Alberta Chambers of Commerce

An Overview of Potential Impacts of Kyoto on Alberta

The Advocate for Alberta Business

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An Overview of Potential

Impacts of Kyoto on Alberta

Prepared For

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Executive Summary

Economies like Alberta, which are highly dependent on greenhouse gas intensive industrial sectors, cannot grow or compete unless the Kyoto implementation policies concerning greenhouse gases abatement are made clear, and are achievable over a reasonable time period. Alberta's economic advantage may be at risk from Kyoto uncertainty and future policy initiatives, potentially leading to reduced growth, lower investment, higher taxes, increased regulation and higher unemployment.

The Alberta Chambers of Commerce (ACC), an organization representing over 22,000 Alberta businesses, sought independent research about the effects of Kyoto on the provincial economy. It is for this purpose that the ACC approached the Centre for Applied Business Research in Energy and Environment (CABREE) at the School of Business, University of Alberta.

The project was comprised of the following three phases:

Phase 1: Retrieval and analysis of GHG emissions data and profiling of GHG intensive sectors in Alberta.
Phase 2: Identification of gaps in the current climate change policies that result in risk exposure to Alberta's economy. Evaluation of associated risks.
Phase 3: Recommendations of alternate courses of action and further analysis.

This report documents the collection and analysis of data and draws from the literature reviewed resulting in the discussion and recommendations. The project started in April 2003 and was completed in August 2003. The main findings of the project are:

1. Alberta emits one-third of all of the Canadian GHG emissions and the GHG intensity per capita of the province is 3 times that of Canada as a whole.

2. 90 percent of Alberta's GHG emissions come from four sectors: oil and gas, power generation, transportation and agriculture. These sectors are the dominant contributors to Alberta's GDP as well.

3. The Federal Action Plan for Climate Change is the only policy document describing the federal Plan for emissions reductions. The federal Plan fails to provide specific targets for various industries. The most affected are Alberta's energy sector industries (oil/gas and power generation), which are confronted with uncertainty over potential risks associated with Kyoto implementation plans.

4. There are valid reasons to believe that GHG emission reduction targets as committed by Canada under the Kyoto Protocol will not be met by domestic actions alone. However, one policy tool provided in the federal Plan is the mechanism of emissions trading. It is anticipated that in Alberta alone up to $4 billion could end up being spent on the purchase of emissions credit from the international market.

5. Sector specific threats include delay or cancellation of planned investments in oil sands as the capital costs increase by absorbing the cost of equipment that

enhances the environmental efficiency of the projects. The power industry faces the risk of early retirement of some of its coal fired power plants. The cost of electricity generation can be expected to increase as a result.

6. Transportation costs are also expected to increase in Alberta.

7. As costs of key inputs like power and transportation increase, competitiveness of both agriculture and manufacturing in Alberta may be affected.

8. At the provincial level, legislation has been recently submitted (Bill 37) to the legislature that aims to address some of the federal policy's gaps. However, all the policy measures in place or under consideration do not address the need to put long term sustainable GHG emission reductions in place that mitigates our exposure to even stringent GHG emission reduction targets in a post Kyoto implementation period.

These problems are analyzed in depth in this report, and some alternate mitigation strategies are recommended.

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1.0 Background

In December 2002, the Canadian government ratified the Kyoto Protocol[1] committing itself to a 6 percent reduction of GHG emissions for the period of 2008-2012, measured with respect to 1990 emission levels. This translates to a reduction of about 30 percent from what "business-as-usual" emissions would otherwise have been in 2008-2012 (i.e. – an estimated reduction of 240 MT (megatonnes)). On November 21, 2002, the federal government released its Climate Change Plan[2] which outlines how the federal government plans to meet the country's commitments made in November 1997 at the UNFCC organized Kyoto Conference on Climate Change.

The Climate Change Plan document is far from being a "clear framework" for the future. In fact, the main shortcoming in the plan is the lack of clarity of the implementation strategies. The Plan devotes a great deal of space to the concept of working with the provinces, territories and municipalities and balancing the costs of Kyoto across all geographic regions and economic sectors. It sets out goals for emissions reductions by both industry and individuals. However, when it comes to how these goals will be met, the plan is vague. The government asserts that it will promote initiatives, consider possible action, explore projects or continue discussions during the course of implementation suggesting among other things, "while allowing for continuous adjustment as we assess progress." There are also mentions of increasing investments in areas such as innovation and technology, as well as the possibility of re-allocating funds from current programs to climate control objectives; there are no details of how much money would be involved. The most controversial aspect of the Plan is that, according to the government, it "would add much less than one percent to production costs" for most industries. Critics believe that the actual costs will be much higher and certainly the Alberta government has been voicing its concerns that certain provincial sectors will be hit hard.

	Step I	Step II	Step III
	Actions Underway	New Actions	
Actions by Canadians and Governments: Transportation and Buildings	13 MT	15-20 MT	
Large Industrial Emitters	25 MT	55 MT	Current and
Other Industrial Emissions: Technology, Infrastructure and Efficiency Gains		16 MT	potential
Agriculture, Forestry and Landfills; Sinks and Offsets	38 MT	*	actions that
		*	could achieve
International Market		Minimum	approximately
	2 MT	10 MT	60 MT
Total	Approximately 80 MT	Approximately 100 MT	

** Offsets are estimated at 20 to 28 MT; because they may be sold to industry through domestic emissions trading, they are not added to the total.*

Source: Government of Canada – Climate Change Plan for Canada

[1] United Nations Framework Convention on Climate Change website http://unfccc.int/
[2] GOC Climate Change Plan website http://www.climatechange.gc.ca/plan_for_canada/index.html

The table above lists a three-step approach proposed in the federal government plan. Step I includes actions already underway, which are expected to reduce emissions by 80 MT. Step II involves further measures outlined in this document, which are expected to reduce emissions by a further 100 MT. Step III will address the remaining 60 MT.

Step I, which includes actions already underway, is expected to reduce emissions by 80 MT. Specifically 50 MT of emission reductions follow as a result of implementation measures initiated in the Action Plan 2000 and the Federal Budget 2001, and 30 MT from agricultural and forest management activities. Since 1998, the Government of Canada has committed $1.6 billion to climate change initiatives, across all sectors and involving every region. Critics though, remain skeptical that Action Plan 2000 will be able to deliver the full 50 MT of GHG emissions reduction. Similarly, the additional 30 MT from sinks is considered by some to be optimistic due to current uncertainty surrounding the measurement of sinks.

Step II involves further measures outlined in this document, which are hoped to reduce emissions by a further 100 MT. The new actions presented in the Plan are reflective of the government's goal to distribute the burden amongst industry, consumers, and government. Step II can be broken down accordingly into four categories of initiatives:

a) Targeted measures for consumers - The Plan issues a challenge of reducing one tonne of GHG emissions per person, but only accounts for two-thirds of this amount in budgeting reductions. The plan proposes 15 to 20 MT reductions from the transportation and building sector, primarily through a 25 percent improvement in new vehicle fuel efficiency standards and consideration of incentives for energy retrofitting a potential 20 percent of existing housing stock.

b) An approach for industrial emitters that mainly focuses on 55 MT emissions reduction gained through a domestic emissions trading system (DET) for large industrial emitters (LIEs) that would, as a reference case, call for 15 percent emissions reductions from the business-as-usual. Targets for specific DET participants, as well as the rules of game for the DET market, are still being developed and have not yet been rolled out - more than eight months following the ratification of the Kyoto accord.

c) Other industrial emissions reductions through technology, infrastructure and efficiency gains etc. are anticipated to help achieve another 16 MT in emissions reduction.

d) Purchase of credits from the international carbon market in lieu of targets not met is expected to deliver 10 MT.

The following table summarizes emissions reductions from Step I and Step II.

	Canadians and Government		Industrial Emitters			Land cover & Use	International market	Totals
	Transportation	Housing & Buildings	Emissions Trading	Renewable Energy and Innovative Projects	Small and Medium Enterprises (SMEs) and Fugitive Emissions	Agriculture, Forestry and Landfill Gas		
Business as usual (BAU) emission 2010	206	84	— 425 —					809
Step I: Action Underway: Action Plan 2000, Budget 2001, BAU Sinks	9	4	— 25 —			8	2	Approx. 80
Step II: New Actions	12	4	**55**	11	5	Potential Offsets* 30	10 Minimum	Approx. 100
Total: Emissions Reduction Targets for Step I and II	21	8	96			38	12 Minimum	Approx. 180

Source: Government of Canada – Climate Change Plan for Canada

Step III will address the remaining 60 MT as emissions from Steps I and II fall short of the 240 MT gap. The Government of Canada initially envisioned securing emissions credit for "clean energy exports" of natural gas and hydroelectricity to the United States. Such credits are not currently recognized by the Kyoto Protocol and efforts towards their recognition have been met with considerable resistance from the international community and are not likely to be realized for the first Kyoto commitment period. Step III outlines options for achieving the remaining 60 MT by other means, including existing and future technology R&D investment and reductions not included in either steps I or II, such as municipal and provincial actions to date.

The federal Plan, with all its broad ideas and rough outlines, is based on two fundamental assumptions. First, that the Kyoto Accord will go ahead[3]. Second, that the federal goals as stated in the Plan will be met[4]. There is doubt among experts about Canada's ability to meet the Kyoto targets. The Conference Board of Canada for instance sees a "high risk" potential of Canada actually falling short of its Kyoto targets. First and foremost is the issue of approval of at least 60 MT credits for "clean energy exports" of Step III as the back up strategies need to be

[3] Russia has still not ratified the treaty and without Russian ratification the Kyoto Accord will not be ratified.

[4] Owen Wood: "Implementing Kyoto: Ottawa's plan", CBC News Online | Oct. 24, 2002 http://www.cbc.ca/news/features/kyoto_govtplan.html

formulated. Among the major bottlenecks suggested, is the lack of bureaucratic infrastructure required to facilitate cooperation between the three levels of government and the private sector on proposed targeted measures identified in Step II, such as the implementation fund. Such infrastructure is not likely to exist some years to come. Equally important is the fact that the Plan's proposed covenant scheme for large industrial emitters does not contain details on emission intensity targets for sectors and firms, the complementary use of emissions trading and international credits, and the application of regulatory or financial backstops. Decisions on such details are thought to be years away. Last but not least, the infrastructure for an international carbon trading system is unlikely to be ready for several years as the modalities of verification and credibility are far from developed. For the purposes of this research paper, we will shift our focus from the lack of details on the points noted in the foregoing paragraph and assume that these will be sorted out in due course.

2.0 Sectoral Impacts

The federal Plan recognizes that industry sectors such as oil, gas, mining, manufacturing and power generation are not only the major contributors to the Canadian economy but also are the major contributors to the country's greenhouse gas emissions[5]. In all, about 50 percent of emissions come from large industrial emitters with transportation accounting for half of the remaining, about 25 percent, and residential and institutional buildings only 10 percent. Agriculture and landfill gas account for the rest.

The cost estimation of emission reductions from transportation and institutional buildings could be considered rather easier to make and is less controversial. The Plan discusses in extensive detail the idea of "intensifying negotiations" with manufacturers and importers to produce more fuel-efficient transportation and ethanol-blended fuel. We also come across the idea of providing "federal assistance and incentives to increase the use of urban transit". In the case of buildings, there is mention of steps like making existing buildings more energy efficient, energy efficiency evaluations for homeowners, improved standards for equipment and appliances, energy efficiency improvements to federal buildings and most of all the ambitious target of increasing energy efficiency in 20 percent of houses and buildings by 2010. Some specific measures were unveiled on August 12, 2003 as part of a $1 billion federal package but are expected to address not more than 20 MT (or 8 percent) of the total Canadian Kyoto target of 240 MT.

The investments are intended to act as a catalyst for, and a complement to, actions by individual Canadians, industry and business, governments and communities. Individual Canadians are given incentives in the form of $79.8 million worth of rebates to make their homes more energy efficient. Investments worth $50.6 million will be made in programs that will help Canadians make

[5] Mark Jaccard, John Nyboer, Bryn Sadonik 2002. *The Cost of Climate Policy*, UBC Press 2002

environmentally friendly transportation choices and purchasing decisions. Alberta is expected to receive the home energy rebates in proportion to its population, which will amount to only $7.9 million. For nearly three million people in the province, this translates to a per capita rebate of $2 each. The second portion of $552.9 million will be spent on fast growing tree plantation and R&D on low emission technologies – most of the R&D money will go into ethanol research and development and not towards R&D for green power. The remaining $320.7 million will go towards administrative expenses required to negotiate and develop partnerships with the provinces and territories on cost-effective emission reduction.

It will be even more difficult for large industrial emitters to reliably estimate Kyoto's impact without a more detailed implementation Plan. The main reason, besides the lack of bureaucratic infrastructure to facilitate co-operation between the governments and the private sector, is complexity in the industrial infrastructure and processes involved. In some cases, such as coal fired power plants, the "clean" technology is far from being fully proven. For coal plants a proportion of capital investments is relatively recent and in some instances is not yet depreciated. Moving to clean power substitutes quickly would most certainly mean costly early retirement of coal plants and fresh new investments in infrastructure. In other cases, such as the Alberta's oil sands plants, modification solutions that enhance the environmental efficiency may have huge capital costs.

Some critics[6] believe that "the Kyoto deadlines aren't long enough to allow for those technologies to be developed and implemented, so Canada would be forced to rely on buying "hot air" credits from other countries to meet its targets". This shortcoming was the basis of Alberta's alternate Kyoto plan, released in April 2002. Alberta's Plan concentrates on reducing "missions intensity", or the amount of energy needed to generate a dollar of gross domestic product. The province's Plan would reduce greenhouse-gas emissions to below 2000 levels by 2020. According to some, the biggest flaw in the Alberta Plan is that the absolute level of emissions would actually rise, creating a large and growing gap between Alberta's strategy and the targets spelled out by the Kyoto Protocol.

3.0 Canadian Focus Versus Albertan Focus

The importance of profiling GHG emissions at the provincial level can be underscored by the fact that the GHG emission reduction costs will vary province by province, based in large part on the type of industrial infrastructure present. Thus, the more or less homogenous cost and economic impacts of the GHG reductions envisioned in the federal Plan may not be representative of actual individual provincial costs and impacts. In the case of Alberta, energy consumption and GHG emissions account for 33 percent of the Canadian total.

[6] Policy Briefing by Premier Ralph Klein http://www.thehilltimes.ca/2002/september/16/klein/: The Hill Times: 2002

The following table illustrates that this ratio is quite different from GDP and population ratios:[7,8]

2001 Numbers	Alberta	Canada	% Alberta – Canada
Population	3,086,034	31,240,487	9.88%
GDP (million)	151,319	1,092,246	13.85%
GHG Emissions (MT)	224	720	31.11%
GHG/Capita (Tonne/Person)	72.59	23.05	

Source: Statistics Canada, Environment Canada, Government of Alberta

The high GHG intensity *(GHG per capita)* for Alberta is strong evidence of the dominance of the fossil-fuel intensive activities in the economy. More than half of the electricity in the province is generated by coal. Gas is used for space heating and fossil fuel extraction and processing is the biggest industrial sector in the province.

As part of this research, we extracted and reviewed the greenhouse gas (GHG) emission data for Alberta and Canada in greater detail. A snapshot of Alberta's industrial sectors and their respective GHG profiles,[9] along with a snap shot of the Canadian GHG emissions,[10] is summarized in the following analysis:

[7] Provincial comparisons: http://www.gov.sk.ca/bureau.stats/pea/rngdpcu1.pdf

[8] Provincial comparisons: http://www.gov.pe.ca/photos/original/pt_newgdpdata.pdf

9 Environment Canada's website: http://www.ec.gc.ca/pdb/ghg/query/index_e.cfm

[10] The only reliable greenhouse gas inventory in Canada is the one done by Environment Canada (http://www.ec.gc.ca/pdb/ghg/ghg_home_e.cfm) based on top down energy use. This database, up to date through year 2001, has been mainly used for reference in this paper. There are a few databases that generate a bottom up estimate for various industries, largely based on energy use. Some of the better ones include: Natural Resources Canada's National Energy Use Database (NEUD) - http://oee1.nrcan.gc.ca/neud/dpa/data_e/database_e.cfm, the SFU's Canadian Industrial Energy End-Use Data and Analysis Centre (CIEEDAC) - http://www.cieedac.sfu.ca/index.php?action=energyghg and data compiled through Statistics Canada's Industrial Consumption of Energy survey (http://www.statcan.ca/english/sdds/2166.htm). Most of the bottom-up GHG data is based on energy use (and applying the appropriate emissions factors to get GHG emissions).

Comparison of Greenhouse Gas Emission For Alberta & Canada by Sector

Sum of CO_2, CH_4, N_2O, HFCs, PFCs, SF_6 in kt CO2 eq	Alberta (AB)		Canada (CA)		Difference AB – CA	Proportion AB/CA	Alberta Incidence
GHG Source and Sink Category			2001 numbers				
	ENERGY						
	Kt	%	Kt	%	%	%	
TOTAL	224,000		720,000			31%	H
Stationary Combustion Sources							
Electricity and Heat Generation	54,700	24.42%	137,000	19.03%	5.39%	40%	H
Fossil Fuel Industries	44,000	19.64%	67,300	9.35%	10.30%	65%	H
Mining (including fossil fuels extraction)	5,800	2.59%	10,200	1.42%	1.17%	57%	H
Manufacturing Industries	8,210	3.67%	48,900	6.79%	-3.13%	17%	L
Construction	168	0.08%	1,010	0.14%	-0.07%	17%	L
Commercial & Institutional	4,760	2.13%	32,900	4.57%	-2.44%	14%	L
Residential	7,210	3.22%	41,900	5.82%	-2.60%	17%	L
Agriculture & Forestry	286	0.13%	2,210	0.31%	-0.18%	13%	L
Stationary Combustion Sources Total	125,000	55.80%	341,420	47.42%	8.38%	37%	H
Transportation Combustion Sources Total	33,100	14.78%	187,000	25.97%	-11.20%	18%	L
Fugitive Sources (Oil/Gas & Mining) Total	34,000	15.18%	54,990	7.64%	7.54%	62%	H
ENERGY TOTAL	192,000	85.71%	84,000	81.11%	4.60%	33%	H
	INDUSTRIAL PROCESSES						
Mineral Production Total	1,060	0.47%	8,643	1.20%	-0.73%	12%	L
Chemical Industry Total	670	0.30%	7,520	1.04%	-0.75%	9%	L
Metal Production Total	-	0.00%	20,000	2.78%	-2.78%	0%	L
Other & Undifferentiated Production	9,320	4.16%	11,700	1.63%	2.54%	80%	H
INDUSTRIAL PROCESSES TOTAL	11,100	4.96%	49,000	6.81%	-1.85%	23%	L
SOLVENT & OTHER PRODUCT USE	46	0.02%	470	0.07%	-0.04%	10%	L
	AGRICULTURE						
Enteric Fermentation	7,200	3.21%	19,000	2.64%	0.58%	38%	H
Manure Management	2,400	1.07%	10,000	1.39%	-0.32%	24%	L
Agriculture Soils Total	10,000	4.46%	31,000	4.31%	0.16%	32%	H
AGRICULTURE TOTAL	20,000	8.93%	60,000	8.33%	0.60%	33%	H
LAND USE CHANGE AND FORESTRY (non-CO_2 only)							
LAND USE CHANGE AND FORESTRY (non-CO_2 only) TOTAL	220	0.10%	2,100	0.29%	-0.19%	10%	L
	WASTE						
WASTE TOTAL	1,200	0.54%	25,000	3.47%	-2.94%	5%	L

H: Higher Incidence; L: Lower Incidence

Source: Environment Canada

Analysis of these numbers confirm our earlier assertions that most of Alberta's GHG emissions originate in energy production and usage. The incidence of across the board policies will be higher (H) in the case of Alberta's industry sectors such as oil, gas, mining, manufacturing and power generation, which are even greater contributors to the Albertan GHG emissions than the Canadian economy as a whole[11]. About 70 percent of Albertan GHG emissions come from large industrial emitters (LIEs). Transportation accounts for only about 15 percent, and residential and institutional buildings for only 5 percent of GHG emissions. Agriculture, including livestock and landfill gases, accounts for the rest.

The energy consumption and usage itself can further be broadly sub-categorized into various stationary combustion sources. The proportion of GHG emissions

[11] Mark Jaccard, John Nyboer, Bryn Sadonik 2002. *The Cost of Climate Policy*, UBC Press 2002

from some of these sub-category sources in Alberta and with respect to respective Canadian sub-category totals are: fuel burned for power generation at 40 percent; fossil fuel processing industries at 65 percent; mining, including fossil fuel extraction, at 57 percent; transport combustion sources, such as fuel burned in cars, and fugitive sources at 18 percent; and commercial and residential building space heating at 16 percent.

We can clarify some important messages here. First, transportation and buildings have a smaller share of GHG emissions in Alberta than those of power generation, fossil fuel and mining industries. Still Alberta/Canada proportions of GHG emissions from transportation and space heating is more than the population and GDP proportions of Alberta and Canada. Thus the transportation and building sectors are not small in proportion or less GHG intensive in Alberta in any way but instead substantial emissions come from the electricity generation, oil and gas and mining sectors in the province than they do with the other sources. Second, the heavy loading of the electricity generation, fossil fuel and mining industries in Alberta's economic portfolio is indicative of the provincial economy's vulnerability to the across the board incidence costs following the implementation path of the current federal Plan. Finally, Alberta has a highly capital-intensive energy based economy, which will see higher than average effects per capita.

Another way of looking at Alberta's GHG emissions is to look at the 2001 provincial GHG emission summary by the various types of gases emitted (Annex A). We can see here that the majority (78 percent) of emissions are CO_2 emissions. CH_4 accounts for 16 percent and N_2O 6 percent. High CO_2 & CH_4 emissions are again indicative of a vibrant energy industry. N_2O emissions mostly originate from agricultural activities. GHG emissions from agriculture are also significant and constitute approximately 9 percent of the total Alberta GHG emissions. From complete Canadian agriculture GHG emissions, Alberta agriculture GHG emissions account for 33 percent of the total.

4.0 Alberta Economic Indicators and GHG Emissions

In essence, from our analysis the top five[12] GHG emitting sectors in Alberta are responsible for 94.5 percent of GHGs. Their share out of the total provincial GDP is 44.54 percent. Mining, oil and gas extraction and processing are sectors with a relatively small gap between the GHG emissions and percentage of GDP. The only way the GHG emissions can be reduced in a meaningful way in mining/oil and gas extraction and processing would be to scale down future growth, which would certainly affect the provincial economy, given the large size of this sector.

Besides mining/oil and gas extraction and processing sector, Alberta's other GHG producing industries seem to have smaller share of the GDP than the percentage of GHG they produce. For instance electricity generation is the biggest outlier in terms of this disparity and contributes 2.06 percent to GDP,

12 Refer to the table on page 11.

while accounting for 24 percent of Alberta's GHG emissions. It must be emphasized here that despite its small contribution to GDP, the electricity sector is very important to Alberta's economic portfolio as electricity is a vital input to many other sectors and current means of production. An increase in electricity prices would certainly amount to loss in competitiveness of provincial agriculture and manufacturing. The same can be said for transportation, which has a 4.95 percent impact on Alberta's GDP and emits 14.78 percent of GHG emissions here.

Agriculture and forestry produce 9.16 percent of GHG emission and share 2.38 percent of the GDP output. This imbalance may be an issue. Again it can be argued that agricultural output is a basic necessity and for a variety of reasons it is important for the province to continue to develop this sector. Manufacturing which provides 8.56 percent of Alberta' GDP is responsible for 9.18 percent of GHG emissions.[12,13]. We must not forget the fact that the bulk of Alberta's service sector (39.21 percent of GDP) is heavily reliant on the GHG emitting large industrial sectors.

2001 Numbers	*GHG Share*	*GHG Rank*	*GDP by Industry %*	*GDP Rank*
Mining & Oil/Gas Extraction/Processing	37.05%	1	26.59%	1
Electricity Generation (Utilities)	24.42%	2	2.06%	11
Transportation	14.78%	3	4.95%	8
Manufacturing	9.18%	4	8.56%	5
Agriculture & Forestry	9.16%	5	2.38%	10
Trade	5.34%	6	8.74%	4
Construction	0.08%	7	7.50%	6
Finance, Insurance & Real Estate	NA	8	14.96%	2
Business Personnel & Other Services	NA	9	13.94%	3
Education, Health & Social Services	NA	10	6.86%	7
Government Services	NA		3.45%	9

Source: Statistics Canada, Government of Alberta

A look at the direct employment ratios for Alberta suggests that 51.74 percent of employment is provided by five of the top seven direct trade employment sources (export oriented) in the province. Again, attention is drawn to the electricity generation sector,which employs only 4.44 percent of the direct trade workforce and is the second biggest emissions source in the province with 24.42 percent of GHG emissions. Mining, oil and gas extraction and processing, transportation, agriculture and forestry lead in "employment" amongst GHG emitting sectors. With the exception of electricity generation, more than half of the provincial direct trade employment is in top five GHG emitters and any negative impact on the performance of these sectors will adversely affect the employment situation in Alberta.

[12] Statistics Canada website www.statcan.ca
[13] Government of Alberta www.finance.gov.ab.ca

2001 Numbers	GHG Share	GHG Rank	Employment*	Employment* Rank
Mining & Oil/Gas Extraction/Processing	37.05%	1	17.88%	3
Electricity Generation (Utilities)	24.42%	2	4.44%	6
Transportation	14.78%	3	20.08%	2
Manufacturing	9.18%	4	0.10%	7
Agriculture & Forestry	9.16%	5	13.68%	4
Trade	5.34%	6	12.19%	5
Construction	0.08%	7	31.63%	1

** Direct trade employment only. Does not include employment in related or other management and service sector(s).*

Another noteworthy perspective is to look at the province's major exports. Natural gas and petroleum products make up 62 percent of all Alberta exports and are exclusively exported to the United States. About 10 percent of exports are linked to agriculture and farm related products, with the remaining 28 percent related to manufacturing. Any downward push on the growth or competitiveness of oil and gas, manufacturing and agriculture sectors, which could arise due to rising input costs (e.g. electricity or transportation costs) would be detrimental to the competitiveness of Alberta exports.

Major Alberta Exports		
2001 numbers		
Industry	% of Total Exports	% of Total Exports excluding Oil & Gas
Oil & Gas	59.9%	
Chemical Manufacturing	6.6%	16.5%
Food	5.2%	12.8%
Computer and Electronics	4.7%	11.6%
Crop Production	3.8%	9.4%
Petroleum & Coal Production	3.5%	8.6%
Paper	2.7%	6.8%
Machinery	2.6%	6.5%
Total	89.0%	72.2%

Source: Government of Alberta

5.0 Exposure and Mitigation Scenarios for the Susceptible Sectors

Possibly the most important policy measure for industry sectors in the prevailing federal Plan is a proposed system of Domestic Emission Trading (DET) covenants for Large Industrial Emitters (LIEs).[14] Canada's success in meeting its

[14] Matthew Bramley: "Doing Their Bit: Ensuring Large Industrial Emitters Contribute Adequately to Canada's Implementation of the Kyoto Protocol." Pembina Institute: 2002

Kyoto Protocol target will depend on the success of covenants and the emissions trading system delivering at least the intended 55 MT per year of emission reductions by the LIEs over the period 2008 to 2012. This translates to an average intensity reduction of about 15 percent across all firms in the LIE sectors. The proposed covenants and emissions trading system, as described in the Climate Change Plan for Canada, can be summarised as follows:

(a) The federal government will negotiate individual GHG emissions targets with large industrial companies and translate these into legally binding covenants.

(b) In order to meet the targets, the companies will have the following options:

- Voluntarily reduce emissions from their own facilities;
- Purchase "offsets" - credits granted to projects that reduce emissions from sources that are not covered by covenants;
- Generate “excess” emissions permits in respect to the amount by which the companies exceed domestic targets (these permits could then be traded in DET market); and,
- Purchase emissions units from outside Canada, available through the three international emissions trading mechanisms of the Kyoto Protocol.

The federal government announced a post ratification commitment on January 15, 2003, which protects the LIEs in case the market price of emissions units (domestic credits or permits and foreign emissions units) rises above $15 per tonne of CO_2. There is also a guarantee that the emission reduction targets for energy industry would be no more than 15 percent below projected business-as-usual levels for 2010 (i.e. not more than the forecast 55 MT reduction).

6.0 Cost of Incidence Estimates

As has been mentioned, there is limited public information on the likely cost shock[15,16] that the combination of these measures would impose on firms in the LIE sectors. What we know is that the federal government has invested or made commitments of $3.7 billion to address climate change over the past five years (including the $1 billion package announced on August 12, 2003). None of these spending commitments address the LIEs. However, the Plan presents a summary table of illustrative costs for a number of these sectors, under the

[15] Kyoto and Competitiveness: Will Short-term Pain Produce Long-term Gain? Joseph A. Doucet Director Centre for Applied Business Research in Energy and the Environment (CABREE) and H&R Drilling Professor of Regulatory Economics The University of Alberta School of Business: June 2003

[16] Joseph A. Doucet:. The Kyoto Conundrum: Are the Dual Objective of Projecting the Economy and Meeting the Kyoto Targets at Odds with Climate Change Progress?”, Centre for Applied Business Research in Energy and the Environment (CABREE) The University of Alberta School of Business - working paper, June 2003

assumptions that only permit purchases are used to meet emissions-reduction responsibilities and that the permit price is $10 per tonne. One would expect a $15 permit price to yield costs that are 50 percent larger than those reported in the table reproduced below. A $40 per tonne price would yield price costs that are 400 percent times higher. Illustrative cost comparison of $10 scenario (as give in the Plan), and $15 and $40 scenarios are given below:

Illustrative Costs for Selected Industries with 85 Percent Free Permit Allocation						
Sector	$10/Tonne Carbon Price (The Plan)		$15/Tonne Carbon Price (150% of the Plan)		$40/Tonne Carbon Price (400% of the Plan)	
	$ per Unit	Cost as % of Price	$ per Unit	Cost as % of Price	$ per Unit	Cost as % of Price
Conventional Oil ($/barrel)	0.03	0.09	0.05	0.14	0.12	0.36
Heavy Crude Oil ($/barrel)	0.015	0.05	0.02	0.08	0.06	0.20
Oil Sands-Bitumen ($/barrel)	0.1	0.34	0.15	0.51	0.40	1.36
Oil Sands-Synthetic ($/barrel)	0.12	0.31	0.18	0.47	0.48	1.24
Natural Gas ($/mcf)	0.005	0.14	0.01	0.21	0.02	0.56
Pipelines ($/mcf)	0.0014	NA	0.00	NA	0.01	NA
Refined Petrol Products ($/m^3)	0.17	0.03	0.26	0.05	0.68	0.12
Steel-Conventional ($/tonne)	2.1	0.29	3.15	0.44	8.40	1.16
Steel-Electric Arc ($/tonne)	0.6	0.08	0.90	0.12	2.40	0.32
Electricity-Coal (¢/KWHr)	0.14	1.94	0.21	2.91	0.56	7.76
Electricity-Oil (¢/KWHr)	0.12	1.57	0.18	2.36	0.48	6.28
Electricity-Gas (¢/KWHr)	0.04	0.60	0.06	0.90	0.16	2.40
Cement ($/tonne)	1.18	1.18	1.77	1.77	4.72	4.72
Lime ($/tonne)	1.85	2.50	2.78	3.75	7.40	10.00
Pulp and Paper ($/tonne)	0.59	0.06	0.89	0.09	2.36	0.24
Aluminum ($/tonne)	4.73	0.23	7.10	0.35	18.92	0.92
Industry Chemicals ($/tonne)	0.31	NA	0.47	NA	1.24	NA
Agriculture Chemicals, Fertilizers, etc. ($/tonne)	2.63	1.46	3.95	2.19	10.52	5.84

Adapted from original $10 cost illustration by Government of Canada in its Plan of Climate Change.

In the $40 case scenario we can see that the cost shocks forecast to be associated with such a carbon credit/offset price reach almost 8 percent of output prices in the case of thermal electricity generation from coal and almost 6 percent for agricultural chemicals and fertilizers. It can be concluded that the cost shocks are sensitive to the price of emission credits and offsets. Currently, uncertainty prevails over the possible price of emission credits and offsets as well as how DET and international markets might take shape. Credit prices are expected to increase and forward price forecasts from various sources vary from a price of about $15 to $40[17,18,19] per tonne of CO_2e during the implementation period of 2008-2012. The fact remains that should market prices of CO_2e increase dramatically beyond the $15 mark currently guaranteed to LIEs by the federal government, costs exceeding $15 would likely be passed on to taxpayers. LIE firms would still not see a greater incentive for emissions reduction on a long-term basis.

Another way of estimating the cost of incidence would be to look at 33 percent or 18.33 MT (i.e. in same proportion as that of Alberta/Canada GHG emissions ratio) of the 55 MT emissions reduction target eventually allocated to Albertan LIEs. In a not so improbable future, with Albertan LIEs having to buy 18.33 MT of credits/offsets, the potential range of purchase dollar value can be worked out as follows:

Credit/Offset Price($/MT of CO2e)	*Potential Cost of Purchase to Alberta LIEs (Million $)*	*Potential Cost of Purchase (Nominal*) for Alberta LIEs in 5 year implementation period 2008-2012*
10	18.33 MT x $10 = 183.30	916.50
15	18.33 MT x $15 = 274.95	1,374.75
20	18.33 MT x $20 = 366.60	1,833.00
25	18.33 MT x $25 = 458.25	2,291.25
30	18.33 MT x $30 = 549.90	2,749.50
35	18.33 MT x $35 = 641.55	3,207.75
40	18.33 MT x $40 = 733.20	3,666.00

* Does not include inflation.

The potential direct cost as a result of purchase for Alberta LIEs in the Kyoto implementation period 2008-2012 would be at minimum $1 billion and could go as high as nearly $4 billion. This translates to 0.7 percent to 2.65 percent of Alberta's current GDP of $151 billion. Considering that Alberta's growth forecast is around 3 percent, the potential impact of Kyoto in any scenario is substantial. For Canada as a whole, the cost of purchase would be 3 times higher, but the cost as a percentage of the Canadian GDP (using current total GDP values) would be 0.26 percent to 1.00 percent.

17 Referred in an IEA presentation available on http://www.iea.org/workshop/emissions/rosenzwe.pdf.

18 Mckinsey & Company, "Climate Change for Europe's Utilities." June 2003

19 Mckinsey & Company, "Climate Change for Europe's Utilities." June 2003

We must also stress that in the above calculations it has been assumed that the other targets of Step I, II and III will be met and that the only credits that are purchased will be the ones purchased by the LIEs in the context of 55 MT target. For each additional 10 MT credit/offset bought over and above the 55 MT in the event that pursuit of the overall target is off the mark, the relevant economy (be it Albertan or Canadian) will have to bear an additional cost in the range of $0.5 billion to $2.0 billion annually. Over a ten-year period this is a tremendous amount of capital, which could otherwise be deployed in R&D to address GHG emission goals on a long-term basis.

With the current GHG policy, the cost of purchases of traded offsets in the DET market, or even more likely from credits purchased from the international market, will be passed on to the provincial taxpayers. Having assessed the magnitude of the cost of purchase involved, we can therefore examine the logic behind an emerging system that merely transfers provincial and national wealth of taxpayers hands. Moreover, most of the international credits will likely be in form of "hot air" from Russia where the credit money is unlikely to be used for technological improvements to reduce emissions in the long run. If the same dollars could be spent on promoting new, low emission technologies such as wind, fuel cells and bio-energy, it could help create and sustain a low emission infrastructure in the province.

7.0 Affected Large Industrial Emitters in Alberta – GHG Emission Outlook and Policy Impacts

7.1 Oil & Gas and Other Fossil Fuel Sectors

The natural gas, crude oil, refined petroleum products, and coal production sectors of the fossil fuel industry together emitted 18.81 percent of Canada's emissions and 37.05 percent of Alberta's emissions. GHG emissions[20] occur through the lifecycle of production in the oil and gas and fossil fuel industry: in drilling, well servicing, processing, pipelines, and distribution to end-users. The emission profile of the crude oil industry is changing significantly as conventional reserves are being depleted and heavy oil production increases. Oil sands extraction is especially energy-intensive. There is also considerable flaring of waste gases in the crude oil sector, although this is expected to diminish.

The emission intensity of crude oil production is currently forecast to increase by about 15 percent by 2030, largely because of the switch to heavier oils. In oil sands, air emissions are produced from mining equipment, from the open face of the mine, and from extraction and upgrading facilities. Utilities supplying electricity, water and steam to the mining, extraction and upgrading processes also produce emissions. For the in situ industry, air quality issues are primarily related to energy consumption during steam generation. Sources of air emissions in the oil

[20] David Suzuki Foundation: Climate Change Special Report: Climate Change Crisis In Canada 2001

sands industry also include infrastructure activities such as roads (traffic), pipelines, engines and buildings.

For mining production, the main source of GHG emissions is the co-generation of electricity and steam for operations, the steam being used mainly in the extraction process that separates the bitumen from the sand. For in situ (oil sands) developments, the main source of CO_2 emissions is the generation of steam in thermal plants. The majority of methane emissions (90 percent) are from the venting of casing gas at satellite facilities. The remainder is from cleaning plants (9 percent) and wellheads (1 percent). Measures to reduce emissions in this sector proposed by technology experts include incentives to support methane capture, leak detection and repair, re-injection of acid gases and CO_2, increased use of co-generation in production, heat recovery and various other efficiency improvements.

Canada, with 1,700 billion barrels of known resources[21], has one of the largest resources of oil sands and heavy oil in the world. The bulk of Canada's resource is classified as oil sands, with no commercial inflow to a well at reservoir conditions. In contrast heavy oil, which forms a smaller portion of Canada's resources, has primary production as of this point in time but extraction and processing of synthetic oil from oil sands is gaining ground.

Canada's oil sands (bitumen) resources are mainly located in northern Alberta. Oil sands are exposed along river valleys in the Fort McMurray area, where the bitumen is extracted by surface mining. The oil sands extend down to depths of about 2,300 feet in the west (Peace River) and south (Cold Lake) where in situ bitumen production is attained with thermal Enhanced Oil Recovery technology. The development of Steam Assisted Gravity Drainage (SAGD) has presented a way of greatly accelerating in situ production. Oil sands currently contribute about 425,000 barrels of oil/day from mining and about 200,000 barrels of oil/day from thermal in situ projects. However, many new mining and (in situ) mainly SAGD projects have been announced that Plan to increase the production level to 2 million barrels/day by year 2010. Investments in these new projects are expected to be in range of $40 billion to $60 billion.

The National Energy Board estimates that approximately 0.125 tonne of CO_2 are released per barrel of synthetic crude oil produced in oil sands. With production at 2 million barrels a day, the BAU CO_2 emissions can be forecast for 2010 as follows:

2,000,000 x 0.125 x 365 / 1,000,000 = 91.5 MT per year

[21] The National Energy Board - Canada's Oil Sands: A Supply and Market Outlook to 2015.2000

This will be about 70 MT more than the emissions of around 21.5 MT year based on the current production levels.

It needs to be emphasized here that the Kyoto targets demand an absolute reduction in the level of emissions. No consideration is given to the expected increase in emissions because of increase in production levels from oil sands projects.

For the oil sands industry it seems impossible to comply with Kyoto's absolute targets, as that would require that the oil sands have no future emissions at all from here onwards. Secondly, the current level of emissions must also be cut down 6 percent below the 1990 level. The consequences of such an implementation would be a complete cap on all future projects, as well as a massive scaling down of current production levels from oil sands: a scenario that would effectively cripple Alberta's economy. The oil sands industry was likely relieved when the federal government announced that the emission reduction targets for the energy industry would be no more than 15 percent below projected business-as-usual levels for 2010. That would mean from our business-as-usual emission estimate in 2010 of 91.5 MT, the oil sands industry would be expected to cut down the emission level by 15 percent to 77.8 MT, which is certainly well above the current level of 21.5 MT.

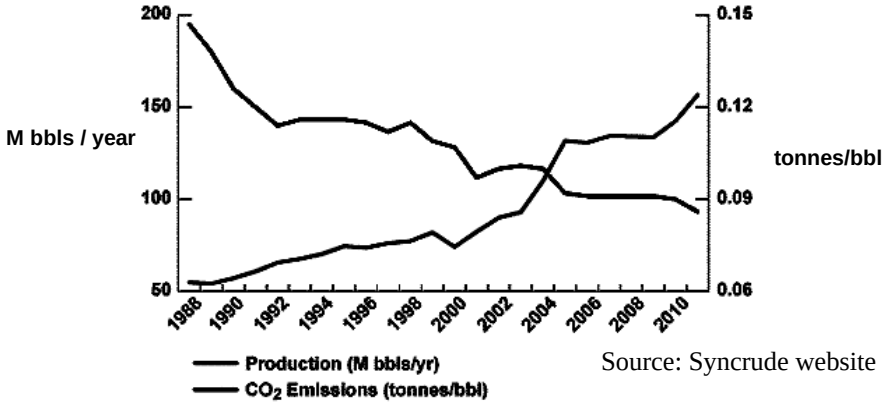
How much does recovery from oil sands cost? Supply costs are expressed as "full cycle" costs. They include all costs associated with exploration, development, and production; capital costs; operating costs; taxes and royalties; and a 10-percent real rate of return to the producer. In the wake of pressure to curb GHG emissions, oil sands are widely believed to invest billions of dollars in technology improvements that are more efficient and greatly reduce emissions per unit of production. Direct investment into emissions reduction and improving the quality of produced synthetic crude have been in the order of billions of dollars (and as high as 25 percent of the budget of expansion and new projects).

In order to assess the impact of Kyoto on operating costs, we will look at Syncrude and Suncor. Syncrude[22] Canada Ltd. is the world's largest producer of crude oil from oil sands and the largest single source producer in Canada. Syncrude operates a large oil sand mine, utilities plant, bitumen extraction plant and upgrading facility in Fort McMurray that processes bitumen and produces value-added light, sweet crude oil for domestic consumption and export. Currently Syncrude's synthetic oil production level is around 82 million barrels a year or 223,000 barrels per day, which is equal to 13 percent of the Canada's petroleum requirements. Syncrude estimates 7.90 MT of CO_2 equivalent per year of greenhouse gas emissions from its operations as of 2001, which translates to 0.097 tonnes of CO_2 equivalent per barrel in 2001.

[22] Syncrude Performance Summary: Part of Syncrude annual report for 2001-2002

By 2010, the total daily production from the Syncrude Project is expected to reach 365,000 barrels of synthetic crude per day. On a business-as-usual basis (i.e. @ 0.097 tonnes of CO_2 equivalent per barrel), the projected emissions in 2010 would have been 12.92 MT of CO_2 equivalent per year of greenhouse gas emissions. But with the January announcement of federal government's stipulated emissions targets for the industry, the target emissions for Syncrude in 2010 should be 10.98 MT of CO_2e per year (i.e. @ 0.082 tonnes of CO_2e per barrel).

Let us now examine Syncrude's plans for greenhouse gas emissions reduction and its internal targets. A chart of CO_2 emissions and crude oil production for data from 1990 to 2012 is presented below:



Source: Syncrude website

Syncrude can be proud of the fact that it will be able to reduce CO_2 emissions by 38 percent per barrel between 1990 and 2008, while crude oil production will more than double. However, we can also see from the above chart that as of 2010 emissions would be 0.09 tonnes of CO_2e per barrel, short of the targeted 0.082 tonnes of CO_2e per barrel. The difference of 0.008 tonnes of CO_2e per barrel translates to an annual emission variance of 1.07 MT of CO_2e beyond the revised Kyoto target of 10.98 MT of CO_2 for Syncrude. Therefore, in addition to improving technology for environmental efficiency Syncrude will have to revert to purchase of credits/offsets by 2010. The federal government's announced price cap of $15/tonne of CO_2e would mean that the maximum annual Kyoto compliance exposure of Syncrude beyond 2010 will be $16 million per year and per barrel cost impact will be $0.12 on an operating cost of around $10-12 per barrel, which is well within the Plan's per unit cost estimates.

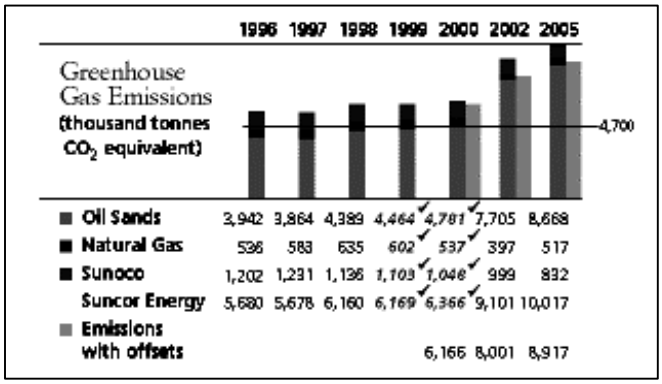
[23] The target used here is based on logical assumptions. It must be noted here that the actual targets for all LIEs are still subject to planned negotiations between the federal government and industry players.

Another player, Suncor[24] Energy, is a pioneer in oil sands as it was the first in the world to open a commercial scale oil sands processing facility. Since start-up of its operations near Fort McMurray, Suncor has produced more than 750 million barrels of oil and has enough reserves to sustain production for the next 50 years.

As Suncor's new Millennium facilities are fully integrated with its base operations, its oil sands operations will produce an average of 77 million barrels a year or 210,000 bpd of synthetic crude oil in 2002. Suncor estimated 7.705 MT of CO_2e per year of greenhouse gas emissions from its 2002 operations. This translated to 0.1 tonnes (nearly to equal to that of Syncrude) of CO_2e per barrel in 2002.

But by 2010, total daily production from the Suncor's operations is expected to reach 500,000 barrels of synthetic crude per day. On business-as-usual basis (i.e. @ 0.1 tonnes of CO_2e per barrel) the projected emissions in 2010 would be 18.25 MT of CO_2e per year of greenhouse gas emissions. With the federal government's stipulated emissions targets for the industry, the target emissions for Suncor in 2010 should[25] now be 15.51 MT of CO_2e per year of greenhouse gas emissions (i.e. @ 0.085 tonnes of CO_2e per barrel).

Let us examine Suncor's plans for greenhouse gas emissions reduction and its internal targets. A chart of CO_2 emissions and crude oil production from 1996 to 2005 is presented below:



Source: Suncor website

Let us for the time being focus on oil sands statistics in the above chart. Unlike Syncrude, in the case of Suncor's oil sands operations we do not have accurate projections of data until 2010 and projections are given until 2005 only. Therefore, as an estimate, linear extrapolation using 1999

24 Suncor Environmental Performance Summary: Part of the Suncor annual report for 2001. 2002

25 The target used here is based on logical assumptions. It must be noted here that the actual targets for all LIEs are still subject to planned negotiations between the federal government and industry players.

CO_2 emissions as the base value and 2005 as the end intermediate value are used to come up with a projection for 2010 CO_2e emissions. Based on simple arithmetical calculations, we come up with 12.17 MT of CO_2e emissions in the year 2010. This is far less (even if we account for errors and omissions in our assumptions) than the 15.51 MT that the federal government's revised target should logically be for Suncor. In an article published in the Globe and Mail on January 10, 2003,[26] Suncor estimates that complying with Kyoto will cost it no more than $49 million per year by 2010, and perhaps as little as $13 million, with added costs per barrel at maximum of $0.27 from a total cash operating cost of between US$10 and US$12 a barrel.

The main component of the full cost cycle affected is therefore the increase in the capital cost. Such additional capital expenditures[27] means that the full cycle costs of oil sands remains well above the widely desired US$10 per barrel mark[28]. With current world oil prices hovering around US$30 per barrel, oil sand producers have no worries regarding competitiveness, however, being aware of the volatility of the oil market, a sharp drop in price would impact the competitiveness of oil sands projects. One or two dollars added on the capital costs to meet the Kyoto target could be a major competitiveness drag on the oil sands profit margins.

Accordingly, not all new entrants are ready to assume Kyoto risks. Delays or cancellations of new oil sands projects are possible[29]. A few companies have already reacted. TrueNorth Energy, which is 100 percent owned by Koch Industries of Wichita, Kansas (but is based in Calgary) recently announced cancellation of its Fort Hills Oil Sands Project and closed its Fort McMurray office. This, after $120 million of expenditures over the past four years, and after getting Alberta's regulatory approvals just last October. Others are weighing options of redeploying investment capital to the United States instead of Alberta. For instance, Canadian Natural Resources has delayed start-up of its $8-billion Horizon project by one year, to 2008. It is holding back, though even with the federal government's assurances about capping Kyoto costs. EnCana Corporation has also publicly indicated that they are considering shifting its future multi-billion oil sands project to the United States[30].

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26 The Globe and Mail – Kyoto Impact Minimal – Suncor http://www.globeandmail.com/servlet/ArticleNews/business/RTGAM/20030109/wbsuncor/Business/businessBN/breakingnews-business January 10, 2003

27 Besides costs on improving environmental efficiency, high cost of labour and high cost of transportation are other reasons for higher full cycle costs.

28 Patrick Brethour – Syncrude Fails to Curtail Cost Overruns – The Globe and Mail Saturday, November 30, 2002

29 Editor's comments. www.OilandGasInvestor.com: Chemical Week Associates NewYork 2002.

30 Gwyn Morgan – CEO EnCana Corp. as reported in the Globe and Mail, November 20, 2002.

It is clear that most oil sands firms understand that emission reduction costs will have to be managed. The impact of any emission reduction cost is however not expected to be significant with high world market oil prices that can help bring in decent returns even with operating costs of well over US$10 per barrel. On a cost impact per barrel basis, even if sensitivities of the CO_2 credit/offset price increase are considered a 400 percent price increase in CO_2 credit/offset price would not impact more than 1 percent on the operating costs of the oil sands mainly because of shear size and volume of operations. As most new projects are under development, expensive emission reduction technologies must be built in during the construction stage, which add to the capital cost of the projects and keeps the operating levelised costs of production from oil sands to around $12 per barrel. Major uncertainty on return on investment for oil sands - due to the historical nature of a volatile world oil market - is thus compounded by the uncertainty posed by Kyoto. As a result, delays in new project roll outs can be expected. This will certainly have an impact on the Alberta economy.

7.2 Power Generation Sector

The power generation industry in Canada is comprised of a mix of hydroelectric dams and nuclear plants, as well as thermal plants using coal, oil, wood waste and gas in utility and private power plants. Coal fired power plants make up 16 percent of the Canada's generating capacity. The main contributors[31] to GHG emissions are the coal fired power plants,[32] which in addition to GHG gases emit SO_2, NOx, particulate matter, heavy metals and mercury.

[31] Manfred Klein: Environment Canada Oil, Gas & Energy Division – Full Cycle Emissions Estimations October 1999.

[32] Assuming GHG release does not continue to occur from large-scale hydro projects, which are accumulated decomposing submerged organic material.

Canada's Electricity Generating Capacity, 1997 (in MW)[33]		
Type	**MW Generated**	**%age**
Hydro	66,803	59.32%
Conventional Thermal	30,988	27.52%
Coal	18,012	16.00%
Oil	7,553	6.71%
Natural Gas	5,423	4.82%
Nuclear	13,390	11.89%
Tidal	20	0.02%
Other (Renewables)	1,405	1.25%
Total	**112,606**	**100.00%**

Source: Natural Resources Canada

Coal remains the world's most abundant fossil fuel. Alberta's coal reserves contain twice the raw energy of all of the province's other non-renewable energy resources, including oil, natural gas and oil sands. Alberta contains 70 percent of Canada's coal reserves and produces about half of the coal currently mined in the country each year. Canada is ranked tenth in the world in total proven coal reserves, with 4 billion tonnes of bituminous and 30 billion tonnes of sub-bituminous coal. The huge abundance of the coal reserves in Alberta coupled with relative lack of hydro and renewable resources in the province has over the years pushed Alberta to become the country's largest coal consumer and producer[34]. It used 26.0 MT of bituminous and sub-bituminous coal in 1998 to generate electricity. This amounted to about half of Canada's total consumption of domestic coal. Nearly 44 percent of the province's power is generated by coal fired power plants.

[33] Natural Resources Canada website – Coal page http://www2.nrcan.gc.ca/es/ener2000/online/html/chap3e_e.cfm: 2000

[34] Alberta is followed by Ontario, Saskatchewan and Nova Scotia in use of coal for power generation. Electricity produced from coal power in each of these provinces is less than in Alberta.

Alberta's Electricity Generating Capacity, 2003 (in MW)				
Capacity (Megawatts)	**Coal**	**Gas**	**Renewables***	**Total Installed**
Generation – Utility Owned				
ATCO Power	1,563	105	—	1,668
EPCOR	768	841	—	1,609
TransAlta	3,150	—	795	3,945
City of Medicine Hat	—	211	—	211
Subtotal	5,481	1,157	795	7,433
% Age	74%	16%	11%	100%
Generation – Independently Owned				
Industrial	—	950	—	950
Independent Power Producers	42	2,751	291	3,084
Subtotal	42	3,701	291	4,034
% Age	1%	92%	7%	100%
Interconnections – Import Capacity				
British Columbia	—	—	—	800
Saskatchewan	—	—	—	150
Subtotal	—	—	—	950
Grand Total	5,523	4,858	1,086	12,417
% Age	44%	39%	9%	100%

Source: Alberta Energy

While coal is the dirtiest of the fossil fuels, natural gas, the favoured replacement fuel for coal, does not have these impurities and is far cleaner. A coal-fired plant will produce nearly one tonne of CO_2e per megawatt of electricity generated in one hour (MWhr). On the other hand a natural gas-fired cogeneration plant produces only 0.4 tonne of CO_2e per MWhr generated. If Alberta was to switch to natural gas for electricity, the result would be at least half the carbon-dioxide emission cut required by Kyoto. This type of change would not be possible however, at least in the short term.

Another alternative is to modify the existing coal-fired plants and convert them into clean coal technology units[35,36]. Clean coal technologies are a family of new technological innovations that are environmentally superior to the technologies in common use today. Most are the products of research that has been conducted over the last 20 years or more. Clean

[35] US Department of Energy website http://www.fossil.energy.gov/coal_power/cct/: - Clean Coal – America's strength. A 2003

[36] Natural Resources Canada website www.nrcan.gc.ca/es/etb/cetc/combustion/cctrm/htmldocs/roadmapping_e.html Canadian Clean Coal Road Mapping – April 2003

coal technologies include combustion processes - like fluidized bed combustion and low-NOx burners - that remove pollutants, or prevent them from forming, while the coal burns. Clean coal technologies can also be new pollution control devices - like advanced scrubbers - that clean pollutants from flue gases before they exit a plant's smokestack. Still other clean coal technologies can convert coal into fuel forms that can be cleaned before being burned. For example, a clean coal plant may convert coal into a gas that has the same environmental characteristics as clean-burning natural gas. However, the efficiency of the combustion cycle is only marginally better than the existing coal fired plants meaning that in combustion cycle plants more coal will be burnt to produce the same amount of energy and will net out any gains in emissions on a per tonne basis of burnt coal.

The price of fuel is a key determining factor for coal-fired and gas-fired Levelised Unit Energy Cost (LUEC)[37]. Coal prices in Alberta for large base load plants range from $0.75/GJ to $1.0/GJ and are fairly constant over time. Delivered natural gas costs are much higher and very volatile. Average real gas prices are currently $5.0/GJ and are expected to go even higher. Coal fired power generation facilities have higher capital and operation costs than gas fired plants. On a LUEC basis and the current fuel costs both a new coal fired power plant and new natural gas fired power plant produce power at a widely believed cost range of around 6 ¢/KWHr. For existing coal plants which have been depreciated – the cost range is 3.5 ¢/KWHr to 4.0 ¢/KWHr. Coal power plants are completely insensitive to gas prices. Provincial electricity costs have risen, partly because increasingly expensive natural gas sets the price of electricity at margin. What happens is that initially at low natural gas prices, (say $2/GJ) the natural gas power plants are more competitive than the coal fired plants and are the first to come online. But as the price of gas rises, the gas fired plants become more costly and instead more and more coal power plants come online as they now produce cheaper power. (This is the case now when coal plants always come online first during on-peak periods). When all the coal fired 5,500 MW capacity is online, the more expensive gas fired power plants come online to fill in the deficit in provincial peak demand of about 8,500 MW or so. Thus, the higher the price of gas the higher will be the cost of power generated beyond the capacity of cheaper coal fired plants.

At an even higher cost of around 7.2 ¢/KWHr lie renewable power sources (mostly wind), but for now they are relatively small part of the generation capacity. A current federal government Wind Power

[37] Allan Chambers: Reduction of Air Emissions from Fossil-Fueled Electricity Production - Carbon and Energy Management Business Unit, Alberta Research Council Inc. Reduction of Air Emissions from Fossil-Fueled Electricity Production: May 29, 2002.

Production Incentive (WPPI[38]) offsets wind power's cost by 1.0 ¢/KWH. The cost of clean coal plants (if constructed at current prices) will also be closer to wind power plants.

Let us incorporate the effects of Kyoto into the equation first by taking the Plan's formula cap of 15 percent reduction from business-as-usual level and apply it to Alberta's coal fired power plants:

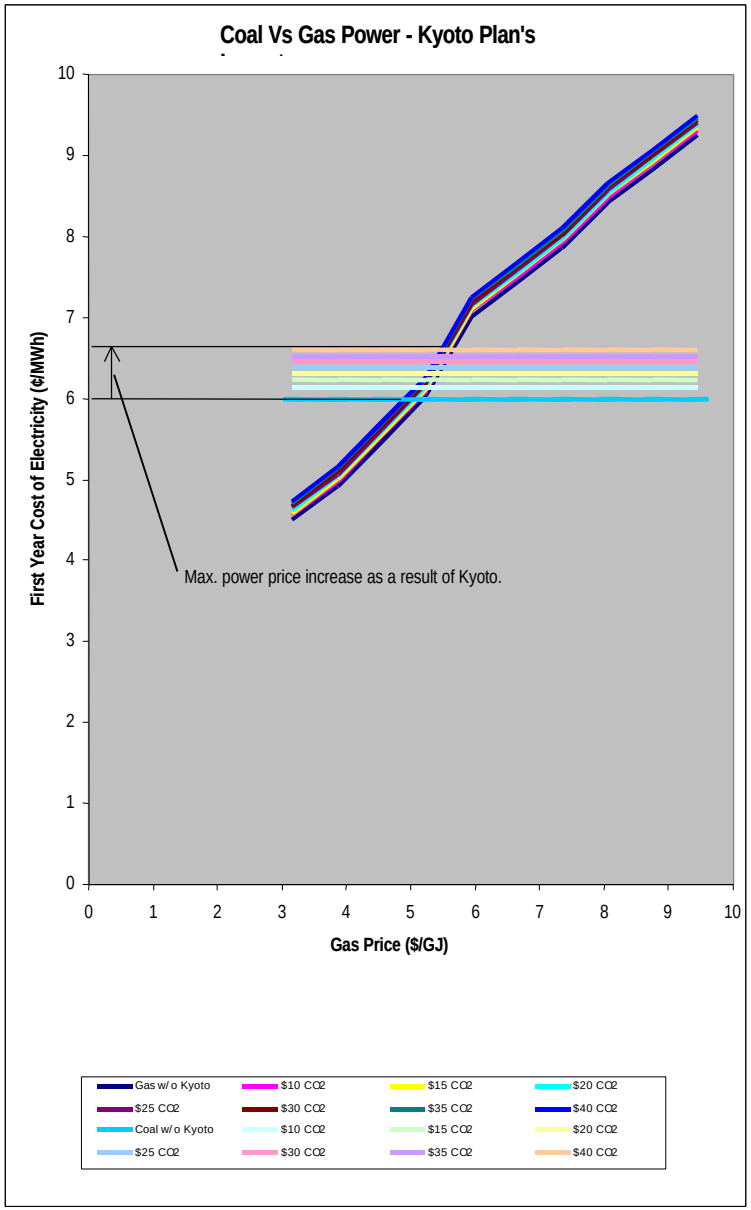
Coal Fired		
Generating Capacity (MW)	5,523	
Capacity Factor	0.90	
Power Output in Kwh	42,946,848,000	
Emissions @ 0.001 MT/Kwh	42,946,848	**--- (a)**
Emissions reduction target – 15% of above (MT)	6,442,027	
Cost of Emissions reductions at CO2 credit/offset price of:	**$ -- (b)**	**¢/KWHr - b/a**
$10/Tonne of CO2e	64,420,272	0.15
$15/Tonne of CO2e	96,630,408	0.23
$20/Tonne of CO2e	128,840,544	0.30
$25/Tonne of CO2e	161,050,680	0.38
$30/Tonne of CO2e	193,260,816	0.45
$35/Tonne of CO2e	225,470,952	0.53
$40/Tonne of CO2e	257,681,088	0.60

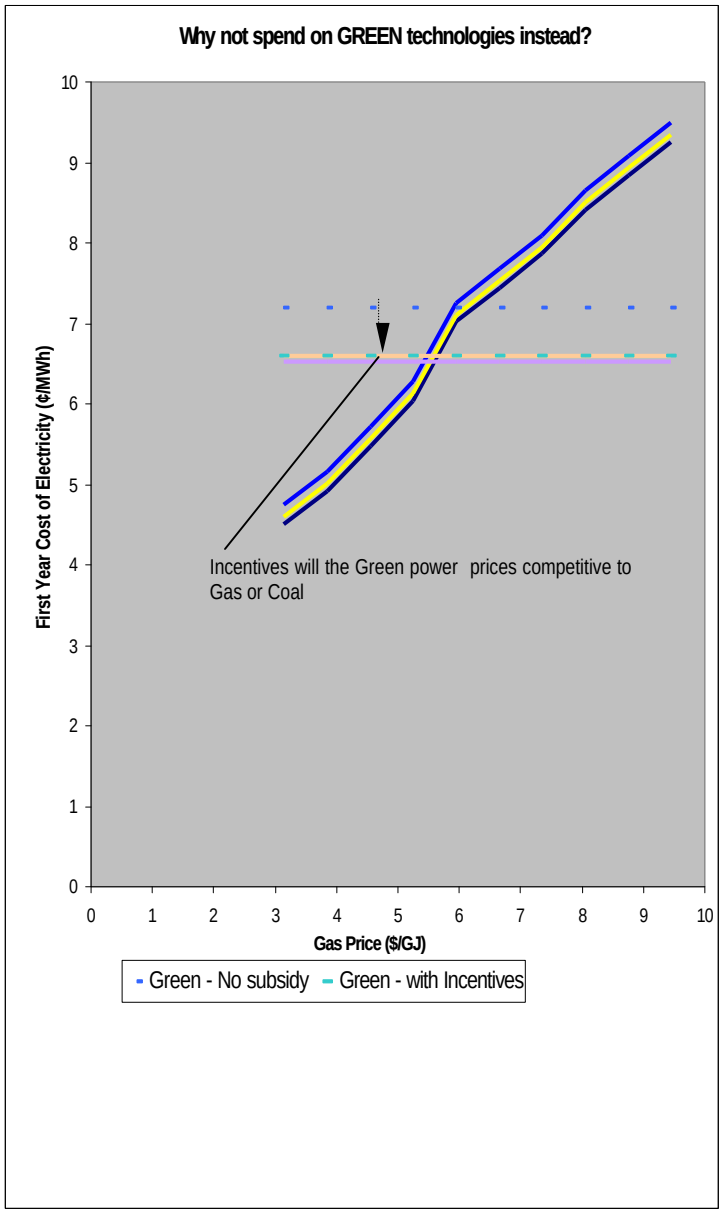
We can see that various CO_2e credit/offset prices the cost impact on the coal fired power plants electrical output ranges from 0.15 ¢/KWHr to 0.60 ¢/KWHr. A similar analysis is now done for gas fired power plants as follows:

[38] As part of Climate Change incentives declared in Budget 2001, the WPPI was created to help Canada reduce its direct greenhouse gas (GHG) emissions by encouraging the development of wind energy, which does not produce emissions. The incentive will also help establish wind energy as a full-fledged competitor in the electricity marketplace. The WPPI encourages participation from prospective producers in all regions and is expected to leverage approximately $1.5 billion in capital investments across Canada. The terms and conditions of the initiative benefited from the input of 50 stakeholders during technical consultations earlier this year. By displacing other electricity sources and through continued momentum, wind power capacity installed under WPPI, is projected to reduce GHG emissions by three megatonnes annually by 2010.

Gas Fired		
Generating Capacity (MW)	4,858	
Capacity Factor	0.90	
Power Output in Kwh	37,775,808,000	
Emissions @ 0.0004 MT/Kwh	15,110,323	**--- (a)**
Emissions reduction target – 15% of above (MT)	2,266,548	
Cost of Emissions reductions at CO2 credit/offset price of:	**$ -- (b)**	**¢/KWHr - b/a**
$10/Tonne of CO2e	22,665,485	0.06
$15/Tonne of CO2e	33,998,227	0.09
$20/Tonne of CO2e	45,330,970	0.12
$25/Tonne of CO2e	56,663,712	0.15
$30/Tonne of CO2e	67,996,454	0.18
$35/Tonne of CO2e	79,329,197	0.21
$40/Tonne of CO2e	90,661,939	0.24

We have also carried out a sensitivity analysis that incorporates the cost of Kyoto and the various gas price scenarios and compares coal fired versus gas fired power costs. On this we can then superimpose the cost of GREEN power, with and without government incentives.


Coal Vs Gas Power - Kyoto Plan's
First Year Cost of Electricity (¢/MWh)
Gas Price ($/GJ)
Max. power price increase as a result of Kyoto.
Gas w/ o Kyoto
$10 CO2
$15 CO2
$20 CO2
$25 CO2
$30 CO2
$35 CO2
$40 CO2
Coal w/ o Kyoto
$10 CO2
$15 CO2
$20 CO2
$25 CO2
$30 CO2
$35 CO2
$40 CO2


Why not spend on GREEN technologies instead?
First Year Cost of Electricity (¢/MWh)
Gas Price ($/GJ)
Incentives will the Green power prices competitive to Gas or Coal
Green - No subsidy
Green - with Incentives

Strikingly, in the above table, ¢/KWHr results are very much in line with those provided in the Plan. The main concern, however, appears to be the fact that the absolute costs will stretch the financial capabilities of the incumbent generators of the province whose portfolios are heavily loaded with coal fired power units. A summary of the revenues and net earnings of these three companies is provided below:

2002 Numbers in Millions $	*ATCO*[39]	*TransAlta*[40]	*EPCOR*[41]	*Total*
Revenue	3,196	1732.9	2748.9	7,678
Net Earnings	336.6	189.9	184.4	711

The impact of Kyoto on electric generators as worked out earlier is expected to be in the range of $87 million to $350 million depending on the price of CO_2e credits which could potentially eat up to half of the net earnings of the incumbent utilities in today's terms. The price cap of $15/MT will limit the cut in earnings to around $130 million but still if the price of the carbon credits/offsets rises beyond $15/MT the question remains as to who will pay the price difference. Will the difference be passed on to electricity consumers in Alberta? This could be up to $100 per capita annually. In this case the impact on Alberta consumers will be much more than if the difference can be made to be absorbed across the board by the federal government in its Kyoto mitigation costs.

The sensitivity analysis chart leads us to the conclusion that we will see a rise in the cost of power generation (and hence prices) as a result of Kyoto. Assuming that the price of natural gas remains at or below $5/GJ, in the short run the coal plants will assume the role of marginal price setting. Contrary to their base load (full utilization now) some coal plants may be partly used. However the shift from coal to gas would be expensive. Most plants are relatively new investments and thus will be exposed to early capital turnover liability both for the utility generators as well as the financing institutions. In the long run we can expect greater investments in either gas-fired plants or in cogeneration plants at the oil sands. However, we can expect to see some actual reduction in GHG emissions as less coal and more gas will be burnt. Note that Alberta has also limited transmission import capacity and therefore the import of electricity from other provinces and from US is not possible. In the long

[39] ATCO Financial Report. ATCO website http://www.atco.ca/investor/pdfs/ATCO%20FinStmt%2002s.pdf 2003

[40] TransAlta Financial Report. TransAlta website http://www.transalta.com/WEBSITE2001/TAWEBSITE.NSF/9601eeb83bcdb335872568dc0062d915/23ac895732782b4b87256cf6007bfead/$FILE/TAC%202002%20Annual%20Report.pdf 2003

[41] EPCOR Financial Report. EPCOR website http://www.epcor.ca/NR/rdonlyres/efkyuxjkgc2qg52idylcnw5tmysiaitdqh76quvuw2jxkp3jngieqdegyqafv3sabqp37faxznq5cx3pbigywq7m4ab/2002+Annual+Report.pdf 2003

run other substitute energy sources, such as wind and nuclear, may become competitive in Alberta[42] which in actual effect is good for the GHG emission reduction in real sense.

As earlier mentioned, gas fired power costs are highly sensitive to the natural gas prices. Natural gas prices are already forecast to go up in Canada. From our analysis if the natural gas prices climb beyond the current level of $5/GJ, additional costs of Kyoto for the coal-fired plants will in effect push the marginal costs upwards and simply help raise the price of electricity. No reductions in GHG emissions will take place directly in Alberta as coal fired plants continue to operate. In the bigger picture in the context of this scenario, with higher electricity prices, the increased cost of production in manufacturing and agriculture will reduce competitiveness of Alberta's economy. The direct cost burden, which the consumers will actually have to bear, will rise. In the long run with sustained higher prices of natural gas we would also see more investments in coal plants that will worsen the real GHG emission profile of the province. This is a paradox.

So, the trade off in the above two scenarios is between some level of reduction in GHG gases with a tremendous pain in the transition period (i.e. shutting down of coal fired plants and greater reliance on natural gas plants) or a pain with no gain scenario (i.e. continued generation from coal fired plants). Ironically the choice between the two is not within the hands of the makers of the current policy but will be dictated by the price of natural gas.

Further, a genuine concern is that the money used to purchase credits might be better spent investing in this sector, specifically, on research and development of GREEN power like clean coal technology and retrofit the existing coal plants.

7.3 Agriculture

Agriculture contributes one-fifth of global anthropogenic greenhouse gas emissions. Approximately 7 percent of Canada's landmass supports agriculture, which is about 167 million acres of agricultural land in Canada. About 30 percent of that is grassland. In Canada, agriculture is responsible for approximately 8 percent of total man-made emissions. Alberta is currently the third largest food and beverage processing province in Canada, contributing 13 percent of national shipments. In recent years, the industry has shown strong growth, with the value of its manufacturing shipments now approaching $9 billion. In recent years, the industry has shown strong growth, with the value of its manufacturing shipments now approaching $8 billion.

[42] DOE's National Energy Technology Laboratory
http://www.netl.doe.gov/publications/proceedings/02/ngt/Maslak.pdf: May 14, 2002

Albertan agri-food processing emissions from fossil fuel use increased by 17 percent between 1990 and 1996, from 0.6 to 0.7 million tonnes of carbon dioxide equivalents. Assuming continued strong growth of the industry over the next decade, its emissions from fossil fuel use are projected to increase by 243 percent, to 2.4 million tonnes of carbon dioxide equivalents, from 1996 levels, by 2008-12. So far, neither the agriculture industry nor individual farmers have been given mandatory reduction targets. Agriculture is expected to play a prominent role in helping Canada reach its goals. Under the Kyoto Protocol, revegetation, cropland management and grazing land management have been included to account for removals by sinks. The Protocol allows unlimited removals of CO_2 from agriculture in Canada. The following table provides the potential carbon sequestration in Canadian agricultural soils. The calculations assume continuation of current practices.

Summary of Potential Agricultural Soil Carbon Sequestration Practices

Strategy	***Annual Sequestration Rate 2008-2010MT CO_2***	***2013-2017MT CO_2***	***Average $/tonne CO_2***	***Cost***
1. Conservation Practices on Cropland	18.3	18.1	4.25	
2. Pasture Management	0.7	2.5	9.00	
3. Convert Marginal Cropland to Grass	2.2	2.2	3.50	

Source: Sinks Table Options Paper. September 1999

The Federal Climate Change Plan suggests that the adoption of improved farm management practices will reduce overall emissions by as much as 66 MT (9 percent of total 2001 GHG emissions in Canada). Environmentally friendly production techniques such as zero-till farming, a practice that is recognized under Kyoto as a way to increase soil-based carbon reserves and reduce carbon dioxide levels in the atmosphere, is expected to play a major role. Developing marginal cultivation land for sequestration is another alternative. The pitfall is that productive farmland has a limited ability to store soil-based carbon and will eventually reach a point of carbon saturation. A soil's potential to sequester carbon is highest in the years immediately after conversion to no-till. That potential diminishes gradually until the saturation point is reached after approximately 20 years. So potential increases in revenue by selling credits will be only temporary.

The three gases from agriculture that cause the greenhouse effect are carbon dioxide, methane, and nitrous oxide. Carbon dioxide is released by combusting fossil fuels for energy and the losses of soil organic matter due to conventional, tillage practices that involve intensive tillage and the removal of crop residue[43] Methane from manure and ruminants is a contributing factor as is the release of nitrous oxide from fertilizer usage, crops and manure. Nitrous oxide (N_2O) from fertilizer and manure

[43] Environment Canada National Sinks Table, (p.50): 1998

application, and carbon dioxide (CO_2) from machinery and decaying soil organic matter stand out as the main GHGs emitted by agriculture.

Approximately 42 percent[44] of Alberta's total agricultural emissions are from nitrogen fertilizer application. One way for producers to reduce N_2O emissions from their cropping systems is to match fertilizer applications to plant nutrient needs. This means applying the amount of nitrogen that is deficient in the soil. As well, optimizing the timing of nitrogen fertilizer application will help to ensure maximum uptake of nitrogen by plants and therefore reduce the amount lost to the atmosphere. If soil conditions are conducive to nitrogen loss (i.e. waterlogged), switching from fall to spring fertilizer application can help reduce nitrogen losses. By adopting this change in practice, nitrogen losses in Alberta could be reduced by 30 – 50 percent. Likewise, changing application methods from broadcast to banding can reduce nitrogen emission by up to 20 percent.

The Government of Canada committed $150 million for Kyoto activites in agriculture. Some of that money is available for “early action” initiatives. For example, Kyoto funds were used to help fund the Iogen ethanol-from-cellulose pilot plant at Ottawa, a $25-million venture ($10 million from Ottawa) designed to make ethanol from materials like corn stover. Agriculture and food (including ethanol and sink activities) will likely be a small part of any future Canadian Kyoto strategy, but agriculture will be a player, and there are many opportunities to be exploited in concert with other improvements which we should do anyway (better manure and fertilizer management, greater energy efficiency, no tillage, fuel ethanol, as examples).

A bigger challenge is that a $12 million investment would be required between 2000 and 2012 to develop and implement a framework for a measuring and monitoring framework on carbon sequestration. The federal Plan estimates that the agriculture sector is expected to provide a sink of 5.8 MT of carbon dioxide. The agriculture sector could provide an additional sink for 8.2 MT by 2010. This will be accomplished through improved nutrient management no-till farming and decreased utilization of summer fallow. The cost by 2010 could be $120 million annually which translates to nearly $15/MT of CO_2e. Thus in actual effect with the amount of investments done, there will be no net benefit in terms of costs of additional offsets.

Input prices, such as the prices of gas and electricity, play a critical role in the competitiveness of agriculture. In section 7.2 we explored the potential of increase in electricity prices as an aftermath of Kyoto’s implementation. Agriculture economists suggest that energy use in agriculture is relatively inelastic (slow to change), therefore, if energy costs increased that cost would come out of the average gross margin of the farmers.

[44] Alberta Agriculture, Food and Rural Development, Production Economics and Statistics Branch. Agriculture Statistics Yearbook 1996.

7.4 Transportation

The transportation sector is the largest single contributor to GHG emissions in Canada. As such transportation GHG emissions will be a key element in achieving Canada's emissions target under the Kyoto Protocol. Less attention has so far been given to reducing emissions here than in other sectors. Without any concrete changes, the historical trends observed between 1980 and 2001 are expected to persist in the near future. By 2020, total transportation demand could be more than 50 percent higher than it was in 1990, with most of the growth expected to come from private vehicles, trucking and aviation. This has the potential to offset overall reductions associated with technological improvements in private vehicle emissions achieved between 1980 and 1990. This is especially true because much of this increase in demand is for larger personal vehicles such as sport utility vehicles (SUVs) and minivans.

In our earlier GHG emissions profiling we have seen that the share of transportation is smaller for the province of Alberta than for the rest of Canada. The smaller share of transportation is merely reflective of the higher loading of GHG emissions coming oil/gas and electricity generation in Alberta than it is the case for the rest of the country.

The federal Plan envisages transport sector CO_2e reduction by 42 MT in all of the 3 steps through technology improvements and policy initiatives. The range of measures identified for action are: vehicles and fuels that produce fewer emissions, the increased use of alternative modes of transportation for passenger travel and more efficient transport of goods. These measures contribute to improved air quality and reduced traffic congestion, making Canadian cities healthier and more sustainable. Transport Canada has adopted a share of this target based on the emissions baseline of its own operations. The target is a 4 percent reduction from Transport Canada's 1998/99 GHG baseline by 2008-12. Transport Canada's GHG emissions reduction strategy mainly targets its motor vehicle fleet with alternative fuel purchasing and the marine vessel fleet with efficiency improvements. Some of the initiatives already in place and for which funding has already been made available by the federal government are listed below:

- **Efficient Fuel & Vehicles:** According to the Motor Vehicle Efficiency Initiative, Action Plan 2000 aims to achieve 25 percent fuel efficiency improvement by 2010 in new vehicle fleet.

- **Less GHG-Intensive Fuels:** When blended with gasoline at low levels (such as 10 percent), ethanol can reduce the amount of GHGs produced. Most vehicles in Canada today can safely operate on ethanol-blended gasoline (E10). While grain-based ethanol may play an important role in the short term, it is recognized that cellulosic ethanol is an emerging Canadian technology that is considered to hold much promise over the longer term. The government's goal is to

have 35 percent of Canada's gasoline supply contain E10 by 2010. In addition to ethanol, Canada is also a world leader in new technologies for the production of biodiesel and a national target of 500 million litres produced by 2010 has been set.

- **Passenger Transportation:** This would be done in conjunction with collaborative efforts to establish supporting transportation management and land-use planning frameworks at the municipal level, and significant provincial and territorial actions to increase demand for public transit and reduce single-occupant vehicle use. Potential actions include mechanisms to give priority to public transit in traffic, and strategic management of the supply and pricing of parking facilities and roads. Municipalities can also improve infrastructure for non-motorized transportation through the creation of walking and biking paths.

- **Alternative Fuels Promotion** – Promotion of Compressed Natural Gas (CNG) as a fuel which can also significantly reduce particulate emissions from vehicles, particularly when it is used as an alternative to diesel fuel.

- **National Information Campaigns and Programs on Environmentally Sustainable Transportation**

- **Reduce Air Emissions from Rail, Air and Marine Transportation**

- **Car Pooling:** Car pooling or ride sharing, particularly for journeys to work and where public transport is limited.

The major challenge for transportation, like the other sectors, is that so far very little quantification of the measures taken by governments to address transport emissions has been undertaken. Unless more clearly targeted measures are adopted to provide incentives for reducing transport carbon dioxide emissions, backed up by quantitative analysis of the expected reductions, the Kyoto targets will not be met.

Transportation is also a major component of the full cost cycle of the oil production and increase in prices of transportation will certainly affect the competitiveness of Alberta's major exports to the United States. For Alberta, the additional issues relate to rural based populations, remote highly capital-intensive industries and the high amount of truck and car traffic, which continues to increase in the province. Calgary is becoming a distribution center as is Edmonton for intermodal transport. In a growing economy with more north-south traffic, the Plan will need clarity in recognizing these facts and developing and implementing long-term plans. Long-term planning also needs to be put in place to define the urban make up and lifestyles in the province that encourages use of mass transit within the cities. A high-speed rail link between Edmonton and Calgary, which has been discussed many times in the past, could help curtail the number of commuting vehicles drastically.

8.0 Conclusions

The major implication of the Federal Climate Change Plan to Alberta's economy is at the risk of experiencing economic transition pains and losing its competitive edge. This risk may drive future investments out of the province and damage the provincial economy. Moreover, it is still uncertain if after all this pain it will be possible to meet Kyoto targets.

Though the federal government has come up with assurance for a $15 per tonne of CO_2e cap for Large Industrial Emitters (LIEs), for now it seems that other than this one assurance the rest of the federal policy initiatives are not focused on the energy sector that is most pertinent to Alberta's economy. The underlying costs and risks that threaten the Albertan economy therefore need to be addressed by all the stakeholders, which includes the federal government, the provincial government and the industry players. One major concern is that current climate change policies may shift capital out of Alberta (from $1 billion to $4 billion during the implementation period of 2008-2012) as a result of purchases of credits from international GHG markets.

The rate of investments in oil sands have slowed down considerably since the Kyoto debates started in 2001. The power generation sector could find itself saddled with high costs of mitigating the impacts of Kyoto and these costs appear highly likely to be passed on to Albertan consumers in the form of higher power prices. Higher power prices would increase the input costs of Alberta's other key manufacturing and agriculture sectors and aggravate the competitive positioning of these sectors. It is still uncertain what the eventual cost impact on transportation, which acts as a key input to Albertan exports, would be. In the long term, there is still need to develop strategies and plans that provide incentives to the development of low cost emission reduction technologies and encourage the social make-up as well as lifestyles that are geared towards energy conservation.

In Alberta's new proposed legislation, Bill 37[45], we can hope to secure a framework for the implementation of Alberta's own action Plan on climate change. If adopted this legislation could help in the development of an overall emission target for Alberta and targets for specific sectors of the province's economy that will be established by negotiated agreements. It could also provide a framework for how emission offsets will be applied against Alberta's regulatory requirements. The provincial government also promises establishment of a provincial climate change management fund to help sectors reduce emissions and invest in energy conservation, energy efficiency and technology.

Still, Bill 37, like the federal Plan does not appear to address the long term planning needs of Alberta as it does not lay down specific policy initiatives in that direction. Such strategies would require taking post 2012 Climate Change scenarios into consideration and would try to develop sustainable low-cost GHG

[45] Bill 37: Legislative Assembly of Alberta - http://www.assembly.ab.ca/pro/bills/ba-bill.asp?SelectBill=037 2003

reduction measures in the post Kyoto implementation period. The planned costs to be spent in international trading of credits can be best spent in financing such initiatives.

Annex A: Alberta GHG Emissions Data

Annex A

2001 GHG Emissions Summary for Alberta

GHG Source and Sink Category	CO2	CH_4	CH4	N_2O	N_2O	HFCs	PFCs	SF_6	Total
Global Warming Potential Multiplier	1		21		310	140-11700	6500-9200	23900	23,900
Units	kt	kt	kt CO2 eq	kt	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO2 eq
ENERGY									
Stationary Combustion Sources									
Electricity and Heat Generation	54,400	1.9	39	1	300				54,700
Fossil Fuel Industries	41,800	93	2,000	1	300				44,000
Mining	5,750	0.1	2	0.2	48				5,800
Manufacturing Industries	8,160	0.2	4	0.2	53				8,210
Construction	166	0	0	0	2.3				168
Commercial & Institutional	4,720	0.1	2	0.1	37				4,760
Residential	7,100	2.8	58	0.2	52				7,210
Agriculture & Forestry	284	0	0	0	1.8				286
Stationary Combustion Sources SUBTOTAL	122,000	98	2,100	2.6	790				125,000
Transportation Combustion Sources									
Domestic Aviation	2,150	0.1	2	0.2	65				2,220
Road Transportation									
Gasoline Automobile	4,650	0.5	11	0.7	230				4,880
Light Duty Gasoline Trucks	5,640	0.8	16	1.5	460				6,120
Heavy Duty Gasoline Vehicles	1,060	0.2	3	0.2	49				1,120
Motorcycles	27	0	1	0	0.2				27
Diesel Automobiles	34	0	-	0	0.8				35
Light Duty Diesel Trucks	154	0	0	0	3.5				158
Heavy Duty Diesel Vehicles	7,050	0.4	7	0.2	64				7,120

Annex A

2001 GHG Emissions Summary for Alberta

GHG Source and Sink Category	CO2	CH_4	CH4	N_2O	N_2O	HFCs	PFCs	SF_6	Total
Global Warming Potential Multiplier	1		21		310	140-11700	6500-9200	23900	23,900
Units	kt	kt	kt CO2 eq	kt	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO2 eq
Propane & Natural Gas Vehicles	265	0.2	3	0	1.6				270
Road Transportation Subtotal	18,900	2	41	2.6	810				19,700
Railways	1,950	0.1	2	0.8	240				2,200
Domestic Marine	-	0	-	0	0				-
Others									
Off Road	5,000	1.5	31	1.6	490				5,520
Pipelines	3,320	3.3	70	0.1	27				3,410
Transportation Combustion Sources SUBTOTAL	31,300	7	150	5.3	1600				33,100
Fugitive Sources									
Others Subtotal									
Coal Mining		8.8	180						180
Oil and Natural Gas	9,080	1200	24,000						33,000
Fugitive Sources SUBTOTAL	9,080	1200	25,000						34,000
ENERGY TOTAL	163,000	1300	27,000	7.9	2400				192,000
INDUSTRIAL PROCESSES									
Mineral Production									
[1]									
Cement	893								893
Lime	166								166
Mineral Production SUBTOTAL	1,060								1,060
Chemical Industry									
[2]									
Nitric Acid Production				2.2	670				670

Annex A

2001 GHG Emissions Summary for Alberta

GHG Source and Sink Category	CO2	CH_4	CH4	N_2O	N_2O	HFCs	PFCs	SF_6	Total
Global Warming Potential Multiplier	1		21		310	140-11700	6500-9200	23900	23,900
Units	kt	kt	kt CO2 eq	kt	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO2 eq
Adipic Acid Production				0	0				-
Chemical Industry SUBTOTAL				2.2	670				670
Metal Production									
Iron and Steel Production	-								-
Aluminum Production	-						0		-
SF6 used in Magnesium Smelters								0	-
Metal Production SUBTOTAL									
Consumption of Halocarbons									
1						0	0		-
Other & Undifferentiated Production									
2	9,320								9,320
INDUSTRIAL PROCESSES TOTAL	10,400			2.2	670				11,100
SOLVENT & OTHER PRODUCT USE				0.2	46				46
AGRICULTURE									
Enteric Fermentation		340	7,200						7,200
Manure Management		36	750	5.3	1700				2,400
Agriculture Soils									
Direct Sources	1,650			21	6400				8,100
Indirect Sources				6.4	2000				2,000

Annex A

2001 GHG Emissions Summary for Alberta

GHG Source and Sink Category	CO2	CH_4	CH4	N_2O	N_2O	HFCs	PFCs	SF_6	Total
Global Warming Potential Multiplier	1		21		310	140-11700	6500-9200	23900	23,900
Units	kt	kt	kt CO2 eq	kt	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO2 eq
Agriculture Soils SUBTOTAL	1,650			27	8400				10,000
AGRICULTURE TOTAL	1,650	380	8,000	32	10000				20,000
LAND USE CHANGE AND FORESTRY (non-CO2 only)									
Prescribed Burns		1.8	37	0.1	22				60
Wildfires in the Wood Production Forest		3.6	76	0.3	90				170
LAND USE CHANGE AND FORESTRY (non-CO_2 only) TOTAL		5.4	110	0.4	110				220
WASTE									
Solid Waste Disposal on Land		51	1,100						1,100
Wastewater Handling		3.2	68	0.3	96				160
Waste Incineration	-	0	-	0	0				-
WASTE TOTAL		54	1,100	0.3	96				1,200
TOTAL	**175,000**	**1700**	**36,000**	**43**	**13000**	**0**	**0**	**0**	**224,000**

Notes:

1 Emissions Associated with the use of HFCs, PFCs, Limestone and soda ash are reported in the national industrial processes total.

2 Ammonia Production emissions are included under undifferentiated production at the provincial level.

3 CO2 emissions and removals in the LUCF sector are not included in the national totals. Non CO2 emission from fires located in the National Parks are not included in the provincial/territorial totals but are reported in the national totals.

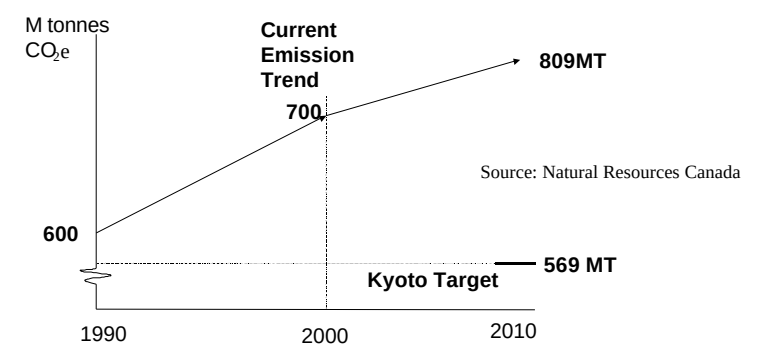
Annex B: Additional Kyoto Information

The Kyoto Timeline

The Path to Kyoto: Timeline on Climate Change Negotiations												
1979	**October 1988**	**August 1990**	**June 1992**	**March 1995**	**December 1995**	**December 1997**	**November 1998**	**November 2000**	**March 2001**	**July 2001**	**December 2002**	**Januray 2008**
First World Climate Conference adopts climate change as major issue and calls on governments "to foresee and prevent potential man-made changes in climate."	The United Nations sets up the Intergovernmental Panel on Climate Change (IPCC) to research and report on global warming.	First Assessment Report (see about link) by the IPCC finds that the planet has warmed by 0.5°C in the past century. IPCC warns that only strong measures to halt rising greenhouse gas emissions will prevent serious global warming. The report leads to a general agreement that an international treaty on climate change is needed.	The Earth Summit in Rio expresses concern about the effects of climate change on agriculture, polar ice caps and sea levels. The Climate Change Convention, signed by 154 nations, sets a target of reducing carbon-based emissions to 1990 levels by the year 2000. The U.S. refuses to make the terms of the agreement legally binding.	The signatories to Rio's Climate Change Convention meet in Berlin. They conclude that the convention's emission reduction targets are inadequate.	IPCC releases the Second Assessment Report (see about link). The findings from the report lay the groundwork for negotiations in Kyoto, Japan.	The Kyoto Protocol calls for a worldwide reduction of carbon-based gases by an average of 5.2 per cent below 1990 levels by 2012. Different countries adopted different targets: The European Union committed to a cut of eight per cent, the U.S. to seven percent, Japan to six per cent and Russia and the Ukraine agreed to cut their emissions to 1990 levels. However, the U.S. says they will not ratify the agreement unless it sees evidence of "meaningful participation" in reducing emissions from developing countries.	Follow-up negotiations are held in Buenos Aires to work out the details of implementing the Kyoto Protocol. Disputes center on a provision that allows countries that have met their emissions reduction targets to trade their surplus with another country. At the end of the meeting most countries call for ratification of the treaty by 2002, the 10th anniversary of the Rio Earth Summit.	The U.S. and Europe fail to reach an agreement on how countries would reach their emission targets. The Europeans wanted targets to be met through actual reductions while the U.S. wanted more credits for emissions trading.	President George W. Bush announces that the U.S. will not ratify Kyoto because of costs to the American economy.	Despite opposition from the U.S., talks continue in Bonn. The agreement is finalized and signatory nations announce that they will try and ratify the protocol before the end of 2002. October 2002: Prime Minister Jean Chretien says that Canada will ratify the Kyoto Protocol.	Canada ratifies the Kyoto Accord	First Implementation period starts *Note: First Implementation period ends December 2012*

Glossary

Canada's Kyoto Target



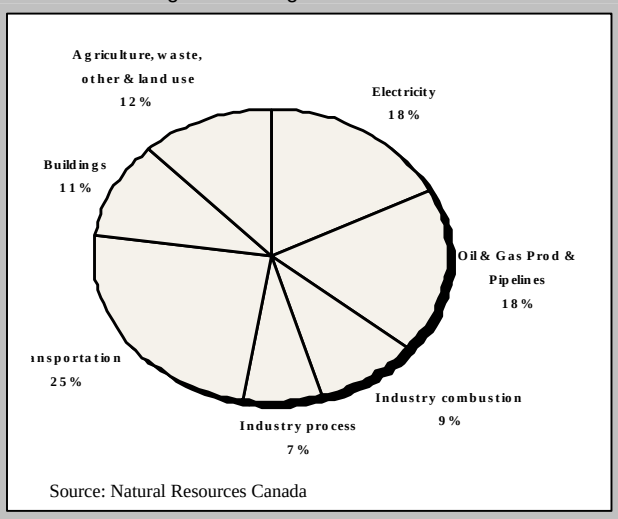
Source: Natural Resources Canada

The above figure provides the overall projected trend in Canada's greenhouse gases from 1990 to 2010. We can also see that in year 2010 there is a difference or a "Kyoto Gap" of 240 MT between the business-as-usual outlook and Canada's target under the Protocol.

In total Canada must reduce emissions by about 1200 MT from 2008 to 2012. Just as a matter of comparison, Japan, with a population and economy 4 times that of Canada's has a reduction challenge of about 660 MT.

Canadian GHG Emission Summary

Total emissions of greenhouse gases in Canada were in year 2000 were about 700 megatonnes per year, up from 606 megatonnes in 1990. 78% of this total is CO2, mostly from fossil fuel production and consumption. Fossil fuel use also produces methane and nitrous oxide (N2O), accounting for 7% of emissions; industrial processes, agriculture and waste dumping also generate various greenhouse gas emissions. The recent growth in emissions has come above all from three sources: the increasing use of light and heavy trucks, increasing emissions from fossil fuel production and refining, and the commissioning of new fossil-fuel driven power plants. Fossil fuel production and the burning of oil and coal to make electricity are both massive sources of greenhouse gas emissions in Canada.



Source: Natural Resources Canada

Carbon Sinks

A sink is any process that removes CO2 from atmosphere and stores it. Forests and agriculture soils can act as carbon sinks. Plants absorb CO2 from atmosphere through the process of photosynthesis. The CO2 is stored in the plant tissue. Agricultural soils can act as carbon sinks when CO2 removed from the atmosphere by crops is stored in the roots. When the plant dies, some proportion of the plant tissue remains in the soil and is transformed into soil organic matter.

Greenhouse Gases[46]

Whenever we talk about emissions, we refer to greenhouse gases in general. Some greenhouse gases occur naturally in the atmosphere, while others result from human activities. Naturally occurring greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, and ozone. Certain human activities, however, add to the levels of most of these naturally occurring gases and even sometimes add new gases into the atmosphere. A tabulation of the various greenhouse gases with the underlying human activity producing these gases is provided below:

GHG	Reason attributed to human activity
Carbon dioxide (CO_2)	CO_2 is released to the atmosphere when solid waste, fossil fuels (oil, natural gas, and coal), and wood and wood products are burned.
Methane (CH_4)	CH_4 is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from the decomposition of organic wastes in municipal solid waste landfills, and the raising of livestock.
Nitrous Oxide (N_2O)	N_2O is emitted during agricultural and industrial activities, as well as during combustion of solid waste and fossil fuels.
Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), & sulfur hexafluoride (SF6)	(HFCs), (PFCs) & (SF6) are very powerful greenhouse gases that are not naturally occurring and are generated in a variety of industrial processes.

Each greenhouse gas differs in its ability to absorb heat in the atmosphere. HFCs and PFCs are the most heat-absorbent. Methane traps over 21 times more heat per molecule than carbon dioxide, and nitrous oxide absorbs 270 times more heat per molecule than carbon dioxide. The concept of a Global Warming Potential (GWP) has been developed to compare the ability of each greenhouse gas to trap heat in the atmosphere relative to another gas. Under the Intergovernmental Panel on Climate Change (IPCC)'s guidelines Carbon dioxide (CO_2) is used as the reference gas as is given a GWP of 1. All other GHGs have GWP greater than 1. Therefore, often, estimates of greenhouse gas emissions are presented in units of millions of metric tons of carbon equivalents (MMTCE, hereinafter referred to as simply "megatonnes" or MT), which weights each gas by its Global Warming Potential (GWP) value.

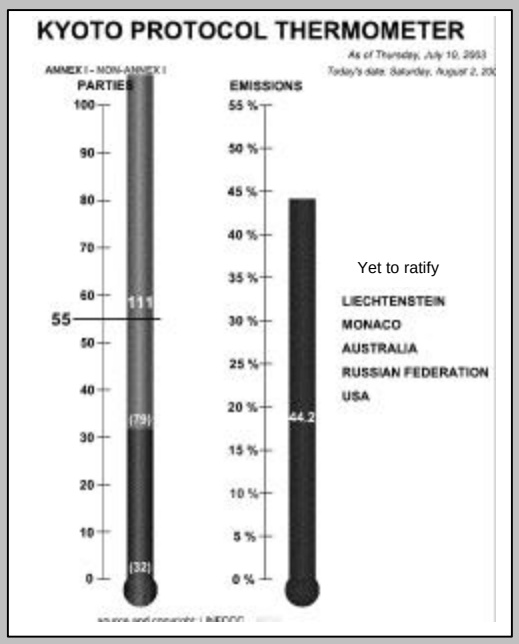
[46] US Environmental Protection Agency website: Page on Global Warming – Emissions. http://yosemite.epa.gov/oar/globalwarming.nsf/content/Emissions.html: 2003

Kyoto Protocol

The Kyoto Protocol is a popular name for the international agreement signed in a conference held in Kyoto, Japan from December 1 through December 11, 1997 under the auspices of the United Nations Framework Convention on Climate Control (UNFCC). More than 160 nations then agreed to reduce emissions of GHGs to combat the danger of man-made interference with the global climate system. The Protocol covers emissions of six gases, of which carbon dioxide from the combustion of fossil fuels is the most significant.

The individual targets for Annex I industrialised countries are identified in Annexure A of the text of the Kyoto Protocol and provide a commitment to reduce collective GHG emissions by 5 percent below 1990 levels during the period 2008 to 2012 (called the first commitment period). Canada's target is a 6 percent reduction; Japan's, 6 percent; and the European Union's, acting as a collective is 8 percent. The United States negotiated a 7 percent reduction target, but it has since chosen not to ratify the Protocol. Russia and some other East European nations "in transition " currently emit at levels below their 1990 emissions because of the economic dislocations of the 1990s. As a result, they have what is called "hot air " in the form of carbon credits to trade to industrialised nations. Although many developing countries have ratified, or will likely ratify Kyoto, none have reduction obligations during the first commitment period.

Around 110 countries and regions have ratified the Kyoto protocol, but their combined emissions account for only 43.9 pct of the global total. For the protocol to be implemented, it must be ratified by at least 55 nations accounting for at least 55 pct of global emissions. US the world biggest GHG emitter with 36.1% emissions withdrew from the Protocol in May 2001. Russia's ratification will be crucial to the fate of the protocol as the country is responsible for 17.4 pct of global greenhouse gas emissions. Ratification by Russia will clear the 55% threshold.



Source: UNFCCC

The penalties for non-compliant ratifying countries are to be finalised after the Protocol comes into force. Two suggestions have be prominent in various rounds of negotiations: (1) non-compliant nations must make up shortfalls in the second commitment period (post 2012), with a 30% added penalty; and (2) rights to trade in the internationals carbon credits could be curtailed. Legally binding penalties however, will require 75% of signatories.

Large Industrial Emitters (LIEs)	Large Industrial Emitters or LIEs group includes firms in nine different industries that together are expected to account for over 50% of total Canadian emissions. These nine different industries are Thermal electricity generation (coal, oil, and gas), Oil & Gas (upstream extraction, pipelines, gas utilities, petroleum refining), Mining (both metal and non-metal), Pulp & Paper production, Chemical production, Iron & Steel production, Smelting & Refining, Cement and Lime production, Glass and glass container production
Levelized Unit Energy Cost	The Levelized Unit Energy Cost (LUEC) approach to the comparative analysis of the economics of various generating options focuses on the discounted life-cycle average cost per unit of electricity produced taking into account all capital and operating costs. This all-in unit cost of producing electricity over the life of a power plant can then be compared as one important measure of the relative attractiveness of each investment option LUEC is defined as the discounted average cost of producing electricity from a power plant and is expressed in terms of cents or dollars per MWh. It takes into account the total discounted cost of producing the energy (capital, operating and maintenance and fuel costs) and the total amount of energy produced over the life of the plant, and distributes these costs over the anticipated operating life of the station. Using LUEC, one can calculate generating costs over the expected operating lives of new baseload power plants using either established or new technologies. LUEC is also helpful in analysing major capital investments in existing plants to determine whether the plants are financially amenable to refurbishment and life extension.
Megatonne	One megatonne (MT) is the normally used unit of measure of GHGs (or more specifically CO2e). One MT is equal to 1,000 kilotonnes (Kt) 1,000,000 tonnes. One tonne is equal to 1,000 kilograms.
Offset	In the DET context when emissions reductions in sectors not covered by an emissions trading system are sold into that system, these reductions are called "offsets" because they offset emissions generated by industries in the emissions trading system. This Plan proposes that the forestry, agriculture and possibly landfill sectors be permitted to sell offsets into the emissions trading system. For example, the mass planting of trees, which acts as a carbon sink, could generate an offset that could be traded to another company looking to reduce its emissions. Since these emissions reductions would offset emissions reductions that would otherwise be required of large industrial emitters, they would not lead to more emissions reductions in Canada overall. The advantage of offsets is that they could provide alternatives for reducing emissions to the large industrial emitters, and a market mechanism for stimulating emissions reductions in other sectors. In the Internal Trading context the term “credit” is normally used in place of the “offset”.
International Emissions Trading Mechanisms	The Protocol establishes three mechanisms that are designed in order to reduce the costs of meeting the emission targets. These mechanisms are known as Emission trading, Joint implementation (JI) and Clean Development Mechanism (CDM). Emission trading is simply an exchange of emission permits among Annex B countries. The operational rules related to emission trading are not yet agreed upon. This study therefore compares three different regimes for international emission trading. Joint implementation is the possibility to acquire additional emission permits by investing in specific projects that reduce emissions in other Annex B countries. This mechanism will only play a role if there are restrictions on emission trading; with free emission trading, joint implementation will be superfluous. CDM is the opportunity to acquire additional emission permits through projects that reduce emissions in developing countries. In our study, we have ignored this mechanism, because we did not have reliable data. This implies that our results will be biased towards high prices of emission permits. As for the fuel markets, our study will project a too large decline in developed countries and a too large increase in developed countries. However, the aggregate numbers are not necessarily biased.

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