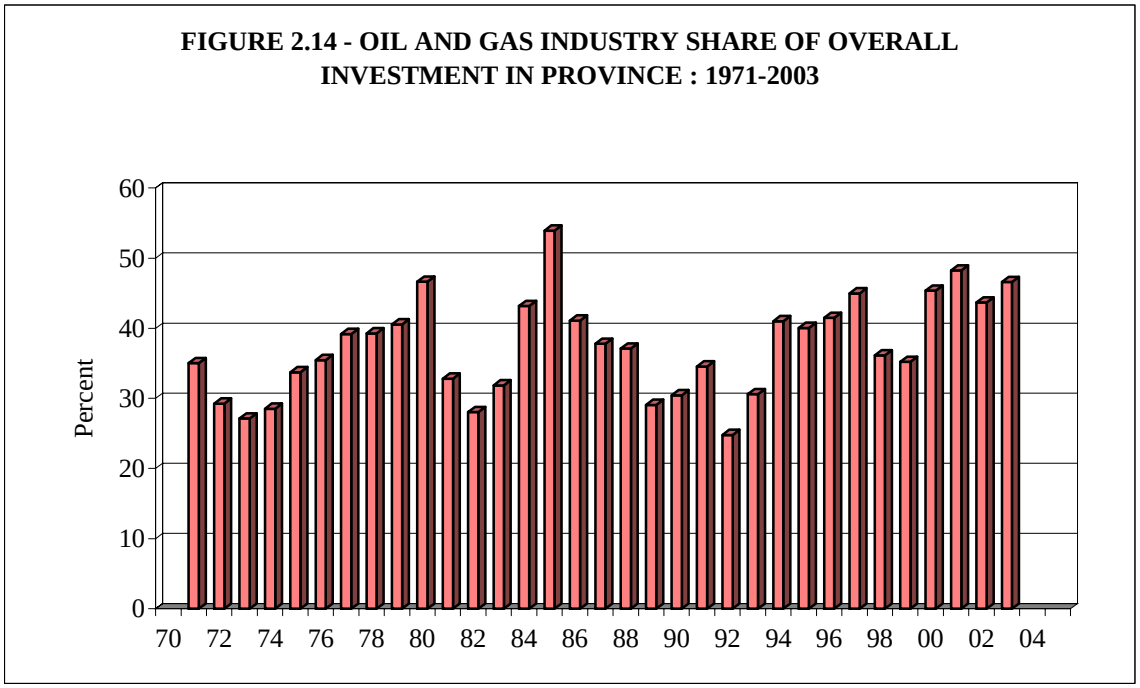
Figure 2.13




**Source: Data from Canadian Association of Petroleum Producers (CAPP), *Statistical Handbook***

These investments dominate, by a wide margin, the investment expenditures associated with any other sector of the provincial economy. As illustrated in Figure 2.14, oil and gas industry investment has averaged 37 percent of total investment in Alberta for the period as a whole and 40 percent for the period since 2000.

Figure 2.14



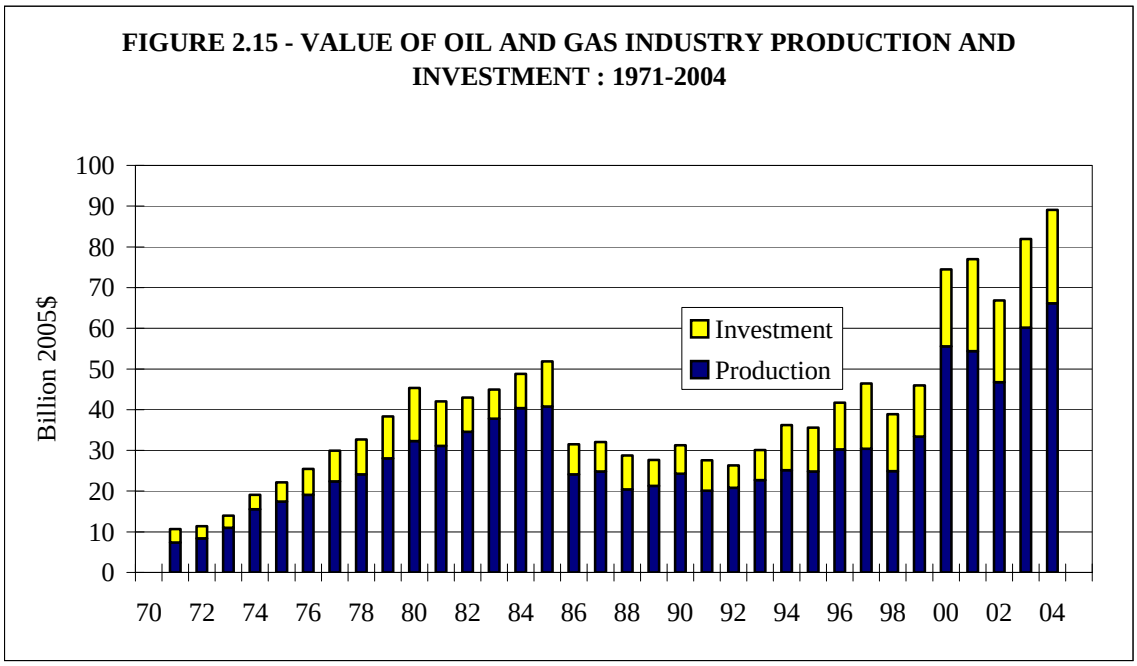

**Source: Data from Canadian Association of Petroleum Producers (CAPP), *Statistical Handbook* and Alberta Treasury, *Alberta Economic Accounts***

## *Investment and Revenue Links*

The value of oil and gas investment and production has been a key driver of Alberta's overall economic performance. Over the period since 1971, the total value of production was over $1 trillion (constant 2005 dollars) and investment expenditures have totaled $350 billion. As indicated in Figure 2.15, the annual values for oil and gas production plus investment have climbed sharply in recent years and have averaged $78 billion annually over the period 2000-2004.

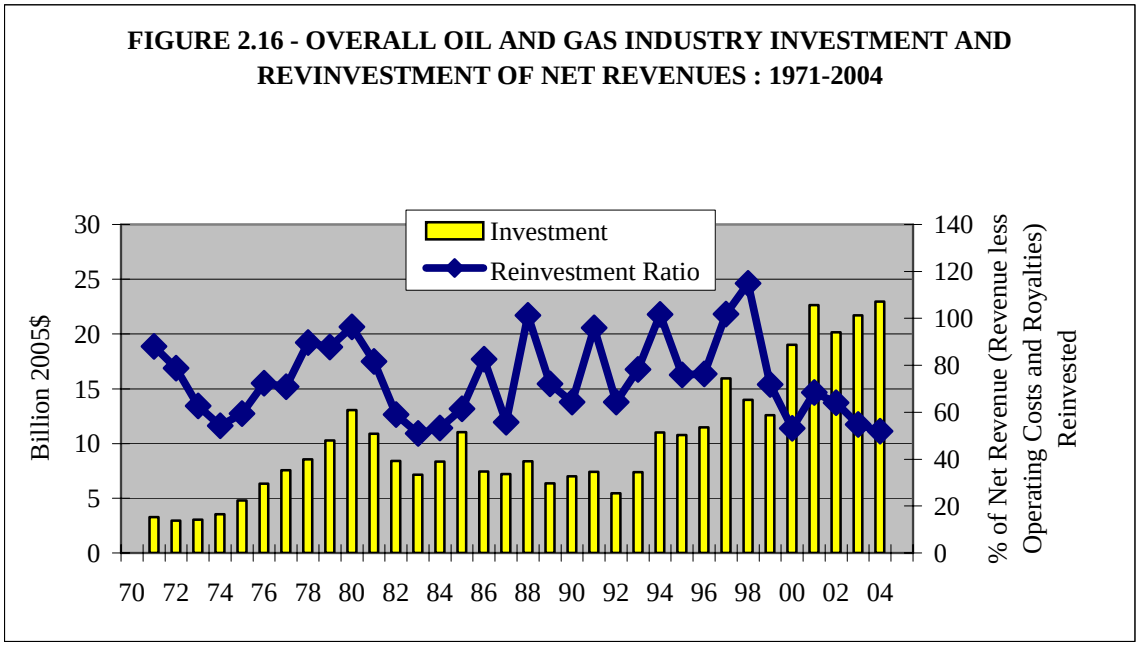
It is important to note that investment expenditures are linked to industry revenues. In general, the industry is constantly reinvesting a substantial portion of its net revenues (net revenues are total revenues less operating costs and royalties). As illustrated in Figure 2.16, over the long term about two-thirds of net revenue has been reinvested. Although there are other determinants of investment (such as price and market expectations and interest rates), a key factor for the oil and gas industry especially is changes in net revenues. Another important feature of this link is that it contributes to a larger overall impact on the economy. For example, an expansion of production in any one period significantly affects reinvestment and future reserves and production.

Figure 2.15




**Source: Data from Canadian Association of Petroleum Producers (CAPP), *Statistical Handbook***

Figure 2.16



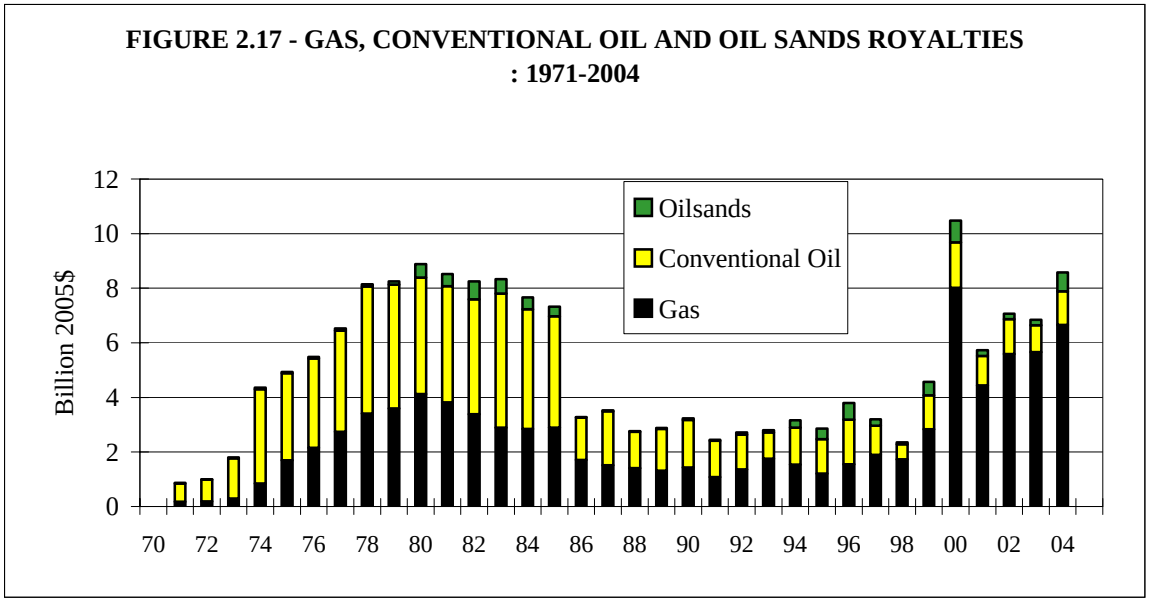

**Source: Data from Canadian Association of Petroleum Producers (CAPP), *Statistical Handbook***

The decline in the reinvestment rate in recent years deserves further investigation. On the one hand it may simply reflect such things as the rapid increase in large oil sands projects which have financing patterns significantly different than the conventional industry; or perhaps lags between revenues and reinvestment. However, it is possibly also related to changes in the structure of the industry (for example, the increasing prevalence of Trusts) or a shift in focus away from a declining conventional oil and gas resource base.

## *Royalties and other Resource Revenue*

Another avenue through which the oil and gas industry makes important contributions to the Alberta economy is through the oil and gas revenues generated for the provincial government. These non-renewable resource revenues (NRRRs) include royalties, rentals and land bonuses which are used to finance various government services that, in turn, result in employment and other economic impacts.

Figure 2.17

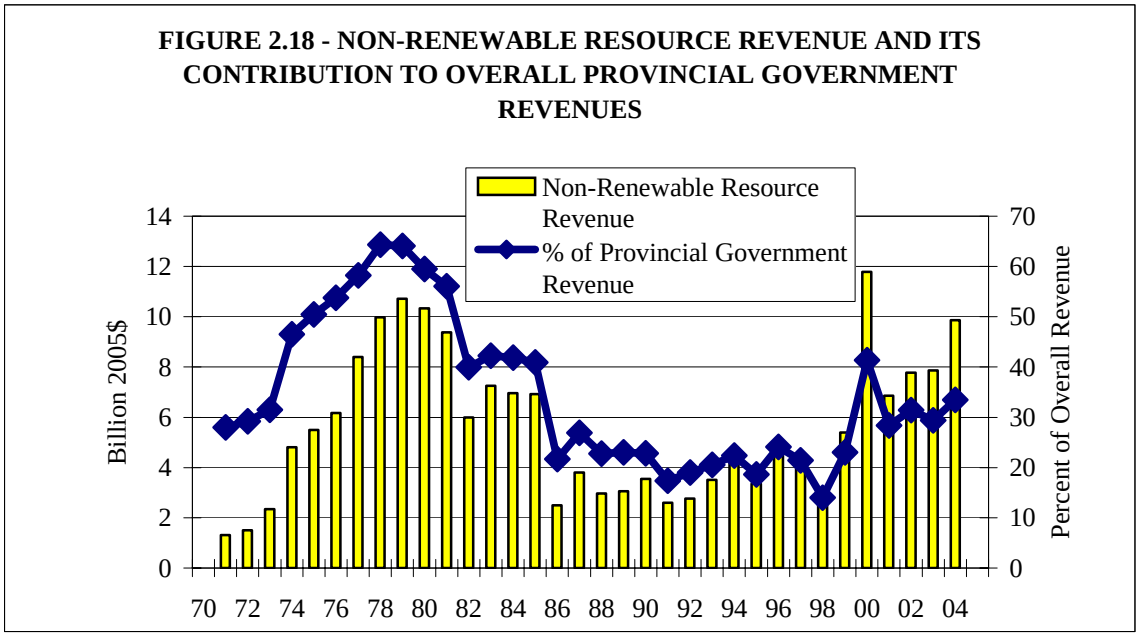



**Source: Data from Alberta Finance, *Government of Alberta Budgets***

Over the period since 1971, royalties paid to the Alberta government have totaled $150 billion (2005 dollars). As indicated in Figure 2.17, annual royalty levels in recent years have risen to levels similar to those in late 1970s and early 1980s. However, the composition is quite different, with conventional gas now the major contributor. Over the period 2000-2004, total oil and gas royalties collected amounted to $38.8 billion (or an annual average of $7.8 billion). Of this, conventional gas royalties accounted for $30.4 billion (78 percent or $6.1 billion annually), conventional oil accounted for $6.3 billion (16 percent or $1.3 billion annually) and oil sands contributed $2.1 billion (about 5.5 percent or $0.4 billion annually). As discussed later, oil sands royalty rates rise from 1 percent of gross revenue to 25 percent of net revenue once the original investments are recovered and this should mean higher oil sands royalty payments in the future. Figure 2.18 shows non-renewable resource revenue paid to the provincial government. Most of this revenue is from royalties, land bonuses, rentals etc. associated with oil and gas production.[14]

[14] Also included are coal royalties. For 2004/05 these are estimated to be $10 million or about 0.1 percent of total NRRR.

Figure 2.18



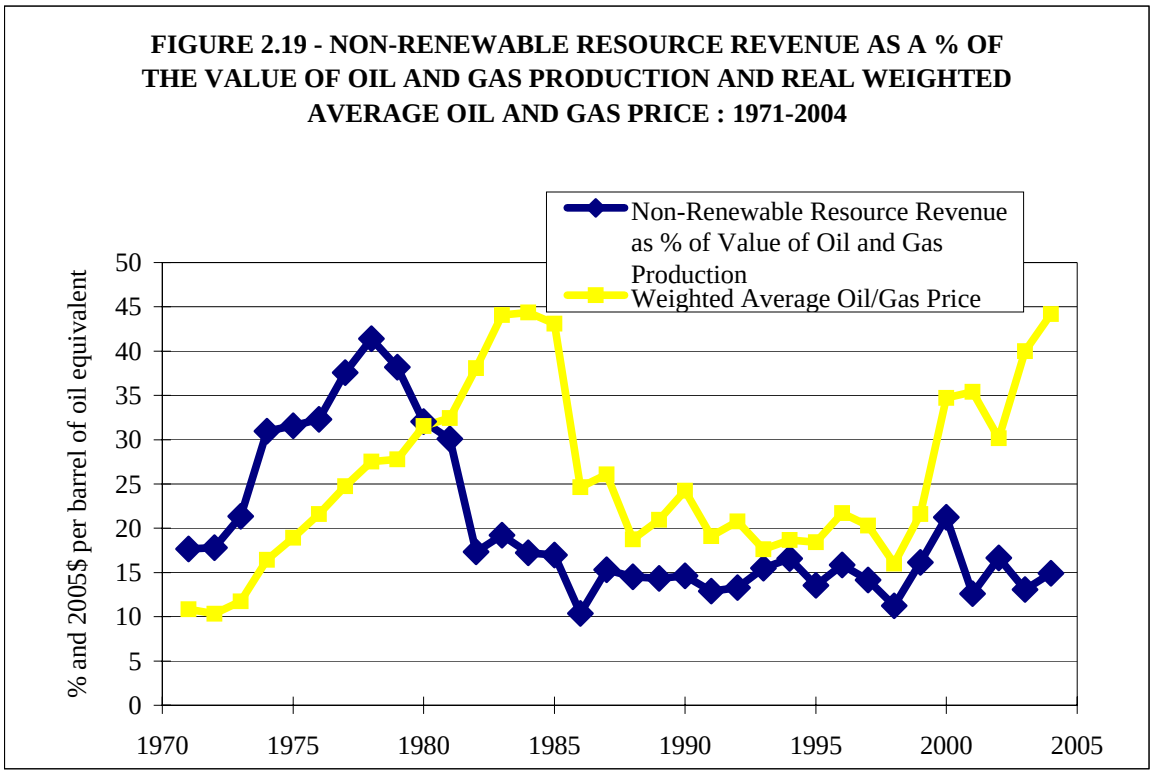

**Source: Data from Alberta Finance, *Government of Alberta Budgets***

The aggregate of this non-renewable resource revenue (NRRR) over the period since 1971 amounts to $175 billion (or an average of $5.1 billion annually). Over the 2000-2004 period it has totaled over $44 billion (or an average of $8.8 billion annually), representing an average of just over 32 percent of total Alberta government revenues. To put these government revenues into perspective it might be noted that in order to obtain the same revenues as achieved in 2004, a provincial sales tax of 16 percent would be required.[15]

Figure 2.19 illustrates non-renewable resource revenue as a percentage of the total value of oil and gas production. During the 1970s, NRRR rates rose sharply and peaked at over 40 percent in 1978. As the absolute level of NRRR fell, largely due to the National Energy Program and then the 1986 world oil price collapse, the NRRR rate declined to about 15 percent. Royalty rates were adjusted in the early 1990s to reflect the lower energy price and higher-cost environment and have remained essentially unchanged since that time. Since that time non-renewable resource revenue has averaged about 15 percent of the value of oil and gas production.

[15] This assumes a sales tax similar in operation to the federal GST.

Figure 2.19




**Source: Data from Alberta Finance, *Government of Alberta Budgets* and Canadian Association of Petroleum Producers (CAPP), *Statistical Handbook***

Over the period since the late 1990s, there has been a growing gap between the weighted real average of oil and gas prices and the effective NRRR rate. In general, a growing proportion of conventional oil and gas is subject to low productivity offsets that significantly reduce the effective royalty rates. This rate for new conventional gas is under 20 percent and for conventional oil it is now about 10 percent. As well, the royalty rates associated with oil sands production are significantly less than those for conventional oil such that growing oil sands production has not created sufficient additional NRRR to offset that associated with declining conventional production.

# 3. IMPACTS OF OIL AND GAS ON THE ALBERTA ECONOMY

The main objective in this section is to develop estimates of the total impacts of the oil and gas sector on the Alberta economy over historical periods (the future impacts and implications are evaluated in Section 4). The focus is on the impacts on Alberta Gross Domestic Product (GDP or value added), incomes, employment and government revenues.

## 3.1 Methodology

### *Sectoral Breakdown*

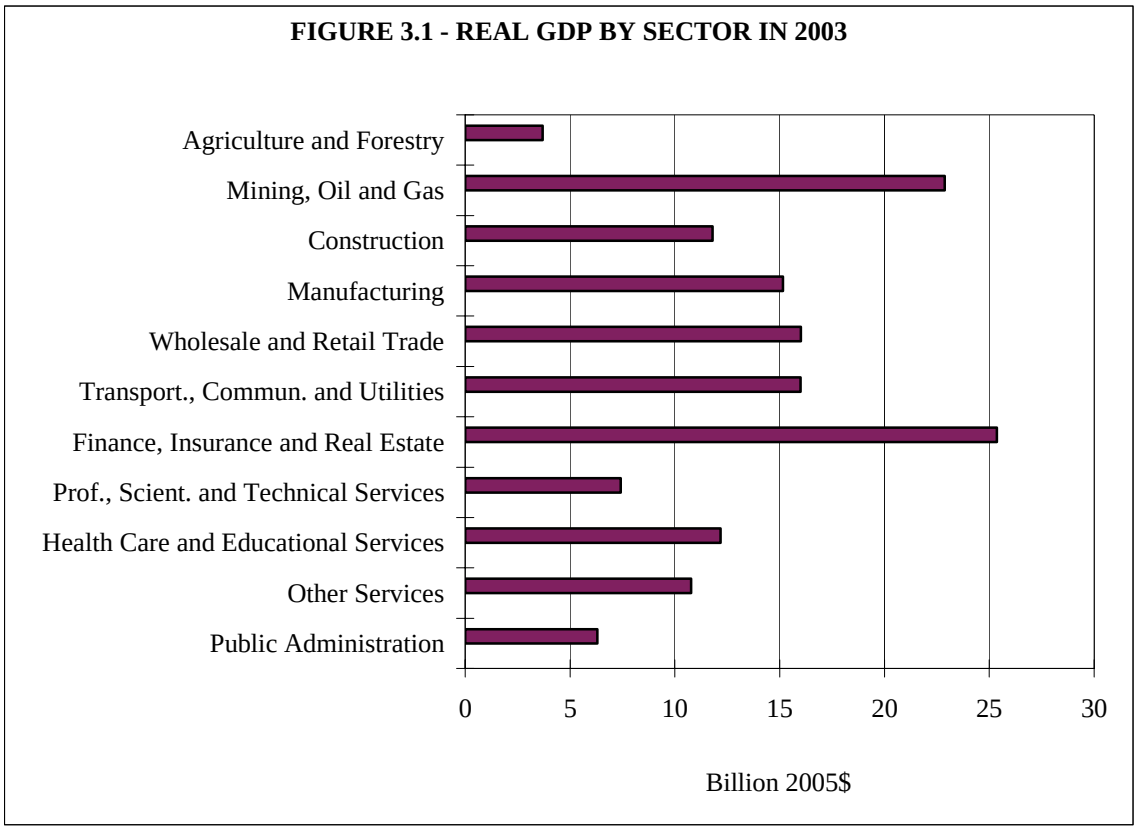
A first step in assessing the importance of a particular industry to the Alberta economy is to simply look at the sectoral breakdown for GDP. This is shown, using values for 2003, in Figure 3.1. As indicated, GDP in the mining and oil and gas sector (a sector overwhelmingly dominated by oil and gas) amounted to $23 billion, or roughly 15 percent of total Alberta GDP in that year.[16]

However, to begin to more accurately capture the full contributions of oil and gas to total GDP or value added, it is necessary to take into account the GDP in the other sectors that are dependent on oil and gas investment and production. For example, it might be recalled from Figure 2.14 that about 40 percent of investment in the province is directly related to oil and gas. Given this, one would expect that a roughly equivalent proportion of the GDP associated with the Construction Sector is directly attributable to oil and gas.

Similarly, in the case of the manufacturing industry, many of the components are intimately tied to the oil and gas sector. For example, as shown in Figure 3.2, the petrochemical industry is the single largest component of the province's manufacturing sector and accounts for over 20 percent of manufacturing value added in Alberta. Virtually all of the feedstock inputs for this industry come from the oil and gas sector and it would be hard to argue that the petrochemical industry would exist in Alberta in the absence of the oil and gas industry.

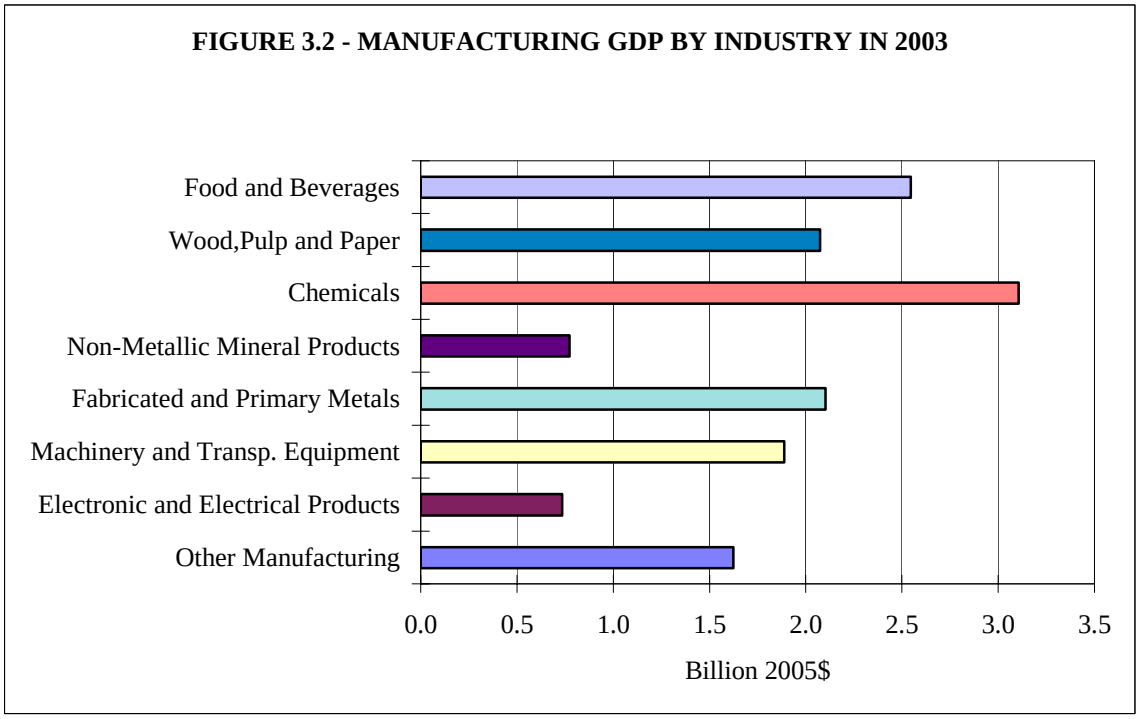
[16] GDP related to oil and gas production comprised 97 percent of total GDP for the Mining and Oil and Gas sector in 2003, compared to 3 percent for the traditional mining industries (coal and hard rock mining).

Figure 3.1




**Source: Alberta Treasury, *Alberta Economic Accounts***

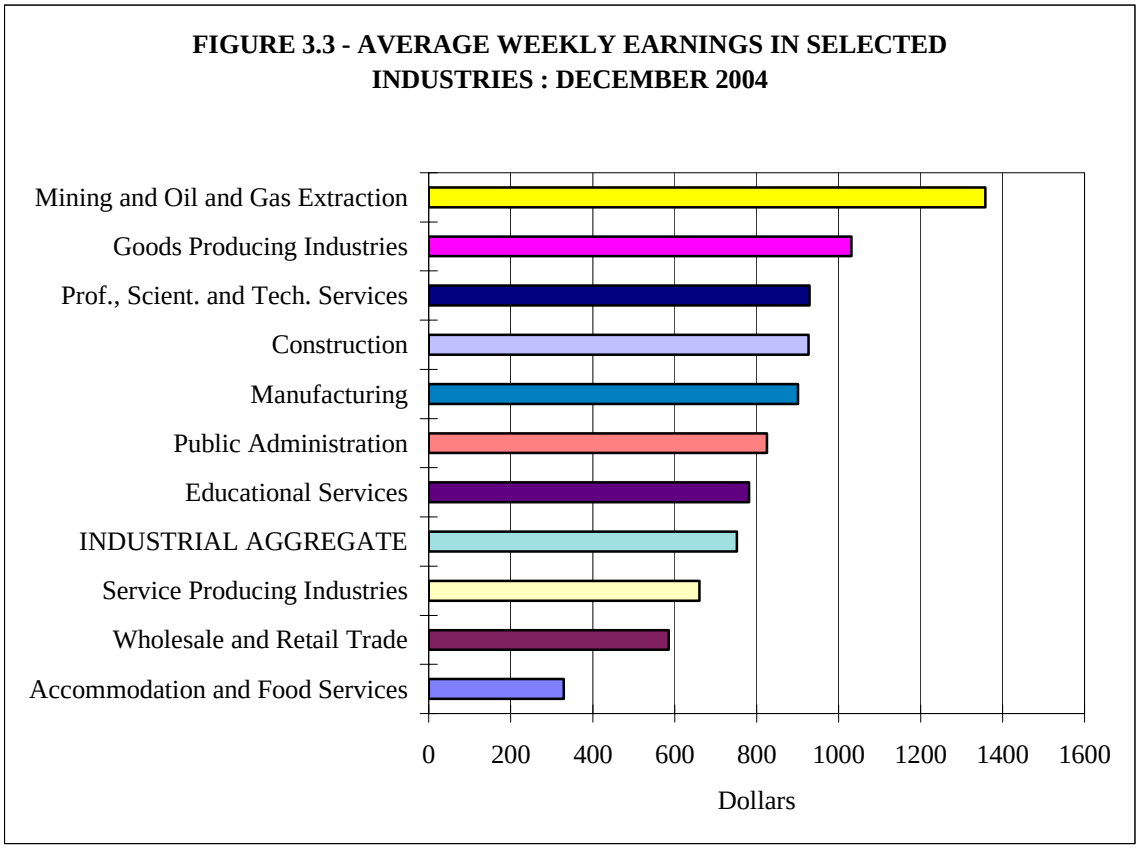
Figure 3.2




**Source: Alberta Treasury, *Alberta Economic Accounts***

Similar arguments can be applied with respect to other components of the manufacturing sector such as fabricated and primary metals and machinery and transportation equipment. And, indeed, they can be applied to most of the sectors noted in Figure 3.1. For example, sizable components of the transportation, finance, professional and trade sectors are fairly directly related to oil and gas activity.

Figure 3.3

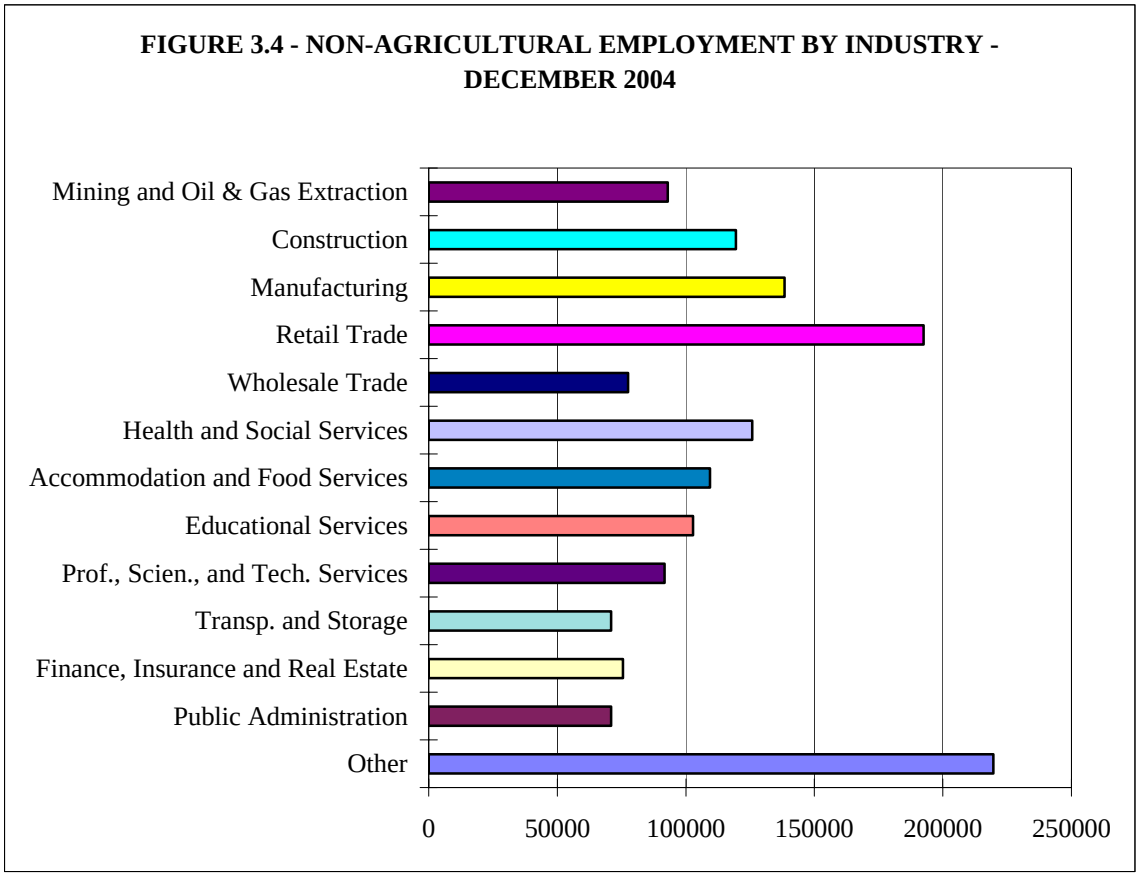



**Source: Data from Statistics Canada, CANSIM 2810028**

It is useful to note that average annual earnings in the oil and gas sector are over $70,000, making this the highest-paying sector in the provincial economy (see Figure 3.3) and, many of the other high-paying industries (professional/scientific/technical services, construction and manufacturing) are closely tied to oil and gas. These incomes lead to purchases of goods and services across most other sectors in the economy, furthering the impacts of the oil and gas industry.

Finally, it can be noted that these various linkage effects also apply to other variables such as employment. For example, as shown in Figure 3.4, the mining and oil and gas sector does not directly account for a large percentage of total employment. In December 2004 this direct employment represented only about 6 percent of total Alberta employment. However, when the employment in other sectors that is attributable to oil and gas industry activity is taken into account, it is clear that the total employment impact is many times larger.

Figure 3.4




**Source: Data from Statistics Canada, CANSIM 2810025**

## *Export Base Models*

The foregoing has provided an intuitive explanation of the some of the factors that must be considered in quantifying the impact of the oil and gas industry. However, what is required is a much more detailed and systematic approach and this involves the use of one or more regional economic models.

One of the simplest models of regional economic growth and development is the export base model.[17] It is summarized here to highlight several fundamental concepts relevant to the task of determining the impacts of the oil and gas sector.

Within this model, there is a distinction between export and non-export sectors or industries. The former[18] are those primarily aimed at serving markets beyond the local region. In the case of Alberta, oil production would be an example of an export industry.

[17] For a summary of this and other models (including input output models), see J. Blair, *Local Economic Development: Analysis and Practice*, London: Sage Publications, 1995.
[18] These are similar to the staple industries referred to in Section 2.2.

The development of such industries provides the base for further development of the regional economy.

The other main component is the non-export sector. Non-export industries will become established with the purpose of supplying goods and services used as inputs in the export industry or with the purpose of processing, refining or upgrading the output of the export sector. Further, the incomes earned by those employed in the export activity will translate into demands for a variety of other goods and services such as housing and health care. These non-export activities also contribute to employment and incomes and lead to a multiplier process. For example, every additional job in the export sector might create another two jobs in the non-export sector.

This simple model highlights the fact that it is the export or basic activities which drive regional income and employment. Increased export activity (or import-replacing activity) will typically lead to a multiplied growth in the economy by providing a base for expansion of non-export activities. Put differently, without an export sector there is no base for the non-export sector.

### *Input Output Model*

While the export base approach provides important insights into the fundamentals, a much more complex model is required to adequately capture and quantify these dynamics. Input Output models are commonly used for this purpose. Such a model traces the flows of goods and services among all industries and sectors (for example, categorized as final demand sectors consisting of consumption, investment, government goods and services and net exports). As an example, suppose the objective was to determine the impact on total GDP of a one-dollar increase in production by the oil and gas industry. There would be a direct impact showing up as increased value added in that industry. But the model would also capture the fact that this increase would bring with it, on average, additional inputs from geological and geophysical firms, the drilling industry, accounting, professional and technical service providers, and so on. These represent the so-called inter-industry or indirect impacts.

Further, the generation of employment and income leads to additional consumer expenditures. In addition, reinvestment of corporate profits (such as the net revenue reinvestment of the oil and gas industry described previously in Section 2.2 and Figure 2.16) could be expected to create additional economic activity. These represent ‘induced impacts’ and, along with the direct and indirect impacts described above, are explicitly estimated in this analysis.

It should be noted that there are additional induced impacts associated with the ultimate production from reserves discovered as a result of oil and gas industry reinvestment, as well as impacts associated with the spending of government revenues attributable to the oil and gas industry. However, these are not as easily modelled and are not included in the estimates presented in this study.

The Statistics Canada Interprovincial Input-Output Model (2001 Version released in 2004) is utilized in this study to estimate economic impacts. The model offers a high level of disaggregation (over 700 commodities, 300 industries and 13 regions) and, hence, offers the flexibility to allow the incorporation of project-specific information to the greatest extent possible.

This type of analysis relies on several fundamental assumptions. First, production technologies are assumed to be 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. In the context of this analysis, it is indeed the average effect that would be relevant (at least from a historical perspective).

Second, increases in demand from different sectors are assumed to have no effect on the prices of goods. For this assumption to apply, it is critical that infrastructure and supporting industries would be able to respond to increases in demand without incurring any significant increases in average costs should expansion be necessary.

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, the model results may not provide the most accurate representation of what would actually happen in the current or future environment.

Given these considerations, intensity ratios (i.e. GDP created per dollar of oil and gas production value or investment spending) from the Statistics Canada model have been used in conjunction with the direct impact estimates as summarized in Figure 2.15 to estimate GDP, labour income, provincial government revenue and employment impacts in Alberta.

## 3.2 Cumulative Impacts

Using this approach, the cumulative impacts associated with the conventional oil and gas industry are as summarized in Figure 3.5. Over the period 1971-2004, this industry accounted for over $1.3 trillion in GDP or value added (or an annual average of $39 billion) for the province, about $500 billion in labour income (or an annual average of $16 billion), more than $250 billion in government revenues (or an annual average of $7.6 billion) and over 11 million person-years of employment (or an annual average of 327,000 person-years).

The cumulative impacts associated with the oil sands component of the industry are shown in Figure 3.6. Over the same period, the oil sands component accounted for $200 billion in GDP (or an annual average of $5.9 billion) for the province, $78 billion in labour income (or an annual average of $2.3 billion), more than $19 billion in government revenues (or an annual average of $560 million) and about 1.6 million

person-years of employment (or an annual average of 47,000 jobs). In general, these impacts for GDP, labour income and employment from the oil sands component were about 15 percent of those for the conventional oil and gas industry (the impacts for government revenue, including royalties, rentals, income and other taxes, were a somewhat smaller percentage of those for the conventional industry).

Figure 3.5

**FIGURE 3.5 - OVERALL IMPACTS OF CONVENTIONAL OIL AND GAS INDUSTRY IN ALBERTA : 1971-2004**

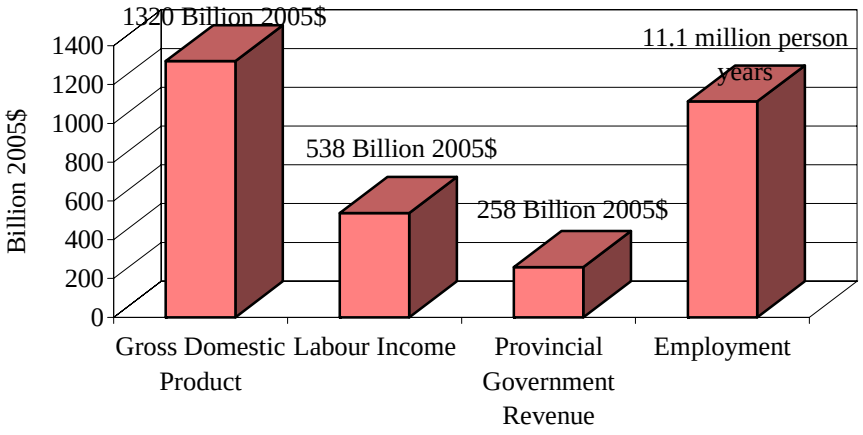
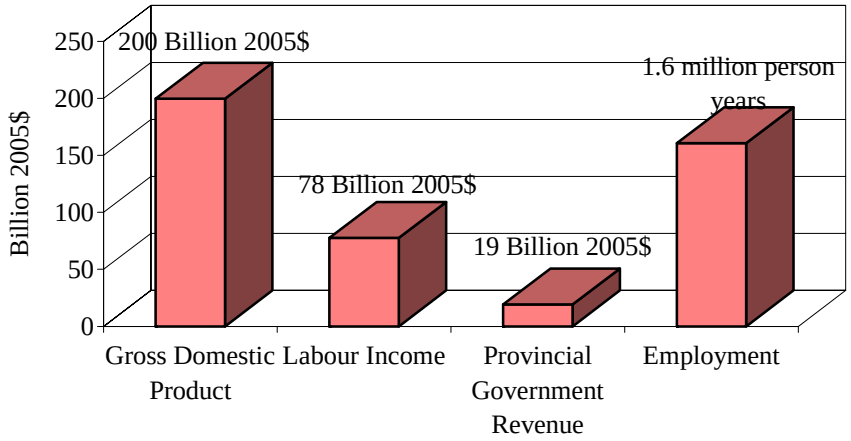


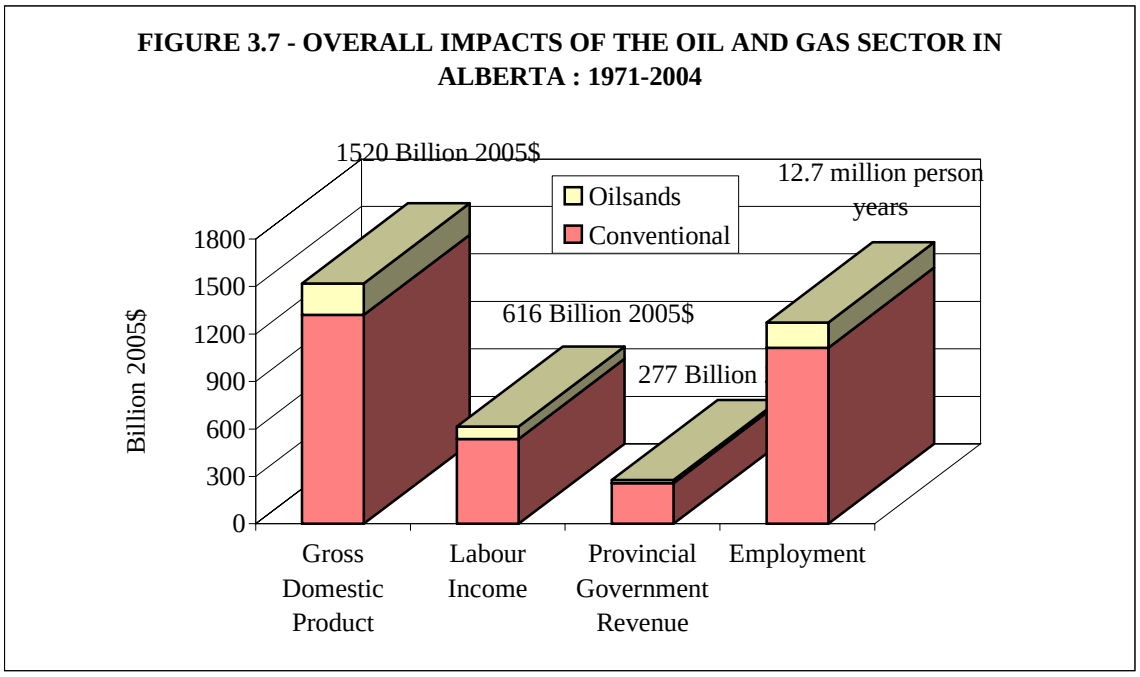

Figure 3.6

**FIGURE 3.6 - OVERALL IMPACTS OF OILSANDS INDUSTRY IN ALBERTA : 1971-2004**



The cumulative impacts for the combined conventional oil and gas and oil sands industry are shown in Figure 3.7. In summary, the cumulative impacts associated with the 'overall' oil and gas industry accounted for over $1.5 trillion in GDP (or an annual average of $45 billion) for the province, $600 billion in labour income (or an annual average of $18 billion), almost $300 billion in government revenues (or an annual average of $8 billion) and close to 13 million person-years of employment (or an annual average of 375,000 jobs).

Figure 3.7



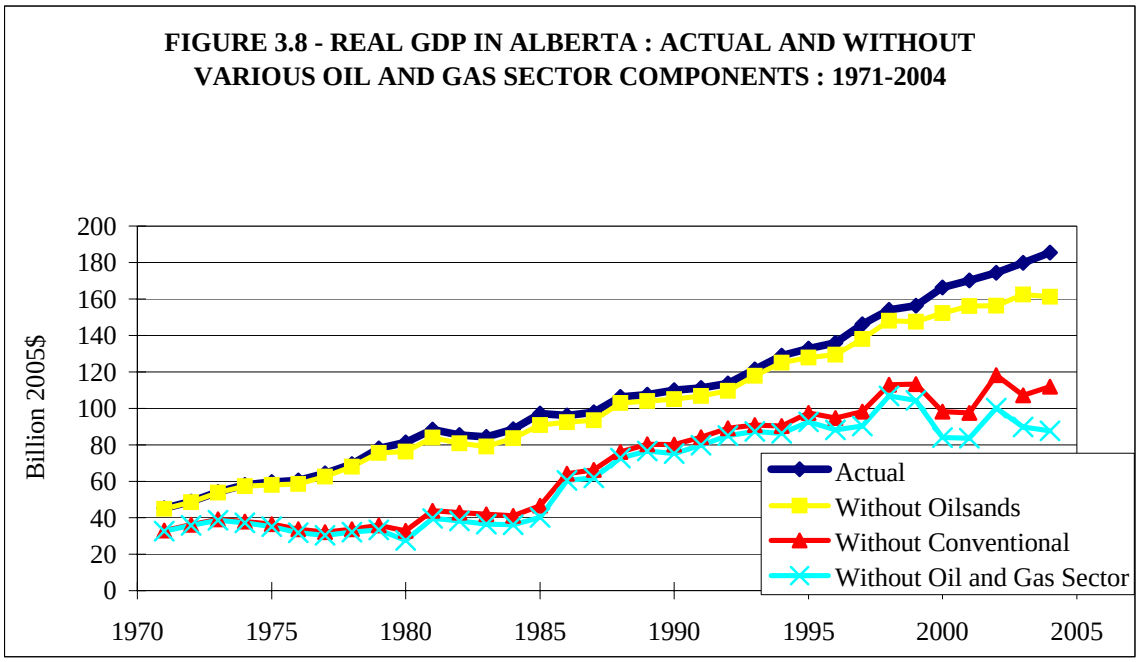

## 3.3 Impacts Relative to the Overall Economy

To put these impacts in perspective, it is useful to express them relative to actual historical levels of Alberta GDP and employment (see Figures 3.8 and 3.9 below).

Without the oil and gas industry, the Alberta economy, measured in terms of GDP, would, on average over the 1971-2004 period, be about 42 percent smaller than with this industry. Or, using recent years or the 1975-1985 period, the economy would be about half the size. For example, without the oil and gas industry, provincial GDP would have been only 47 percent of what it actually was in 2004.

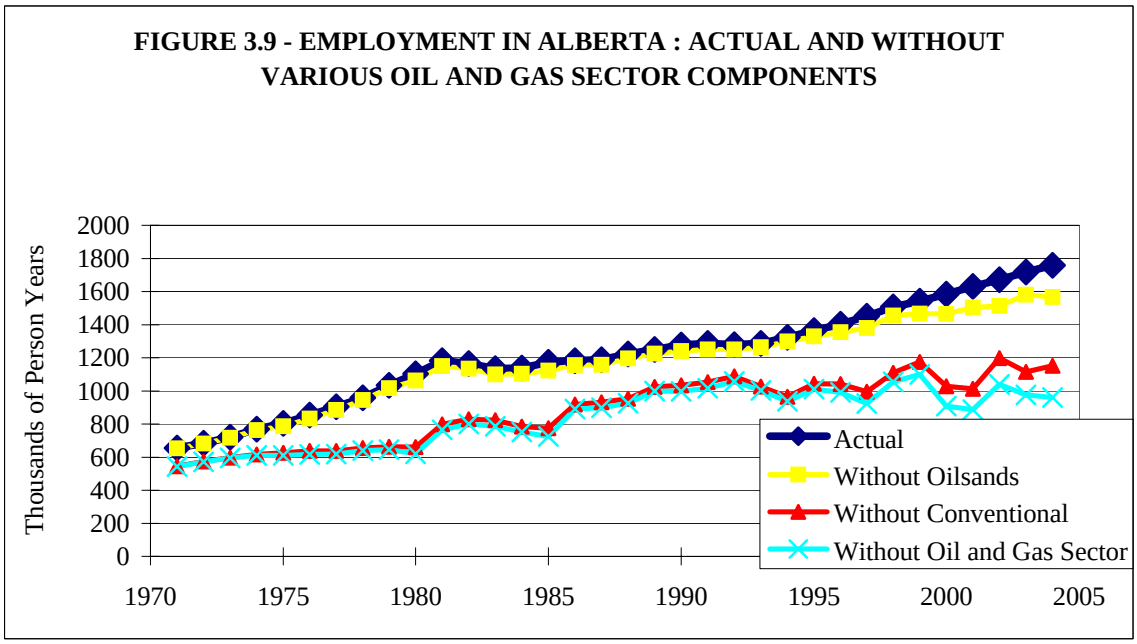
The impacts in terms of employment are slightly less pronounced. Averaged over the period, without the oil and gas industry, employment would be about two-thirds of what it actually was. These impacts, however, do vary over time. For instance, without the oil and gas industry, Alberta employment in 2004 would be just over 55 percent of what it actually was.

Figure 3.8




**Source: Actual (baseline) from Alberta Treasury, *Alberta Economic Accounts***

Figure 3.9




**Source: Actual (baseline) from Alberta Treasury, *Alberta Economic Accounts***

## 3.4 Other Considerations

The results presented in the previous two sections are no doubt significant underestimates of the total impacts of the oil and gas industry. First, as discussed earlier, the induced impacts associated with the additional oil and gas production arising from first and subsequent rounds of reinvestment and the effects on reserve additions are not captured in the estimates. Nor are the investment impacts beyond the first round of reinvestment, or any additional government expenditures arising from the higher non-renewable resource revenues or tax revenues. Second, the estimated impacts do not include effects associated with the large petrochemical industry. Including these impacts would result in an additional direct loss of about 2 percent of Alberta's economy and a loss of close to 4 percent when direct and indirect effects are taken into account.

Third, the analysis excluded many of the factors discussed in Section 2.2 that, although difficult to quantify, are nevertheless important. For example, without the energy sector there would have been much less net in-migration and, as a consequence, a much different population in terms of average age, education, or entrepreneurial drive. These changes would undoubtedly translate into a significantly lower level of economic activity and prosperity.

# 4. FUTURE IMPACTS OF OIL AND GAS

The main objective in this section is to develop estimates of the total impacts of the oil and gas sector on the Alberta economy over the period to 2013/2014. The focus is on the impacts on Alberta Gross Domestic Product (GDP or value added), incomes, employment and government revenues.

## 4.1 Methodology and Assumptions

As in the previous section, the approach to estimating future impacts of the oil and gas industry involves the use of the Statistics Canada Interprovincial Input Output model. However, in order to employ the model in a forward-looking exercise of this type, some assumptions are required.

### *Prices*

In order to provide an illustrative analysis of what the medium-term future of the Alberta oil and gas sector might look like, energy price and production forecasts have been taken from recent editions of the Alberta Energy and Utilities Board's (AEUB's) annual review of reserves and supply/demand outlook.[19] The averages for AEUB's low and high 2004 and 2005 forecasts of real (2005$) average wellhead/plantgate oil and gas prices in Alberta through to 2014 are outlined in Figure 4.1. The most recent (2006) forecast has somewhat higher expected future oil prices, ranging from an average of about $65 to about $85 over the period 2006-2015.

It should be emphasized that the downward trends shown in Figure 4.1, particularly in the early part of the forecast period, primarily reflect a reversion from current levels to long-term forecast values, where the latter are a simple average of the forecast prices under the high and low energy price scenarios. Further, the relatively stable / flat patterns over the forecast period simply reflect the fact that it is not possible to forecast short-term variations. Also, it should be noted that the 2004 forecasts are used for the basic impact analysis outlined later (but with adjustments to reflect the higher expectations in 2005.[20])

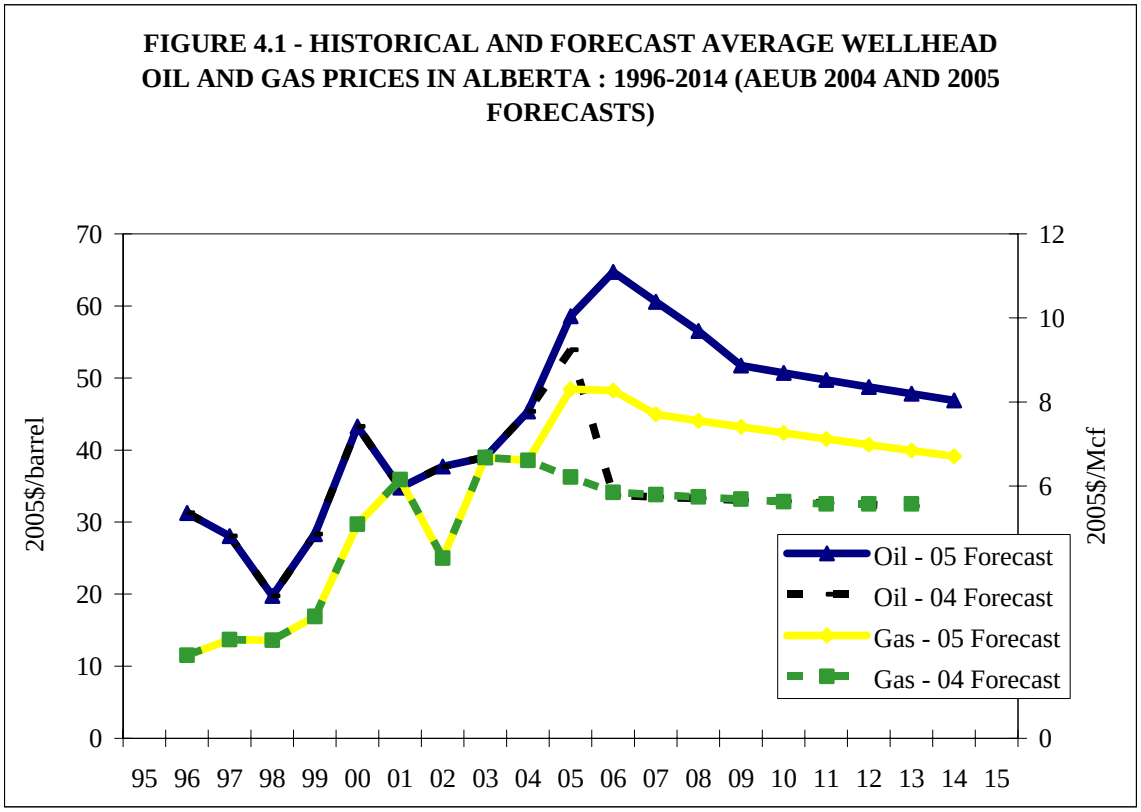
In general, the forecast prices for oil and gas suggest a convergence on a heat equivalent basis. This convergence of gas and oil prices in the North American market assumes that gas will continue to be a more attractive fuel because of its lower emissions compared to many alternative fossil fuel energy sources. These forecasts also suggest that the levels of future real oil and gas prices will be much higher than long-run historical levels. Given the pattern of relatively high gas and oil prices since 2000, most forecasters do not anticipate a return to the relatively low prices that prevailed during most of the 1990s.

---

[19] See AEUB ST98-2004, ST98-2005 and ST98-2006, *Alberta's Reserves and Supply/Demand Outlook.*

[20] For example, see Sproule Associates Limited's oil and gas price forecasts on the company's website (www.sproule.com).

Figure 4.1



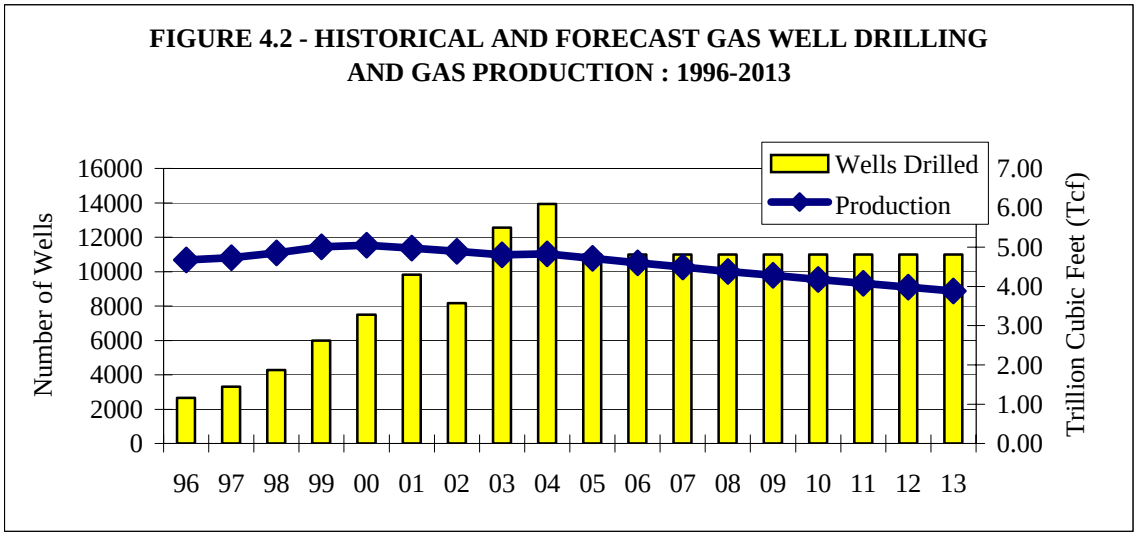

**Source: Data from Canadian Association of Petroleum Producers (CAPP) and Alberta Energy and Utilities Board (AEUB), Reports ST98-2004 and ST98-2005**

## *Production*

The AEUB has projected gas and oil production over the period to 2013-2015 and the 2004 gas production forecast is shown in Figure 4.2, along with gas well drilling projections. In 2004, after successive years of production declines since 2000, gas production rose slightly. This was achieved in no small part due to record levels of drilling when close to 14,000 wells were drilled in the province. There is considerable uncertainty whether such levels could be maintained over a longer term, especially as gas prices weaken from the levels in 2005. In the analysis presented later, the 2004 AEUB forecast of 11,000 gas wells annually is used. Under such a scenario, gas production is expected to fall by 2.4 percent per year and by 2013 gas production in Alberta would be about 80 percent of the 2004 level.

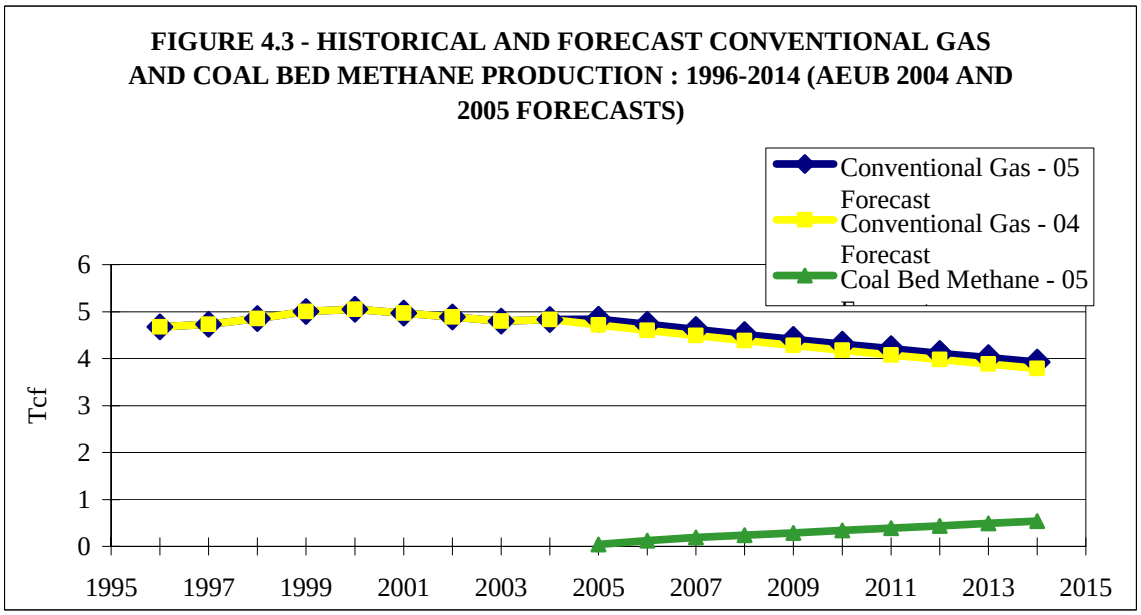
It should be noted that the 2005 AEUB forecast for gas production is slightly higher and also includes estimates for production of natural gas from coal (NGC or coal bed methane). These changes are shown in Figure 4.3 and suggest NGC (and other unconventional gas such as tight and shale gas) will be particularly important in terms of offsetting the decline in conventional gas production.

Figure 4.2




**Source: Data from Canadian Association of Petroleum Producers (CAPP) and Alberta Energy and Utilities Board (AEUB), Report ST98-2004**

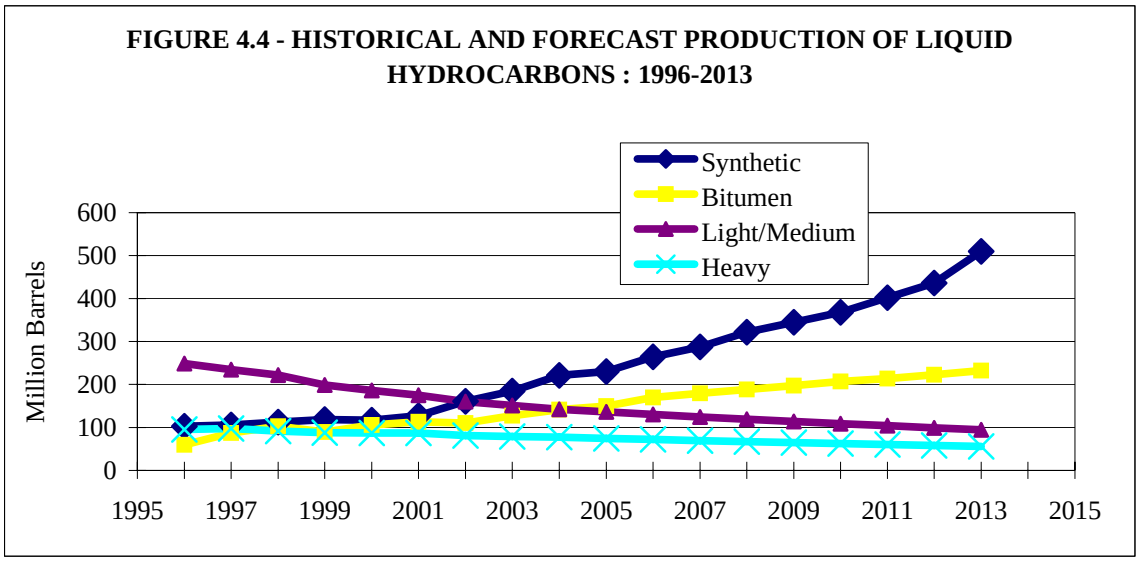
Figure 4.3




**Source: Data from Alberta Energy and Utilities Board (AEUB), Reports ST98-2004 and ST98-2005**

The 2004 AEUB analysis projected conventional oil drilling to be flat at 2200 wells per year over the forecast period. That projection is adopted in the analysis here and, given the maturity of the Alberta basin and the already declining production over the past decade (as illustrated in Figure 4.4), production of conventional light/medium and heavy oil is forecast to fall by 4.4 percent and 3.5 percent per year respectively over the period to 2013.

Figure 4.4




**Source: Data from Canadian Association of Petroleum Producers (CAPP) and Alberta Energy and Utilities Board (AEUB), Report ST98-2004**

While conventional oil production is expected to continue to decline, significant increases in synthetic crude oil (SCO) and bitumen production are anticipated. SCO production in Alberta first exceeded conventional light/medium production in 2003 and it is expected that the bulk of the province's liquid hydrocarbon production will consist of SCO by 2013. SCO production is forecast to be about 1.4 million barrels per day (bpd), or more than double the 2004 production level (roughly 600,000 bpd). Bitumen production is also expected to rise significantly, from the 2004 level of close to 400,000 bpd to more than 600,000 bpd by 2013 (or by over 50 percent). Given these anticipated increases combined with the expected declines in conventional oil production, oil sands (SCO + bitumen) production is expected to comprise over 80 percent of total liquid hydrocarbon production in Alberta by 2013.

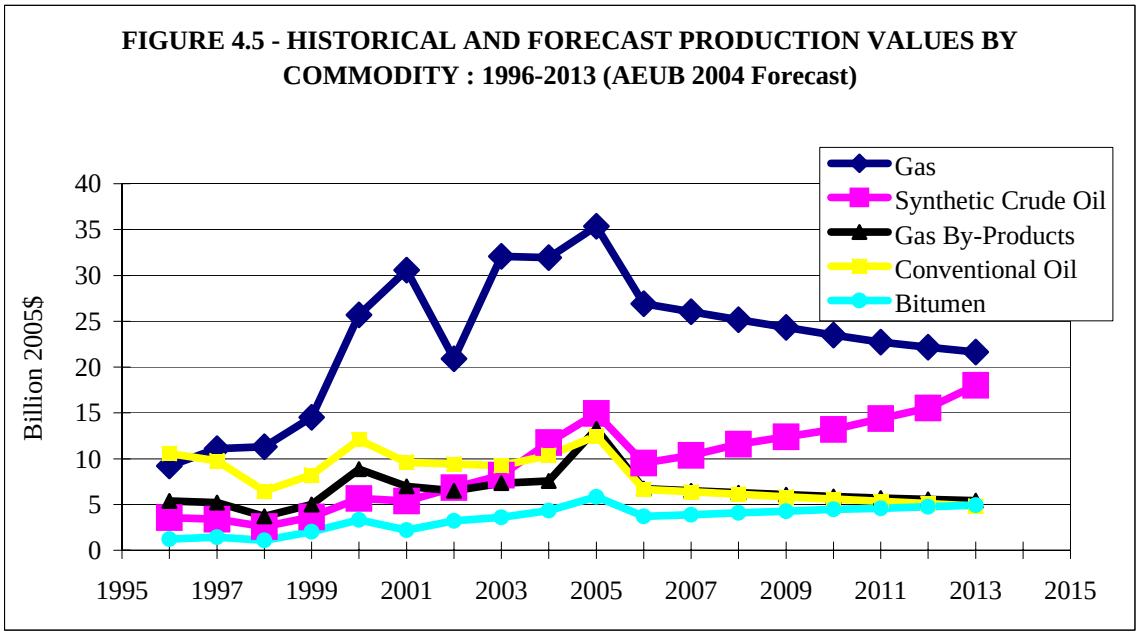
The more recent (2005) AEUB forecast suggests slightly higher growth rates for SCO and bitumen production over the forecast period. The effects of incorporating these higher production levels in the analysis will be shown in the next section.

## 4.2 Implications for Revenues

### *Production Revenues*

The price and production forecasts illustrated in Figures 4.1-4.4 have been used to prepare forecasts of production revenues by product as illustrated in Figure 4.5. It can be observed that in the last five years, the value of gas production in Alberta has easily exceeded production values of any of the other products shown in the figure. In fact, since 2000 gas revenues have essentially equaled the sum of revenues from all of the other products combined.

Figure 4.5



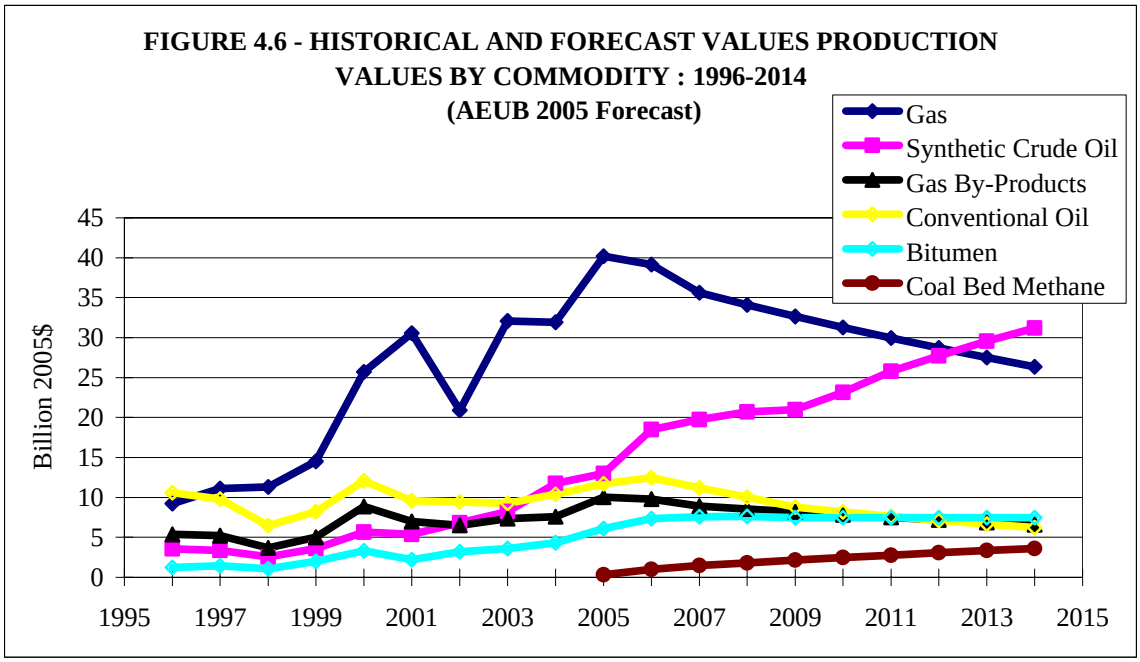

**Source: Historical data from Alberta Finance, *Government of Alberta Budgets;* forecast values as described Section 4.1**

This trend is not expected to continue in the future with the leveling off and expected declines in gas production and fairly level gas prices (albeit prices at a much higher level than historically). By 2013, gas revenues are expected to comprise 40 percent of overall oil and gas production revenues compared to about 50 percent in 2003. Declines in conventional oil and gas by-product revenues are also anticipated for similar reasons. In contrast, rising production of SCO and bitumen should translate into significantly higher production revenues over the forecast period. In particular, the value of SCO production is expected to rise from about 12 percent of total oil and gas industry revenues in 2003 to roughly one-third of industry revenues in 2013.

The comparable production values when the higher long-term price and production forecasts from the 2005 AEUB report are incorporated are shown in Figure 4.6. These indicate, by 2013, increases in the value of the various components ranging from 18

percent for natural gas to about 60 percent for SCO. Most of this increase is related to the higher forecast levels for oil and natural gas prices.

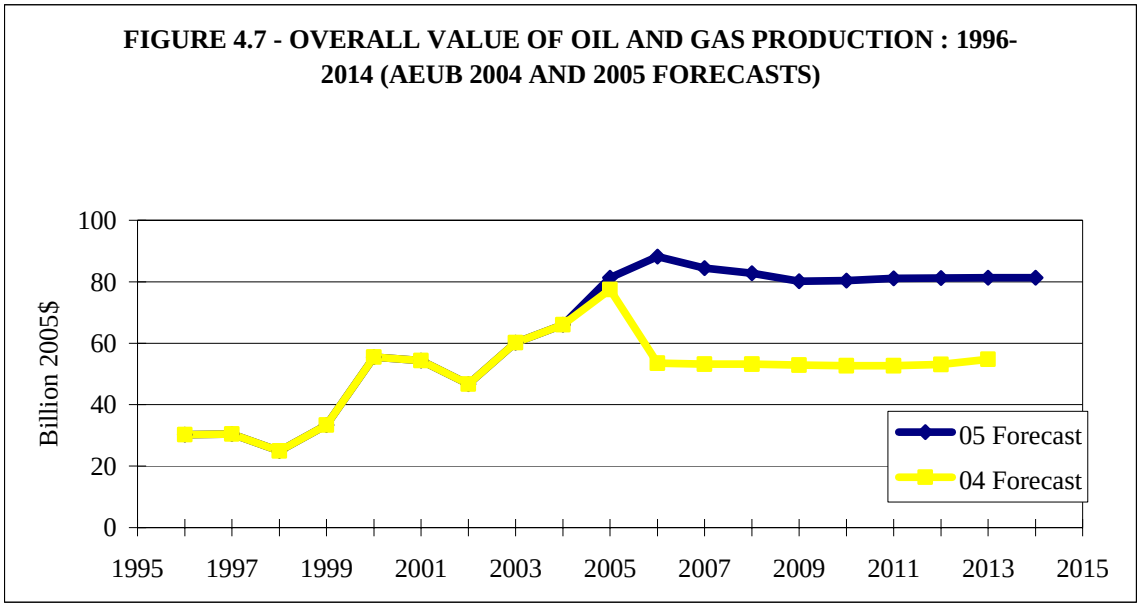
Figure 4.6




**Source: Historical data from Alberta Finance, *Government of Alberta Budgets;* forecast values computed as described Section 4.1**

The total value of oil and gas production under the two price and production forecasts is shown in Figure 4.7. There is a fairly wide range of likely future values for total oil and gas production revenues but what is striking is that the longer-term prospects diverge sharply from the pattern of rapid growth over the last decade. The prospects range from an approximately flat to significantly lower future production values and this undoubtedly translates into significant downward pressure on Alberta's longer-term growth rate and prospects. Put differently, even with the rapid growth in unconventional oil production, this is largely offset by the leveling and decline of conventional gas production (which, including the production of gas liquids, currently accounts for approximately one-half of the total value of Alberta energy production). Consequently, there is little likelihood of continued substantial growth in the total value of Alberta energy production at levels anything comparable to those over the last few decades. Indeed, the flattening of this important economic driver will likely have profound effects on the province's entire economy.

Figure 4.7

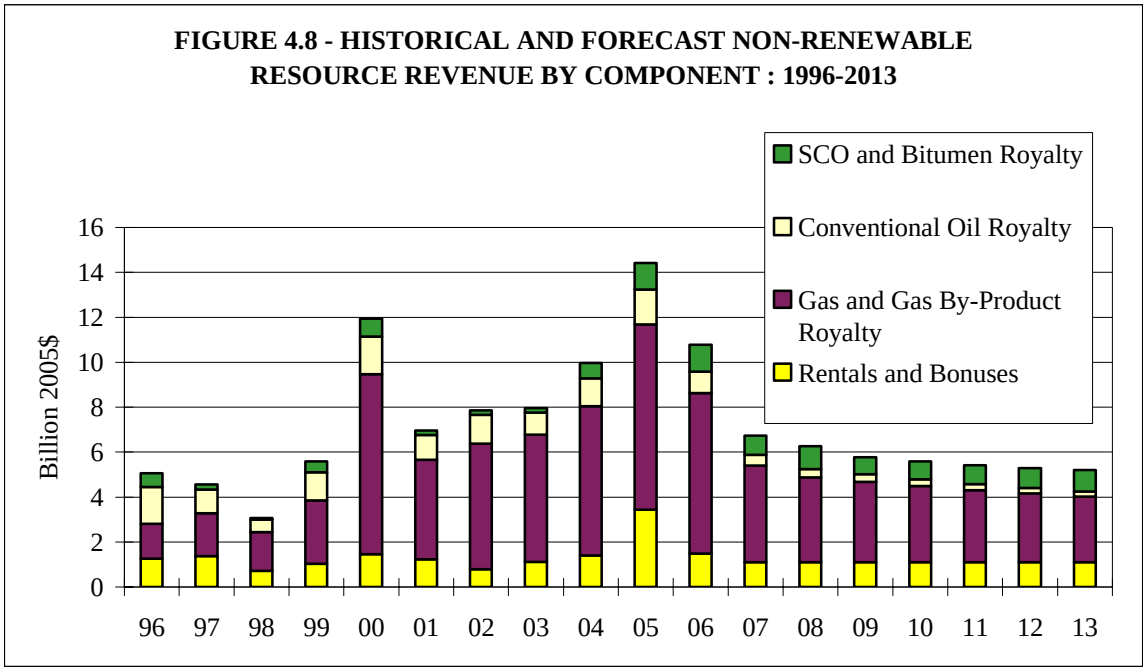



**Source: aggregation of values shown in Figures 4.5 and 4.6**

## *Government Resource Revenues*

These expected changes in the growth and mix of oil and gas industry revenue can be anticipated to have some major implications with respect to the provincial government's non-renewable resource revenue (NRRR). Figure 4.8 shows forecasts of royalties by type of product, as well as rentals and bonuses through to 2013. Bonus payments tend to be highly variable from year to year and may often reflect overly optimistic or pessimistic expectations with respect to commodity prices. Given the relatively flat long-term real prices for oil and gas, bonuses (and rentals), a constant long-term trend for real rentals and bonuses is projected. It is assumed that the average value for this variable over the forecast period will be comparable to historical values.

Figure 4.8




**Source: Historical data from Alberta Finance, *Government of Alberta Budgets***
**Note that values after 2006 are based on expected long-term averages and do not capture the substantial but unpredictable short-term variations that will undoubtedly occur. Further, the use of higher energy price forecasts would significantly increase the expected future values for non-renewable resource income.**

Figure 4.8 illustrates that the bulk of the provincial government's non-renewable resource revenue (NRRR) in recent years has consisted of gas and gas by-product royalties. Starting in 1997, gas-related royalties began to exceed conventional oil royalties on an annual basis and by 2004 roughly two-thirds of the NRRR (or $6.7 billion in 2005$) consisted of gas and gas by-product royalties. With the anticipated decline in conventional gas production in the future, combined with level gas prices (albeit at levels much higher than historical averages), gas-related royalties are expected to contribute less on an absolute and relative basis to the provincial government's NRRR. This effect is exacerbated by the fact that an increasingly larger proportion of Alberta's gas production has been subject to a low productivity allowance in recent years. It is anticipated that this trend will continue in the future and it serves to reduce the effective royalty rate on gas and gas by-product revenues. It is estimated that by 2013 gas-related royalties would fall to about $3 billion under the scenario outlined in this analysis but would still make up over half of provincial government NRRR.

Conventional oil royalties can be anticipated to fall for all the same reasons as outlined for gas-related royalties. In contrast, it might be expected that SCO and bitumen royalties would increase significantly as a result of rapidly rising production levels over the forecast period. However, the increase is unlikely to be what might be expected with a similar increase in conventional production. Since the introduction of the revised oil sands royalty regime in the late 1990s, effective royalty rates associated with oil sands

production have, over the shorter term, generally been significantly lower than rates for conventional oil (or gas for that matter).[21]

Under the current scheme, the royalty on oil sands production is 1 percent of gross revenue until payout (the time at which various costs have been completely covered) and after payout it is the greater of 1 percent of gross revenue and 25 percent of net revenue (gross revenue minus allowable costs). As such, once payout occurs, the effective royalty rate could potentially jump by 10 to 15 times (or to 10-15 percent of gross revenue) depending on the costs of a particular oil sands operation.

This potential jump in the royalty rate provides an incentive for companies to delay payout as long as possible and the government has been developing more detailed rules reduce the amount of uncertainty surrounding this issue. Further, the Crown has a number of criteria, including royalty impact, for evaluating projects. If there is a significant royalty impact, the Crown can choose not to approve the project or could treat it as a stand alone project for royalty purposes. In any event, without detailed cost information it is very difficult to predict when the transition to higher rates would occur for a particular project. The task of estimating the aggregate oil sands royalty revenue in the future when many projects are required to fulfill the production forecasts used in the analysis (some of which may barely be in the planning stages currently) is especially daunting.

Information contained in the 2005 and 2006 Alberta budgets suggest that the effective royalty rate on gross oil sands revenue can generally be expected to rise from recent levels until 2008 as more projects reach payout. Most projects are paying royalties based on bitumen rather than synthetic crude oil (SCO). Two SCO producers (Suncor and Syncrude) have a bitumen royalty option[22] and it is expected that after 2008 both will choose to pay royalties based on bitumen rather than SCO values. The net revenue used to determine royalty would be based on the much lower bitumen price (vs. SCO price) but this would be partly offset by lower allowable costs. The net effect would be a reduction in royalties paid by those projects.

Incorporating these assumptions, the effective royalty rate on oil sands versus conventional production can be examined. For example, it can be observed in Figure 4.8 that in 2005 conventional oil and oil sands-related royalties are roughly equal. The respective production values are roughly $6.7 billion and $13.2 billion, yielding an effective royalty rate on conventional oil of about 9 percent versus roughly 4.5 percent on oil sands production. Evidence over the historical period shows similar relative royalty rates since the royalty regime change in the late 1990s.

In general, one would expect significantly lower royalties as a percentage of revenues in the case of oil sands compared to the case of conventional oil. That is, in the former case the unit production costs are higher and, on average, the value of the product is lower

[21] A more meaningful comparison of royalty rates for unconventional and conventional oil would require the effective rates to be computed on a life cycle rather than an anuual basis.
[22] See Orders in Council 245/96 and 246/96.

(given that a significant portion is bitumen). This translates into lower economic rents available for capture by the royalty regime.

It can be argued that the streamlining and adjustment to royalty rates on oil sands production in the late 1990s was fundamental in creating an investment climate that would allow the massive capital expenditures that have since occurred in the oil sands industry. Without that change the industry would be much smaller over the past five years and into the future.

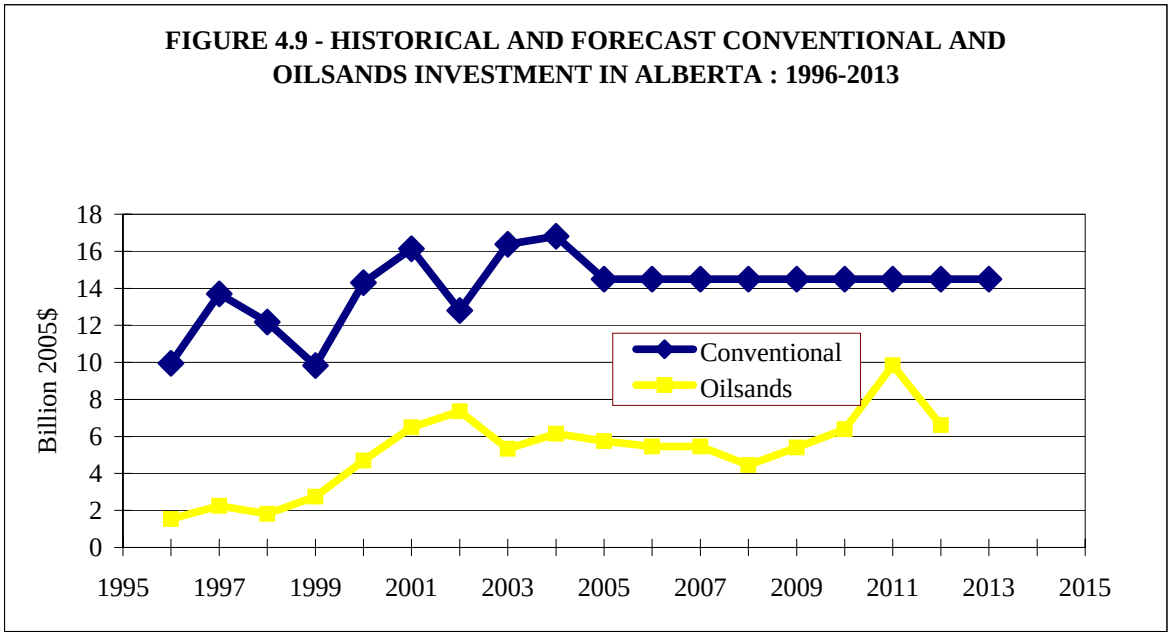
The significant drop in non-renewable resource revenue (NRRR) in 2007 shown in Figure 4.8 is primarily related to the assumption that the prevailing prices in that year will equal the long-term values set out in the AEUB 2004 projections. As noted earlier, there has been no attempt to incorporate year-to-year variations around those projected trends. Nevertheless, based on observed oil and gas prices for the first six months of 2006, the projected values for natural gas and oil for the entire year are expected to be similar to those incorporated in Figure 4.8.

Based on these projections, expected provincial government NRRR over the forecast period can be anticipated to be substantially lower than the levels observed in recent years. For example, the projected NRRR for 2013 (using the 2004 AEUB projections) are just over $5 billion or about one-half the average levels over the last five years. It may be that increases in personal and corporate tax revenues (as captured by the input-output analysis) more than make up for this negative effect on NRRR. In general, the large investments associated with unconventional oil and gas production, and the associated multiplier effects, can be expected to significantly increase provincial revenues from personal and corporate taxes and from various indirect taxes. It is useful to note, however, that the largest beneficiary from these sources will be the federal treasury given the much lower personal and corporate tax rates levied by the province.

## 4.3 Implications for Investment

Aside from the production revenue and NRRR projections outlined above, forecasts of investment in the conventional oil and gas and oil sands industries are also required to estimate the future impacts of the sector. These are shown in Figure 4.9 and reflect many of the assumptions made to this point. Given that the annual number of oil and gas wells drilled is assumed to be constant throughout the forecast period, the level of conventional oil and gas industry investment does not change. Real cost increases that might develop through time are assumed to be offset by technological improvements that invariably occur in what has always been a very innovative industry.

Figure 4.9




**Source: Historical data from Canadian Association of Petroleum Producers, *Statistical Handbook;* projected values based on methodology outlined in Section 4.1**

For the oil sands industry investment, various cost estimates from the National Energy Board's 2004 report on the industry[23] are incorporated in order to arrive at the investment profile shown in Figure 4.9. In particular, it is assumed that incremental integrated mining/extraction/upgrading capacity would cost $40,000 per bpd (2003$) of capacity and that incremental steam-assisted gravity drainage (SAGD) capacity would cost $18,000 per bpd of capacity. These figures are used in conjunction with the AEUB SCO and bitumen production forecasts to estimate required capital investment through time, with consideration given to the staging of investment required to achieve a certain production increment at a particular point in time.

In the forecast period, roughly $49 billion or about 27 percent of overall oil and gas industry investment in Alberta is anticipated to be oil sands related. This proportion corresponds almost exactly to the percentage observed over the last six years when oil sands investment has constituted about $33 billion out of the $119 billion spent in the overall oil and gas industry.

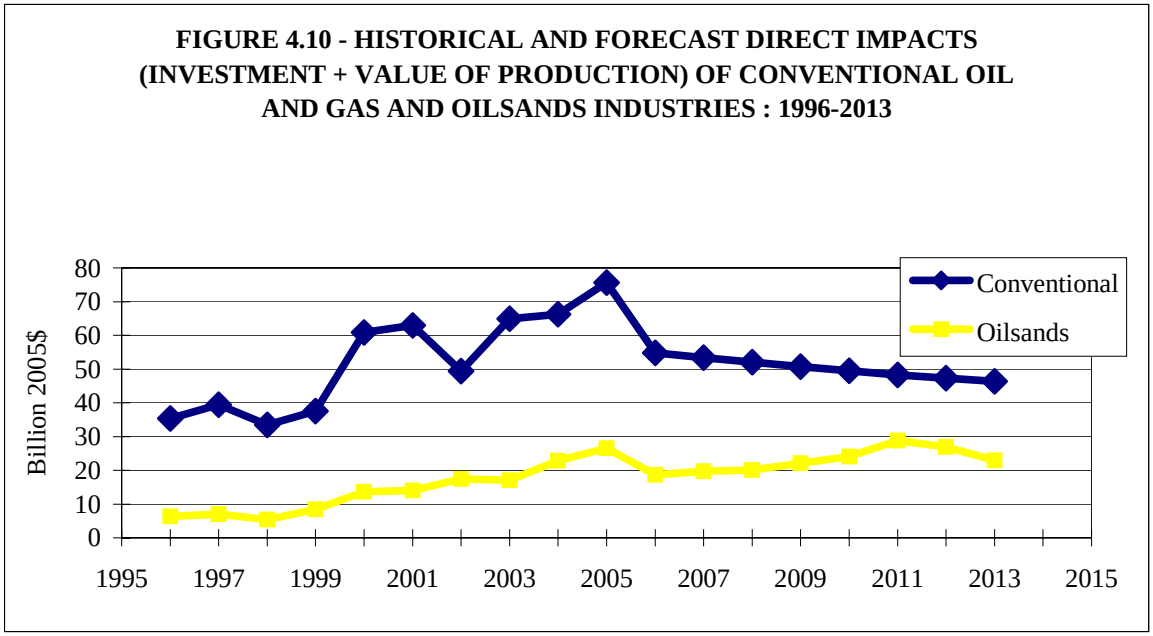
[23] see National Energy Board, *Canada's Oil Sands: Opportunities and Challenges to 2015*, May 2004

## 4.4 Macroeconomic Implications

### *Projected Investment and Production Impacts*

These investment impacts are combined with the impacts associated with the production of various hydrocarbons in order to arrive at the direct impacts expected over the forecast period as shown in Figure 4.10. Oil sands-related direct impacts are expected to be much more pronounced than those observed over the historical period and are forecast to average $23 billion annually. In contrast, the direct impacts associated with the conventional industry are expected to decrease over the longer term as a result of continued declines in production. The decrease in 2006 mainly reflects the drop back to more sustainable price levels that is incorporated in the price forecast. Still, the average annual direct impact over the forecast period related to the conventional industry is expected to be $53 billion. In total then, the direct impact of oil and gas industry investment and production is expected to be $76 billion per year between 2005 and 2013.

Figure 4.10




**Source: Historical data from Canadian Association of Petroleum Producers, *Statistical Handbook;* projected values calculated as described above**

### *Projected Oil Sands Impacts*

Given the typical reinvestment of a significant portion of net revenue by the oil and gas industry, as well as the spending of labour income generated directly or indirectly by the industry, the overall impacts of Alberta's oil and gas industry can be expected to be quite substantial in the future and some of these impacts are summarized in Figures 4.11 to 4.13.

Figure 4.11

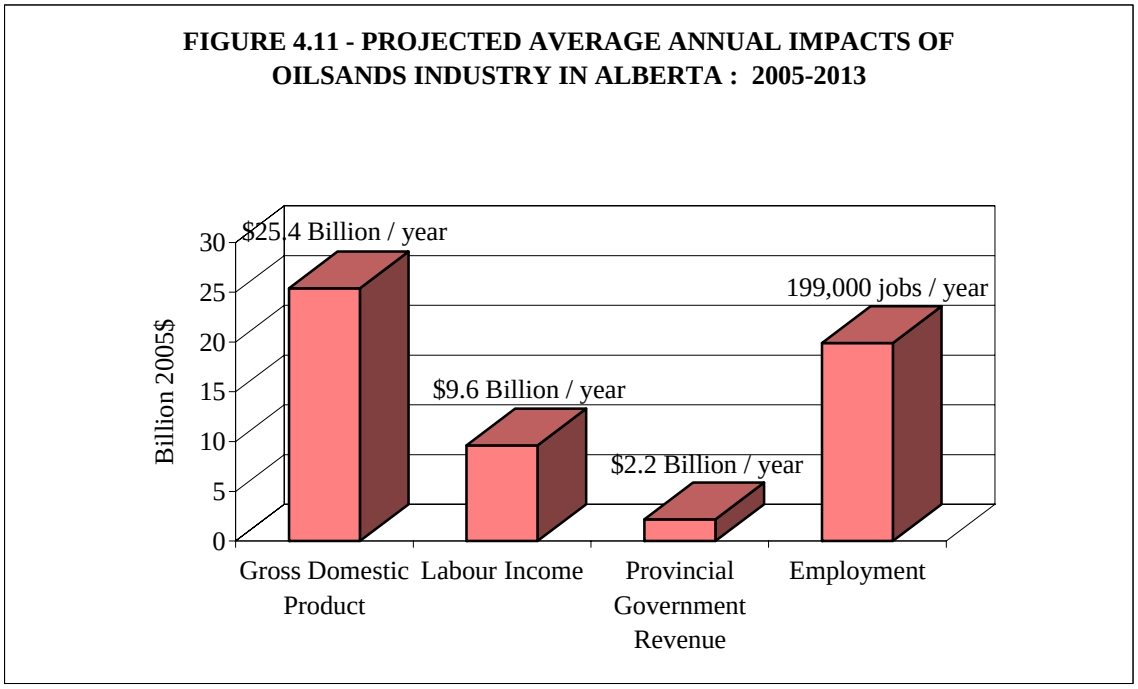


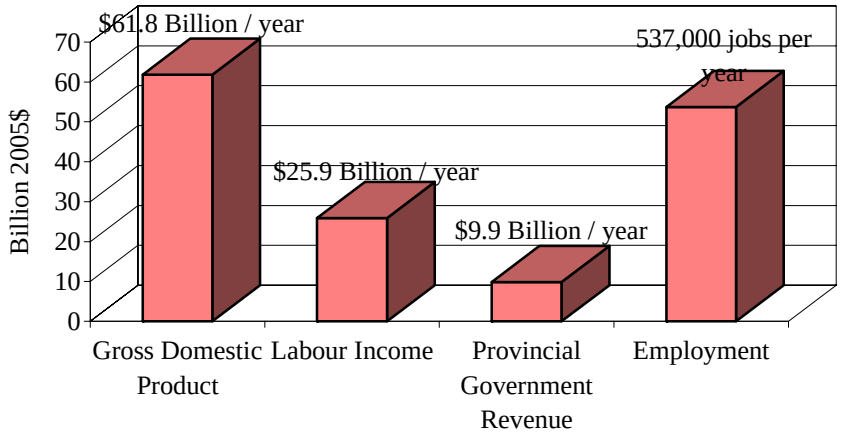

Figure 4.11 illustrates the forecast average annual impacts associated with the oil sands industry over the forecast period to 2013. The average annual impact on provincial GDP associated with this industry is projected to be $25 billion and this would represent about 12 percent of total Alberta GDP given the growth rates incorporated in the AEUB forecast. Close to 200,000 jobs per year would be linked to the oil sands, comprising about 10 percent of the total expected employment in the province. The significance of the oil sands industry in the future is anticipated to be much greater than in the past, where the contributions to historical GDP and employment were shown to be roughly 6 percent and 4 percent respectively since 1971 (see Section 3).

## *Projected Impacts of the Conventional Oil and Gas Industry*

Impacts related to the conventional industry are shown in Figure 4.12. Aggregate GDP and employment impacts between 2005-2013 total $560 billion and 4.8 million person-years respectively. On an average annual basis, this corresponds to $62 billion per year in GDP and 540,000 jobs per year. These would represent about 28 percent of provincial GDP and 27 percent of provincial employment given the AEUB's forecast growth rates for the Alberta economy. Furthermore, the average annual impact on provincial government revenue of almost $10 billion per year would constitute about one-third of the anticipated total during this period.

Figure 4.12

**FIGURE 4.12 - PROJECTED AVERAGE ANNUAL IMPACTS OF CONVENTIONAL OIL AND GAS INDUSTRY IN ALBERTA : 2005-2013**



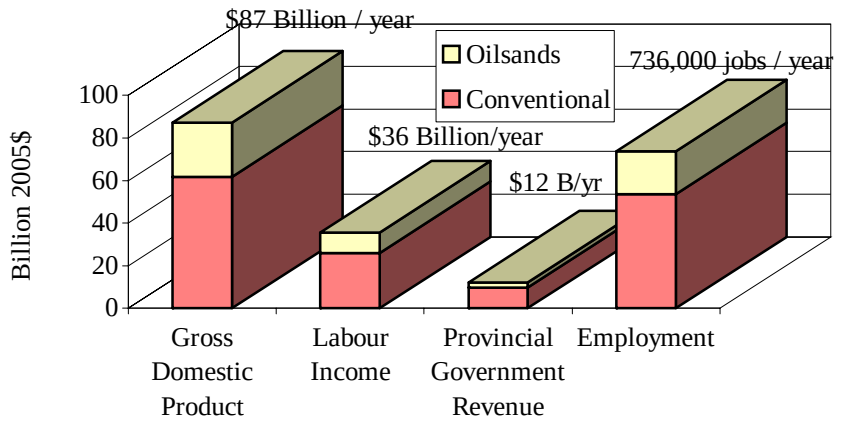

## *Projected Impacts of the Oil and Gas Industry*

The combined effect of the conventional and oil sands industries on the Alberta economy over the period 2005-2013 is summarized in Figure 4.13. The average annual contribution to provincial GDP is projected to be $87 billion per year and would comprise 40 percent of overall provincial GDP. This percentage is slightly lower than that observed in the historical period (42 percent) but remains substantial. The relative contribution of the sector to employment in the province is forecast to increase from 31 percent in the historical period to 37 percent in the forecast period. Roughly 740,000 jobs per year would be attributable to the oil and gas sector between 2005 and 2013.

The relative increase in employment impacts compared to the historical period relates primarily to two factors. First, the fact that it is becoming more difficult to sustain or limit the decline in conventional oil and gas production means that more exploration and development effort will be required in the future in order to get a unit of production than in the past. Since the employment impacts associated with oil and gas industry investment are substantially larger than those related to oil and gas industry production, employment impacts are anticipated to rise in relative terms as time progresses.

Figure 4.13

**FIGURE 4.13 - PROJECTED ANNUAL AVERAGE IMPACTS OF THE OIL AND GAS SECTOR IN ALBERTA : 2005-2013**




Second, the creation of labour income by the oil sands industries is forecast to be relatively more significant than in the past. The employment impacts associated with the spending of labour income are much larger than either investment or production-related impacts so this adds to the enhanced relative employment impact over the forecast period.

In concluding this section it should be emphasized that these estimated contributions of the oil and gas industry to Alberta's economic future are subject to considerable uncertainty. As noted in the next section, there are many challenges that need to be met in order to attain even the levels and contributions shown. Equally important, however, is the possibility of exceeding these levels if we are prepared to make visionary investments and policies aimed at responsibly unlocking a larger portion of the province's huge energy potential.

# 5. UNCERTAINTIES, CHALLENGES AND OPPORTUNITIES

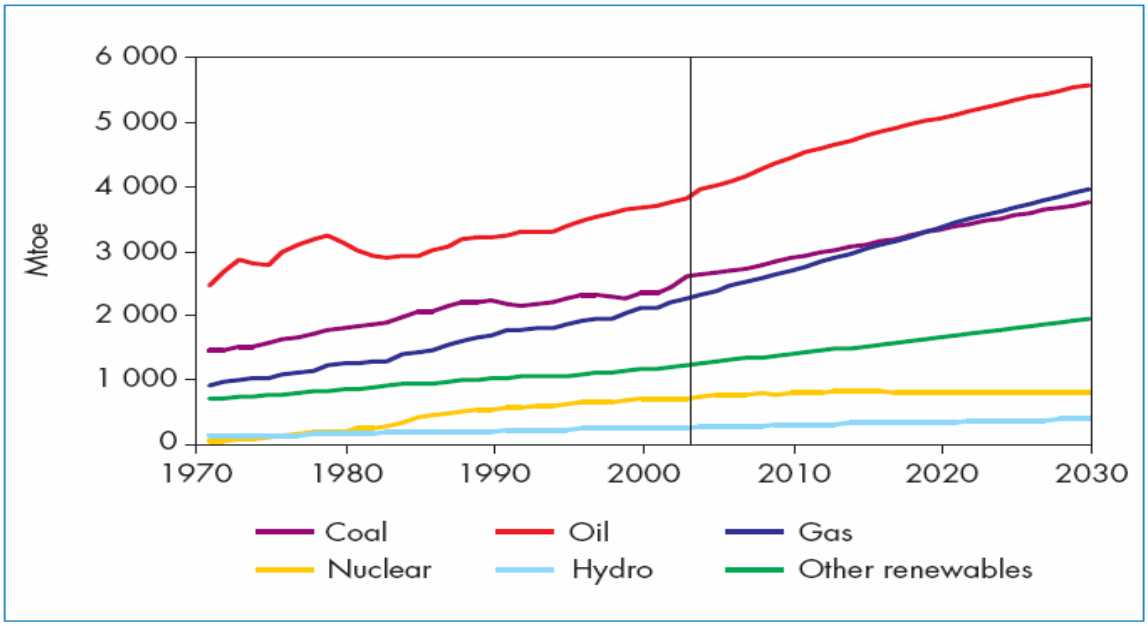
It is clear that the oil and gas industry will remain the main engine of Alberta's economic growth and prosperity for many decades to come. Simply put, it is such a dominant sector in terms of both size and impact it is difficult to imagine the possibility of another sector with the prerequisite comparative advantage and size to significantly replace energy as the key driver of the provincial economy. Yet the relative impetus provided by that engine is uncertain and, while there is the possibility of converting the province's huge energy potential into sustained, long-term prosperity, there are large challenges. These are highlighted in this section.

## 5.1 Opportunities

### *Growing Demand*

Energy and related environmental concerns will likely prove to be defining issues of the 21st century. It is highly certain that as long as there continues to be economic and population growth, the global demand for energy will continue to increase. Indeed, increasing supplies of energy are required to sustain economic and population growth and rising living standards. As shown in Figure 5.1 below, the projections from the International Energy Association suggest that globally the growth in the demand for energy will average 1 percent annually and increase by 50 percent by 2030. More than two-thirds of this increase in demand is projected to be in developing countries and, even in 2030, 81 percent of this demand will be met by oil, gas and coal.

**Figure 5.1-World Primary Energy Demand by Fuel in the Reference Scenario**




**Source: International Energy Association, *World Energy Outlook*, 2005**

Along with this expectation of continued growth in global energy demand, it is also quite certain that declining conventional oil and gas reserves and ever-increasing environmental constraints - from water restrictions, to resource access, to greenhouse gas limits - will present huge challenges. In summary, it would seem that the era of relatively cheap and accessible energy is over. However, there are great opportunities for those who can supply increasing amounts of safe, clean, secure and competitively priced, albeit more costly, energy.

## *Huge Supply Potential*

In this context, Alberta's huge energy potential stands out as a beacon of economic opportunity. Indeed, the province contains one of the largest concentrations of energy resources in the world. The remaining established reserves that are recoverable given current knowledge, technology and economics include 174 billion barrels of crude bitumen, 1.6 billion barrels of conventional crude oil, 41 trillion cubic feet of natural gas and 37 billion tons of raw coal. However, the potential recoverable reserves are much greater. They consist of 315 billion barrels of crude bitumen, 20 billion barrels of conventional crude oil, 223 trillion cubic feet of conventional gas and coal bed methane, 683 billion tons of raw coal, plus undetermined but substantial potential for alternative and renewable energy.[24]

While the oil sands resource is currently receiving most of the attention in terms of future potential, it is important that the other elements of this large energy resource portfolio not be overlooked. For example, current recovery rates for conventional oil and gas are, respectively, 27 and 59 percent. However, it is believed that, with a long-term commitment to research, development and deployment of new technologies, the recovery factor for conventional oil could be ultimately raised to an average of 41 percent and that for gas could be increased to 72 percent. Such an increase in the oil recovery factor would translate into 8.4 billion additional barrels of oil generating over $30 billion in royalties and over $550 billion in GDP. The increase in the gas recovery rate means an additional 32.5 trillion cubic feet of gas that would increase royalty income by about $16 billion and GDP by over $250 billion.[25] Since most of the physical infrastructure is already in place, a further benefit is that very little additional public expenditure would be required and the environmental footprints may be more easily managed.

Success in advancing knowledge, technology and economics to convert even a modest portion of the ultimate potential into clean, secure and competitive energy supplies translates into a huge prize. Given the size and location of this resource base, it would seem that energy represents one of the clearest and most significant examples of comparative advantage for Alberta and Canada in an increasingly competitive global economy. Put simply, we have the potential to become an energy superpower in a world with an ever-growing appetite for energy.

---

[24] Figures from AEUB, ST98-2006, *Alberta's Energy Reserves (2005) and Supply / Demand Outlook 2006-2015*, p.2.

[25] See Petroleum Technology Alliance of Canada, *Spudding Innovation*, October, 2003.

In spite of the huge potential, it is far from certain that even a modest portion can or will be converted to sustainable prosperity. The uncertainties and challenges are daunting. In general, most of the lowest-cost oil and gas resources in the province have been discovered and the costs of producing the large remaining conventional reserves and the mostly untapped unconventional reserves will be much greater. They are fundamentally more difficult to produce, and especially more difficult to produce in an environmentally responsible manner. They will require major advances in technologies even for an industry that is already technologically very sophisticated. And they will require even more capital and energy-intensive processes that can be efficiently and cleanly operated in an environment with increasing constraints on water usage, emissions, landscape footprint, and use of 'premium' energy such as natural gas.

## 5.2 The Curse of Natural Resources

It is instructive at the outset to examine some of the more fundamental challenges associated with building stable and sustained prosperity based on natural resources.

It has been observed based on long-term data for many societies around the world that resource abundance does not typically translate into strong economic performance as measured by many indicators such as growth rates, stability and high average living standards. This surprising result is referred to as the 'curse of natural resources'[26] and a large literature has developed to explain the tendency for a negative rather than a positive correlation between resource abundance and key aspects of economic performance. Indeed, Alberta is among the exceptions to this tendency.

While the precise reasons for this 'curse of natural resources' have yet to be fully disentangled, there are a number of broad themes identified in the literature. The following provides an overview and their relevance to the case of Alberta.

### *Dissipation of Rents and Inefficiency*

Many natural resources have important common property elements and, in the absence of appropriate regulation, they are exploited at rates and in ways that dissipate or destroy the associated economic rents. Simply put, these rents are the difference between the market value of the produced resource and the cost of labour and capital resources required to produce the resource. All or a portion of these rents can be appropriated by the owner of the resource (often the Crown) through royalties or taxes and expended or distributed in various ways. Without appropriately designed rights structures and regulation, the 'rule of capture'[27] often dominates, leading to an over-exploitation of the resource, a destruction of the economic rents and sometimes the destruction of the resource itself. In

[26] For a summary of the literature on the curse of natural resources see: Allan H.Gelb and Associates, *Oil Windfalls: Blessing or Curse?*, New York: Oxford University Press, 1988; Raymond F. Mikesell, "Explaining the Resource Curse, with special reference to mineral exporting countries," *Resources Policy*, 23 (1997), 191-199; and, Jeffery D. Sachs and Andrew M. Warner, "The Curse of Natural Resources," *European Economic Review*, 45 (2001), 827-838.

[27] That is, where the benefits go to the party first able to capture the resource.

the context of conventional oil and gas, such a case arises where each producer attempts to drill as many wells as possible to capture production from a common pool before it is captured by competitors. The result is too much investment, the destruction of the primary drive in the reservoir (which means less of the resource is recovered) and excessive production (which drives the price below sustainable levels and encourages further waste).

It will suffice to note that with the formation of the Petroleum and Natural Gas Conservation Board in 1938, which later became the Energy Resources Conservation Board and then, in 1995, the Alberta Energy and Utilities Board, Alberta has been a world leader in regulatory practice to prevent this inefficiency and waste.[28] The Board's focus on conservation and ensuring "economic, efficient and orderly development in the public interest" has served the province extremely well. It has largely prevented the types of inefficiency and waste that have destroyed the sustainable benefits of conventional oil and gas resources in many other parts of the world. A key challenge will be to ensure these types of enlightened regulation are applied to the province's increasingly important unconventional oil and gas resources.

## *Rent Dependency*

A related element of the 'curse of natural resources' is the tendency for societies benefiting from natural resource rents to become 'rentier' societies. That is, they become overly dependent on these rents to finance current consumption expenditures rather than reinvesting a portion for the future. As such, the policy focus tends to be on how the rents should be spent and there is little recognition of the need to reinvest in good resource stewardship. This would include investing in the development of technologies and policies that would extend the sustainability and/or value of the resources.

An excellent example of the latter was the long-term commitment by the Government of Alberta in the 1970s to invest in developing oil sands technologies. Much of the current development of the oil sands can be attributed to the technologies generated through the Alberta Oil Sands Technology Research Authority (AOSTRA) program. This involved a joint government and industry investment of about $2 billion in oil sands research and development (R&D) over the 20 years AOSTRA operated and it illustrates how reinvesting energy rents can lead to an expanding resource base, both in physical and value terms.[29]

These examples notwithstanding, Alberta, and indeed Canada, is not immune to the tendencies to spend rather than invest resource rents. It is noteworthy that overall energy and environment R&D has fallen more or less continuously in Canada since the early 1980s. Measured in real or constant dollar terms, today it is about one-third of what it was in the early 1980s and this may in part be a reflection of the rent dependency

---

[28] For a history, see David H. Breen, *Alberta's Petroleum Industry and the Conservation Board*. University of Alberta Press (1993).

[29] The successor to AOSTRA is the Alberta Energy Research Institute (AERI). See www.aeri.ab.ca for other examples of investments that have expanded Alberta's energy resource base.

phenomenon.[30] In any event, it will be a significant task to substantially reverse this trend in R&D and bring it to levels consistent with the magnitude of the energy opportunities and challenges. It is encouraging to note recent increases in R&D funding by the provincial government.

### *Dutch Disease*

This element of the natural resources curse is associated with the impacts of a booming primary sector such as oil and gas. The term 'Dutch Disease' was initially coined to describe the less desirable impacts associated with the rapid development of oil resources in the North Sea in the 1970s. Since that time it has been used more generally to describe the negative impacts on the structure and stability of an economy when a key primary sector expands in response to a significant increase in resource prices. For example, with higher energy prices, the energy sector can and will pay much higher wages and other input prices in order to attract the resources necessary to expand. However, this has negative impacts on some other diversifying sectors in the economy which do not see higher prices for their goods or services. For example, they may be unable to offer the higher wages needed to be competitive with the booming energy sector and may be forced to retrench or move to another region not experiencing a resource boom. As well, there may be significant impacts via exchange rate mechanisms. To the extent that the higher prices and production of the energy sector creates an increase in the value of the domestic currency in international markets it will be more difficult for other sectors to remain competitive in export markets.

It is difficult to quantify how much dislocation and 'de-diversification' there has been in recent years as a result of the booming energy sector. It is clear that the relative contribution of the energy sector to the provincial economy has increased significantly over the past five years or so, similar to the situation between the mid-1970s and early 1980s.[31] In other words, there has been an increase in the degree of specialization of the economy in energy production and, by extension, a relative decline in the contributions of other sectors. Anecdotal evidence of increasing difficulty of some sectors being able to compete for labour also suggests that Dutch Disease stresses are becoming a concern.

### *Instability*

As outlined above, the reductions in diversification (or increase in specialization) associated with Dutch Disease can make a regional economy less stable. However, there is a more direct concern related to the increase in the size of investment expenditures in the economy.

The high capital intensity of the energy sector translates into a large impact on the provincial economy via investment expenditures. Such expenditures are, however, more sensitive to actual and expected market, monetary and policy factors than are the other elements of aggregate demand which include consumer expenditures, government

[30] For example, according to estimates published by the International Energy Agency, by 2000 total energy R&D in Canada had fallen to about $250 million per year (measured in year 2000 dollars) compared to about $750 million in the mid-1980s.

[31] This can be observed from the results summarized in Figure 3.8.

expenditures on goods and services and net exports (or exports minus imports). Investment is inherently the most variable element of aggregate demand and its relatively large size in an energy-driven economy such as Alberta's can lead to economic instability.

Given the strong demand for energy and relatively high prices, the investments by the conventional oil and gas and oil sands industries alone are expected to be in the range of $20 billion per year.[32] As well, there are substantial social and physical infrastructure investments required to address infrastructure deficits accumulated over the past several decades and to accommodate the strong growth of the provincial economy. In combination with the investments by industries directly or indirectly impacted by energy sector investment, and an economy already operating at full employment, it will be a challenge over the next few years to avoid substantial swings in overall investment levels and their impacts on the regional economy.

This inherent variability associated with investment is compounded by the variability in energy prices and, if history is a guide, potential variability in energy and environmental policies. While it is reasonable to expect future real oil and gas prices to be, on average, much higher than historical levels, these higher prices also translate into greater volatility and thus more potential for substantial swings.

## 5.3 Key Challenges

The issues discussed above should serve as constant reminders that vigilance is required to avoid the pitfalls associated with resource-based economic development. While Alberta has done a remarkably good job of building a strong and prosperous economy from its energy resources, it is not immune to the often seductive elements of the natural resources curse. In this section, however, we turn attention to some of the more specific short-and longer-term challenges that must be confronted if the province is to convert the huge energy potential into sustainable growth and prosperity.

### *Fundamental Objectives*

The nature of the specific challenges that must be confronted is closely related to ultimate provincial goals. Putting it as simply as possible, it is important to determine whether, for example, the objective is to maximize Alberta's aggregate income and output or whether it is to maximize sustainable real per capita income and output. One is aimed at growing the overall size and influence of the province and maximizing opportunities for the largest number of people (including individuals not yet resident in Alberta); the other is focused on growing the average per capita living standards (including quality of life) for its residents. Expressed differently, it is critical that we distinguish between extensive and intensive (value-added) growth and development. For the former, a rapid expansion of energy resource development and increasing exports of relatively unprocessed energy products is called for. However, if it is the latter, the focus must be more on maximizing

[32] For example, see Figure 4.6.

the net benefits (the difference between overall benefits and costs) associated with resource development of multiple higher-value products and this is likely to mean a more measured overall growth rate but greater stability and sustainability.

To cast this issue in concrete terms it is perhaps useful to provide an example. Attempting to accommodate a rapid development and export of relatively low-value, unprocessed resources will lead to strong economic growth. However, to the extent that it produces dislocations such as those associated with Dutch Disease, the end result may well be that real per capita incomes (that is, average incomes adjusted by changes in the prices of consumer goods and services, including housing costs) actually decline and become less stable.

In practice, it is not possible to define the fundamental objective for a complex society in such simple either/or terms. For example, it is important to take into account benefits to other Canadians outside the province rather than just the benefits to residents of Alberta. And, it is not always possible to simply delay or stretch out the benefits; foregone opportunities may be permanently lost. Nevertheless, when examining the particular challenges, opportunities and their priorities, it is important to have some notion of the appropriate and necessary balance between extensive and intensive development and growth. Ultimately, one would expect that in a democratic society this 'appropriate' balance would be determined by informed political debate and, as such, it is not our objective here to suggest what that balance should be. Rather, it is to provide a caution that in the absence of clarity on the appropriate balance we run the risk of focusing on means rather than ends and on symptoms rather than causes.

## *Role of Government*

A related and equally difficult issue concerns the role of government in managing the rate of growth and development in a resource-driven economy. Clearly, as the steward of the resources, the provincial government has a responsibility to ensure that they are developed responsibly within the context of all determinants of societal welfare, including environmental quality, and to ensure the resources contribute to sustainable long-term prosperity. Among other things this involves orderly and efficient social and physical infrastructure development. It also involves predictable governance and regulatory structures that clearly define resource rights and provide a framework for well-functioning markets that take into account all costs and benefits associated with resource development.

However, resource-based development is inevitably uneven and it is less clear what the provincial government's role should be in smoothing the inevitable economic swings arising from fluctuations in key factors such as externally determined energy prices. The tools it has available for such a mission are limited, particularly as it does not control key levers, such as interest rates, that are commonly used to smooth economic fluctuations. Further, in a highly capital-intensive economy like Alberta's and one where the investments in the key energy sector typically have very long lives, policy stability and

predictability is critical.[33] As such, shorter-term variations in the fiscal instruments the provincial government has available are generally not advisable. This aside, there is also the issue of whether it is realistic to expect the government would have the ability to foresee impending swings soon enough and to respond quickly enough to counteract the economic fluctuations.

Nevertheless, it can be argued that, at a minimum, actions of the provincial government should not exacerbate the fluctuations. For instance, it seems sensible to adhere closely to long-term social and physical infrastructure planning and implementation. This would mean a deliberate program of longer-term funding commitments to allow infrastructure upkeep and additions to proceed at a reasonably steady rate. Such an approach would reduce the destabilizing tendency for such expenditures to fall sharply when private sector investments drop and the economy slows and to rise sharply when private sector investments are high and the economy is growing rapidly.

Perhaps more importantly, there is room for informed discussion on the appropriate role of government in an environment of risk and uncertainty.[34] In evaluating or charting Alberta's energy and economic future there are many elements which are not known or even knowable. For example, substantial climate change, dramatic shifts in future U.S. energy policies or the development of 'game-changing' energy technologies would all have major implications for the province.[35] Such events cannot be accurately predicted or foreseen and highlight an increasingly important role for the government of good asset and risk management.

The implications of incorporating an asset and risk management framework in setting policy and regulatory agendas should not be underestimated. Within such a framework there is an explicit recognition that virtually all activities, including resource development, have negative impacts along with the benefits and there is uncertainty about both. Consequently, the focus shifts from the (false) notion that good decisions can eliminate risks of undesirable outcomes to a more realistic notion that good decisions are more about how uncertain impacts in an uncertain world can be acceptably managed.

Within this framework there is more of a focus on the longer term, on preserving, developing and preparing for future options, and on minimizing the likelihood of irreversible or very damaging future outcomes. For example, in an Alberta context this would mean approaching the vast array of resources as a 'portfolio.' These assets, like those in a 'financial portfolio' are subject to varying degrees of risk and uncertainty and established principles and tools for risk and portfolio management can be applied.

---

[33] Uncertainty and unpredictability are major barriers for investments with long lives and where the assets are sunk and specific (that is, they cannot be transferred to another location or use).

[34] Risk refers to a situation where there is sufficient information to establish probabilities of a particular event occurring; uncertainty is where there is insufficient information to even establish probabilities.

[35] Imagine, for instance, the impacts associated with severe constraints on the use of water resources for oil sands production, a major push by the U.S. to dramatically increase imports of Liquified Natural Gas and expand nuclear generation capability, combined with major improvements in the economics of novel hydrogen production.

Good management, as in the case of a well-managed financial portfolio, would mean balance and diversification. These principles would suggest, for example, that it would be an error to place all or even most of our bets on one component (say, the oil sands) as the key to Alberta's future. Rather, they would suggest the advisability of investing in the development of a range of energy opportunities. At the same time, however, they would recommend differential weighting or shares of investments in the various alternatives based on fundamental comparative advantage and the size of the potential payoff. These principles would suggest that the largest weighting be on technologies and policies to recover, upgrade and 'green up' the province's large and diverse fossil fuel base. For example, this heavier weighting would involve becoming world leaders in research and development for technologies and policies focused on clean and efficient *in situ* recovery and upgrading of the oil sands (given that most of this huge resource is too deep to mine), on unconventional gas (given the size of the potential and the fact it will remain a premium energy source), and on integrating technologies that would take advantage of the large supplies of (but often low-value) coal, biomass and by-products and the associated substantial potential for upgrading into high-value products such as electricity, gas and petrochemicals.

The principles within an asset and risk management framework emphasize the importance of integration. They recognize that the various energy paths are not independent but, rather, have systematic negative or positive covariance tendencies. In other words, the range of future outcomes is determined not just by the ranges of uncertainties for each energy resource or energy path but even more importantly by the degree to which they are likely to vary in similar or opposite directions.[36] Further, the variance of each energy path is heavily dependent on the level of upgrading. In general, the higher the level of upgrading the less is the variance.

There are other elements of integration that are important in this context. There is little doubt that the largest gains will come from an ability to integrate energy types and to integrate energy and the environment. Rather than viewing each energy type in isolation, it seems far more productive to consider the richness of combinations. For instance, many types of renewable or alternative energy are unlikely to be economic on a stand-alone basis. However, when combined with conventional or unconventional energy and related infrastructure, the prospects of such 'hybrid' systems being economically viable are much improved.

Consider also the gains through integration via 'polygeneration,' along with carbon capture and storage. As already noted, relatively low-value energy sources such as coal, coke or biomass can be converted (using a platform technology such as gasification) into a range of high-value end products like electricity, gas and petrochemicals. This adds a considerable degree of value added and market diversification. At the same time, it offers the potential for the capture of pure carbon dioxide in large quantities that can be

[36] Negative covariance refers to a situation where they tend to vary in opposite directions while positive covariance is where they tend to more together. The variance of a portfolio consisting of elements A and B, for example, would be: Var (A+B) = Var (A) + Var (B) + 2 Cov (AB). If can be observed that if there is negative covariance the variance of the overall portfolio is substantially reduced.

used to produce larger volumes of conventional oil and/or be permanently stored in the many depleted petroleum reservoirs in the province. In essence, the synergy creates added value and can assist in covering the cost of mitigating greenhouse gas emissions.

Other implications of adopting an asset and risk management framework include a greater emphasis on carbon management and on integrated resource management. It seems clear that the future will be increasingly carbon constrained. In such a future, having a large carbon-intensive base of unconventional oil and coal may not represent a valuable asset without an efficient and effective carbon-management system. However, with the large potential for carbon capture, use and storage, this would seem to be an important element of the province's asset and risk management strategy.[37]

The case for development and implementation of integrated resource management is similar. A more systematic, integrated and comprehensive approach could be helpful in ensuring available synergies are captured, the inevitable tradeoffs are transparent and considered, and the full costs and benefits (including those related to the environment) are captured in pubic and private decision making. For example, this could involve more of a regional regulatory approach (versus the traditional well-by-well or plant-by-plant approach). A related consideration should be the development of integrated energy and environment market systems. While there will always remain the need for the government to employ some 'command and control' approaches to resource management, in an environment where the interactions among resources (including environmental resources) are increasingly important and complex the only practical and efficient way of achieving efficient, effective and coordinated outcomes is to employ well-designed market systems. Well-functioning markets that generate the 'right' signals and incentives for optimal outcomes do not simply materialize. Rather, they must be developed and this is a key role for the government.

## *Specific Challenges*

Along with the broad, fundamental challenges of the types discussed above, there are many specific issues and challenges that are frequently found in the daily media headlines. For the most part these are dealt with at length in the other papers in this Series and in other reports. The objective here is to simply provide an overview and a few contextual remarks.

- **Access to sufficient labour and highly qualified personnel, demographic shifts, and net in-migration.** The provincial economy has been operating at or close to full employment in recent years and these tight labour market conditions are expected to continue for the near term. As noted earlier in Section 5.2, there

[37] The Western Canadian Sedimentary Basin provides opportunities to absorb immense quantities of carbon dioxide through enhanced oil and coal bed methane options, the use of depleted oil and gas reservoirs and injection into deep saline aquifers. These are large enough to store all of Canada's carbon dioxide emissions for centuries. A particular focus within an asset and risk management approach would be on improving the economics of carbon dioxide capture and the development of the necessary policy framework.

are concerns that continuing shortages of labour and the impacts on wages and costs will have undesirable longer-term impacts on the structure of the provincial economy (that is, where a booming primary sector causes dislocations in other sectors and ultimately a narrower economic base). Given the dampening effects expected from an inevitable narrowing of oil and gas price and cost differentials (particularly as costs are driven up), along with the current path of stable or declining gas production, it is reasonable to expect some weakening of labour demand growth in the medium term.

Nevertheless, achieving adequate supplies of highly educated, trained and experienced labour will undoubtedly remain a significant challenge for Alberta. Compounding the growing demands for labour arising directly and indirectly from the expansion of the energy sector is the need to replace those workers who will be retiring in accelerating numbers over the next five to ten years. Taking these into account, current projections suggest substantial worker shortfalls over the next decade.[38] It is useful to note, however, that adjustments in wages and costs will ultimately maintain labour supply and demand balance (for instance, by dampening the demands in some sectors). The real question is what these types of adjustments mean in terms of achieving sustainable prosperity. The tendency for productivity levels to suffer under sustained conditions of full or over-full employment represents a further challenge.

Historically, the province has been able to fill its growing needs for highly qualified labour through substantial rates of net in-migration. Because migrants tend to be in the prime working ages and embody high levels of education and training this has allowed the province to maintain one of the youngest populations in Canada, along with one of the most highly educated populations. The latter has been in spite of having one of the lowest post-secondary participation rates.

The projections discussed in Section 4 suggest that Alberta can continue to maintain above-average growth in employment and incomes and this translates into continued positive and substantial net in-migration rates. However, it seems unlikely that the rates can be maintained at the high levels experienced in recent years. The demographic changes occurring in other regions and countries will undoubtedly mean a shrinking source of potential inflows. Further, particularly in the current environment, there are increasing constraints on the provinces ability to expand the social and physical infrastructure necessary to accommodate such high rates of net in-migration over a lengthy period of time.

Perhaps the most important challenge will be to provide the education and training opportunities to maintain a dynamic and highly educated labour force. As noted earlier, developing such resources is key to securing a strong economic future for the province. While there will always be uncertainty about future

[38] See, for example, sector specific reports such as that by the Petroleum Human Resources Council (April 2005) or Alberta Human Resources and Employment, *Alberta's Occupational Demand and Supply Outlook, 2005-2015* (November 2005).

challenges and opportunities in the province, having a high-quality, dynamic, adjustable and innovative labour supply can provide assurance that, however the future unfolds, the challenges can be met and the opportunities can be unlocked.

- **Resource access and related infrastructure development challenges.** It is reasonable to expect increasing density/intensity of development associated with future energy-related growth. Resource recovery activities will intensify and generally move into more remote and/or sensitive areas such as those close to urban areas. Increased tensions between holders of surface rights and those exercising mineral rights and between the need for energy development to maintain prosperity and the demands for reduced environmental/landscape impacts seem inevitable. These may well be exacerbated by the inability of many residents to see the connection between their economic welfare and energy investment and production. Further compounding the difficulty is the tendency to view each of energy, the environment and the economy as individual and isolated components rather than as an interconnected and integrated 'complex' or interface. Managing these tensions will undoubtedly require increasingly sophisticated and demanding regulatory and policy stewardship.

  Along with these resource access issues, there is the challenge of building adequate social and physical infrastructure to support energy-driven growth and development. In the near term there are the issues of cost escalation and finding sufficient labour to build and operate the added infrastructure. In many areas there are large amounts of deferred maintenance accumulated over the extended period of fiscal restraint particularly during the 1990s, along with the added infrastructure just to accommodate the population and economic growth over that period. In addition, the infrastructure requirements to accommodate recent and expected growth are large.

  These infrastructure deficits also present a fiscal challenge. On average, over the past few decades government investment has averaged about 10 percent of business investment. This would have to increase substantially in order to address the infrastructure issues but may be difficult to accomplish within the current fiscal arrangements. That is, without the ability to debt-finance substantial portions of these growing infrastructure requirements, the reliance has been on current government revenues. However, given the trends in these revenues over the longer term (especially as non-renewable resource revenues decline) and taking into account the large fluctuations from variations in energy market conditions, it will be a significant challenge to finance these requirements without higher tax rates or incurring provincial debt.

- **Water and carbon management.** Although the oil and gas industry is a relatively small user of fresh water resources, it seems likely that there will be increasing sensitivities around water use by the industry as overall water constraints become more binding. While these constraints are generally expected to be more severe in the southern parts of the province, they will also become

increasingly important in the Fort McMurray region. In the latter case, issues around the size of the draw on the Athabasca River by new mining projects and around the oil sands' large tailings ponds will likely remain high on the water management agenda. Additional issues arise from the concerns that recovery activities for conventional and unconventional oil and gas in some formations could possibly contaminate aquifers and fresh water supplies in the immediate area.

At the same time it is useful to note that the oil and gas industry is a major producer of water and often in the areas where water constraints are likely to become most binding. There are prospects that these water supplies can be treated and reused for certain purposes, such as irrigation, rather than being reinjected into the oil or gas reservoirs where they originated.

It is reasonable to expect that carbon management issues will only grow in importance over time. This represents a major challenge for a fossil fuel-producing region such as Alberta, and particularly the oil sands and coal/electricity segments of the energy sector. Indeed, it is hard to see how the province would be able to become a growing energy power without becoming an acknowledged 'clean' energy leader. This would require leadership in energy efficiency, in substantial 'greening up' of its fossil fuels, along with the continued development of renewable and alternative energy. As discussed earlier, the province has the potential to become such a leader.

- **Gas supplies, costs and oil sands development.** The larger challenges associated with the decline in the dominant conventional gas industry were noted in Section 4. These include the dampening effects on overall growth in the province, declining natural gas-sourced feedstocks for the large petrochemical sector, and declining non-renewable resource revenues for the provincial government.

  It is also important to note the large quantities of natural gas currently required for producing hydrogen for oil sands processing/upgrading and for heat, particularly in the context of *in situ* oil sands recovery. It might be noted that about 90 percent of the oil sands resource is too deep to mine and, further, without upgrading, the production and sale of bitumen does not lead to high levels of value added for the province. In addition to these impacts, the expected declines in natural gas and gas liquids production will have serious implications for the large petrochemical industry in the province.[39] These declines, combined with an inability to access significant ethane exports from the province, mean additional and less ideal feedstocks (such as propane in the short run or feedstocks associated with refining and bitumen upgrading in the longer term) must be developed to keep even existing petrochemical capacity utilized at reasonable levels required for economic viability.

[39] It should be noted that Petrochemicals represent the largest component of Alberta's manufacturing sector and an important source of value added overall.

A key challenge will be to develop technologies that allow lower-value energy (such as coal or residuals and by-products from oil sands processing) to substitute for natural gas use in the oil sands and to allow these lower-value energy sources to be economically and cleanly converted into petrochemical feedstocks.

- **Increasing costs**. With the maturation of the Western Sedimentary Basin, it is reasonable to expect that discovery and recovery costs for conventional oil and gas will continue to increase in real terms.[40] Without offsetting increases in real oil and gas prices and/or significant technological advancement, total economic rents available for sharing by the industry and government decline. It is not realistic to expect significant and continued increases in real oil and gas prices over the long term. And, the technological advancements are far from certain. In general, the oil and gas industry is typically near the bottom of the rankings in terms of research and development (R&D) expenditures as a percentage of revenues and oil and gas R&D expenditures by the government sector in Canada are still approximately one-third of what they were 25 years ago.

  The high and escalating construction costs for large energy projects, particularly those associated with oil sands development represent a further challenge. Unless these can be more effectively managed, particularly in an economy with very low unemployment rates, the investment expenditures underpinning the provincial economic projections noted earlier could be quite optimistic.

## 5.4 Opportunities and the Way Forward

The challenges outlined above are daunting. But there are also huge opportunities for substantial expansion of the energy sector well beyond that envisioned in the projections presented in Section 4. More importantly, these provide an opportunity for sustainable prosperity. It seems highly probable that the demand for oil, natural gas and coal will continue to grow at a very significant rate over the foreseeable future. And, there is little doubt that in terms of sheer energy potential there are few other regions in the world that can match Alberta's concentration of unconventional oil, conventional oil and gas, unconventional gas, coal, coke and various alternative and renewable energy sources.

### *Opportunities*

Here we highlight a few examples of the opportunities.

- **Advanced *In* Situ Recovery and Upgrading.** About 90 percent of the huge oil sands resource is too deep to mine and must be accessed using *in situ* technologies. SAGD (or steam assisted gravity drainage), a technology developed

[40] In general, these cost pressures are most severe when oil and gas prices are high and rising. For example, land and drilling costs typically rise significantly as overall activity levels increase in response to higher oil and gas prices. The danger is that once these higher costs become embedded, any subsequent declines in oil and gas prices create serious dislocations.

by Dr. Roger Butler at Imperial Oil and at the University of Calgary more than 20 years ago, is the most common *in situ* technology now being incorporated in commercial projects. While this technology has unlocked billions of barrels of bitumen, it is not adequately efficient, particularly in an environment of high natural gas prices, costly diluent requirements and tight water constraints. However, it seems entirely feasible to achieve step-changes for *in situ* technology that would allow much higher recovery rates along with a significant degree of *in situ* upgrading. For example, technology now being developed[41] involves new approaches (such as catalysts dispersed in the formation and then recovered, along with underground combustion and gasification) that would substantially reduce the natural gas requirements (for heat and hydrogen for upgrading), greatly reduce water requirements, eliminate the need for diluent to transport the bitumen and result in a much higher level of value added. With just a modest 10 percent increase in the recovery and upgrading rate, this would translate into about $260 billion of GDP, $100 billion in labour income and $29 billion in government revenues. A further advantage is that this type of technology does not require large centralized facilities and would build on the strengths of the many world-class service and supply industries in Alberta that developed with the conventional oil and gas industry.[42]

- **Unconventional Gas Development.** There is huge potential for unconventional gas, particularly in the form of natural gas from coal (NGC) and tight gas. In short, the potential for unconventional gas could be as important as that for unconventional oil. However, it will be a significant challenge to convert this potential into high production levels. In general, these resources are higher cost, especially at current levels of technology development and particularly because the productivity of wells is low (but can be maintained for much longer periods than conventional gas). The rents available to government may be significantly less than for conventional gas and it seems likely that substantial policy and regulatory changes will be required given the quite different characteristics of unconventional gas production.[43]

- **Enhanced Conventional Oil and Gas Recovery and GHG Mitigation.** The potential for increased recovery of conventional oil and gas is also believed to be large. For example, almost 70% of conventional oil and 40 percent of conventional gas cannot be recovered using current technology. However, by developing advanced recovery techniques (for example, through $CO_2$ injection) these rates can be markedly increased and with huge benefits. For the most part, the required infrastructure is already in place and little additional landscape disturbance is involved.

---

[41] This technology is under development at the Alberta Ingenuity Centre for In Situ Energy.

[42] A convenient summary of the main technological challenges can be found in: Petroleum Technology Alliance of Canada. *Oil Sands Technology Roadmap*, January 2004.

[43] For a summary of the main technological challenges see the Petroleum Technology Alliance of Canada, *Filling the Gap: Unconventional Gas Technology Roadmap*, October, 2006.

- **Energy Efficiency, Alternative Energy and Polygeneration**. There are substantial opportunities for Alberta to become a leader in energy efficiency. This is related to the fact that its economy is very energy intensive, the rapid growth of infrastructure allows easier incorporation of new technologies and in many instances the export of energy saved in local markets (along with cost reductions and reductions in emissions) can provide strong incentives for greater energy efficiency.

  While Alberta may not have a significant comparative advantage over other regions in many types of alternative energy production when these are viewed in isolation, there is the potential for important synergies when viewed in the context of the province's natural energy advantages. Building upon the considerable energy expertise accumulated in the province and through integration using the large energy infrastructure already in place (including that associated with the conventional and unconventional energy sectors and with agriculture), there would seem to be considerable leadership potential for Alberta.

  There is major potential associated with platform technologies such as gasification to convert one or a combination of coal, coke, oil sands residues and biomass into a high-value stream of synthetic gas, electricity, heat and petrochemical feedstocks, and with $CO_2$ capture and storage. High-efficiency, direct current electricity transmission could allow the export of surplus, clean electricity to distant, high-value markets. Additional substantial upgrading could be obtained through conversion of by-products (feedstocks) into petrochemicals.

## *The Way Ahead*

It is clear from the discussion in this study that Alberta is very much at a crossroads of challenges and opportunities. The challenges of achieving sustainable prosperity along with environmental goals are daunting, and failure to meet the most critical of these will almost certainly dim the province's prospects in terms of both objectives. In such a case we will be currently witnessing the height of Alberta's prosperity. On the other hand, the province is in the enviable position in that if the main challenges can be met (including the unlocking of our energy potential in an economic and environmentally sustainable way) a bright future is almost assured.

In this study we have outlined many of the fundamental and specific challenges and have undoubtedly raised more questions than we have provided answers. But often the way forward is illuminated by asking the right questions rather than providing answers to what turn out to be the wrong questions. In any case, this is just one step in developing the broader discussions that will help guide the province in developing the necessary vision and commitments for the way forward. The one thing we can be certain about is that meeting the challenges and unlocking the opportunities will require a clear vision and long-term commitments to achieving that vision. It is almost certain that we will not achieve everything in that vision. But that is less important than the strength, discoveries and knowledge gained through the striving to achieve the vision.

As a final note, it should be emphasized that there is a very real urgency. There are typically very long lags between the development of a new technology and its implementation. For example in the case of SAGD noted earlier that lag was over two decades. What this means is that the next-generation technology and knowledge being developed today will not be widely implemented for many years to come. Put differently, in terms of many of the challenges and opportunities discussed, we would have had to begin development a decade or more ago for the advances to be helpful today. In the meantime, each additional large investment today essentially locks us into 'old' technologies. This highlights the urgency and the escalation of risks with each delay in defining and implementing a clear vision for Alberta's energy future.

# REFERENCES

Alberta Chamber of Resources. *Oil Sands Technology Roadmap: Unlocking the Potential,* January 30, 2004.

Alberta Energy Research Institute. http://www.aeri.ab.ca

Alberta Energy and Utilities Board (AEUB). *http://www.eub.gov.ab.ca.*

Alberta Energy and Utilities Board. *Alberta's Reserves and Supply/Demand Outlook.* ST98-2004, ST98-2005 and ST98-2006.

Alberta Finance. *Government of Alberta Budget.* (various years).

Alberta Human Resources and Employment. *Alberta's Occupational Demand and Supply Outlook, 2005-2015,* November 2005.

Alberta Treasury. *Alberta Economic Accounts.* (various years).

Blair, J. *Local Economic Development: Analysis and Practice.* London: Sage Publications, 1995.

Breen, David H. *Alberta's Petroleum Industry and the Conservation Board.* University of Alberta Press, 1993.

Canadian Association of Petroleum Producers (CAPP). *Statistical Handbook.* (various years).

Gelb, Allan H. and Associates. *Oil Windfalls: Blessing or Curse?* New York: Oxford University Press, 1998.

Hanson, E. *Dynamic Decade: The Evolution and Effects of the Oil Industry in Alberta.* Toronto: McClelland and Stewart, 1958.

International Energy Association. *World Energy Outlook.* 2005.

Mansell, R."Energy Policy, Prices and Rents: Implications for Regional Growth and Development." *Still Living Together: Recent Trends and Future Directions in Canadian Regional Development.* Eds. W. Coffey and M. Polese. Montreal: Institute for Research on Public Policy, 1987.

Mansell, R. "Texas and Alberta: A Comparison of Regional Economies." *Texas Business Review.* 55:6, pp. 241-246,1981.

Mansell, R. "The Alberta Economy: Changes and Challenges." *Alberta's Fiscal Frontiers*. Ed. B. Dahlby. Edmonton: Institute for Public Economics, 2002.

Mansell, R. and M. Percy. *Strength in Adversity: A Study of the Alberta Economy*. Western Centre for Economic Research and C. D. Howe Institute, 1990.

Mikesell, Raymond F. "Explaining the Resource Curse, with special reference to mineral exporting countries." *Resources Policy.* 23, pp.191-199, 1997.

National Energy Board. *Canada's Oil Sands: Opportunities and Challenges to 2015,* May 2004.

Petroleum Technology Alliance of Canada. *Spudding Innovation*. October 2003.

Petroleum Technology Alliance of Canada. *Filling the Gap: Unconventional Gas Technology Roadmap,* October 2006.

Richard, J. "The Staple Debates." *Explorations in Canadian Economic History: Essays in Honour of Irene M. Spry.* Ed. D. Cameron. Ottawa: University of Ottawa Press, 1985.

Sachs, Jeffery D.and Andrew M. Warner. "The Curse of Natural Resources." *European Economic Review.* 45, pp.827-838, 2001.

Sproule and Associates Limited. Oil and Gas Price Forecasts. *http://www.sproule.com.*

Statistics Canada. CANSIM 1110029, 2820001.
Statistics Canada. CANSIM 260003, 270009, 51005.
Statistics Canada. CANSIM 2810025.
Statistics Canada. CANSIM 2820001, 510005.
Statistics Canada. CANSIM 3840002.
Statistics Canada. CANSIM 510005, 3840002.
Statistics Canada. CANSIM 510005, 3840012.
Statistics Canada. CANSIM 52820001.
Statistics Canada, CANSIM Table 051-0004.