ESTIMATING THE COST OF PIPELINE TRANSPORTATION IN CANADA

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INTRODUCTION

Pipeline transportation is an important sector in the Canadian economy. Canada is a major energy producer in the world and pipeline transportation is a practical and economical way of moving large quantities of crude oil and natural gas.

In 2004, Transport Canada initiated a major project called the Full Cost Investigation (FCI). The objective was to compute estimates of the financial and social costs associated with transportation infrastructures and services for passengers and freight. Pipeline transportation was not part of the scope of the FCI project. The purpose of the present paper is to generate estimates of the financial costs associated to the pipeline transportation sector in order to complement the initial FCI cost estimates. These costs include capital costs and operating costs. As it was the case for the FCI project, year 2000 is the base for the computations.

The rest of the paper is organized as follows: section two presents an overview of the pipeline industry and section three presents results on the financial costs of the pipeline industry for the year 2000.

PIPELINES AND ENERGY SECTOR OVERVIEW

Pipeline transportation is transportation of goods through a pipe. Usually liquid and gases are transported in pipelines. Any chemically stable liquid or gas can be moved through a pipeline but the most Canadians employed in the year 2001, of which, more than 10 million

Canada is a major producer of crude oil and natural gas. Canada's crude oil production is derived from three principal sources: conventional light and heavy oil deposits located in underground pools or reservoirs in the Western Canadian Sedimentary Basin, non-

conventional sources, including synthetic crude oil and bitumen, and frontier deposits which are mostly offshore.

Canada is the world's third largest producer of natural gas and the seventh largest producer of crude oil. Undeveloped energy resources include major crude oil and natural gas deposits in offshore areas in the North, gas reserves in the Yukon and Northwest Territories, and massive reserves of oil sands in Alberta. The building of the Mackenzie gas project in Northwest Territories promises a significant increase in the gas production by the year 2010.

Most Canadian crude oil production is transported from Edmonton, Alberta. It is delivered to domestic and foreign refineries by three major pipelines systems: Enbridge Pipelines Inc, TransMountain Pipeline Company Ltd., and Express pipeline. A pipeline system includes all parts of the physical facilities through which the product moves, including line pipe, valves, pumping units, metering stations and tanks.

Crude oil is processed in refineries to produce a wide range of petroleum products required by consumers in the transportation, residential, commercial, and industrial sectors. Refineries are designed according to the kind of products they are intended to provide, as well as to the nature and quality of the crude oil available for processing.
Oil production in Western Canada has experienced record levels of growth due to Alberta's oil sand development. The continued growth of oil production from oil sands means that Canada's pipelines infrastructure will have to expand. Pipeline capacity has increased by over 550,000 barrels per day since late 1990's to 2.5 millions barrels per day. Some forecasts indicate that over the next ten years an additional 600,000 barrels per day will be needed to satisfy the market demand.[1]

[1] This information is from "Pipelines in Canada", by International Business Strategies

Most natural gas production comes from wells classified as gas wells, while the rest comes from oil wells. In the case of gas produced from oil wells, the hydrocarbons flowing from the well consist of a mixture of natural gas and oil. Most oil production yields some gas. The gas is dissolved within the oil and needs to be separated from it before it is transported. This gas is called solution gas or associated gas.
Most natural gas wells produce some liquid hydrocarbons, which are separated at the surface. These natural gas liquids and condensates are counted as part of "crude oil and equivalent" production.

After processing, marketable gas is delivered by producers to high-pressure steel pipeline systems. The natural gas is carried to large industrial customers and local distribution companies. The seven major natural gas pipeline companies in Canada are: Trans Canada Pipelines Ltd., Westcoast Energy, Foothills Pipelines Ltd., TransGas Limited, Union Gas, TransQuébec and Maritimes Pipeline Inc (TQM) and Maritimes & Northeast Pipeline (MNP).

All provinces in Canada with the exception of Newfoundland and Labrador and Prince Edward Island possess gas transport infrastructures. British Columbia and Alberta are self-sufficient with respect to gas. Most gas consumed in Central and Eastern Canada is supplied by Alberta.
Provincial pipeline services are regulated by provincial authorities. Interprovincial and international pipeline services are regulated by the National Energy Board (NEB).

The Canadian Energy Pipelines Association (CEPA) is a major player in the pipeline industry. Its members transport 97% of the crude oil and natural gas produced in Canada..

CEPA full members are:

- TransCanada
- Enbridge
- Spectra
- Alliance
- Kinder Morgan Canada
- TransGas

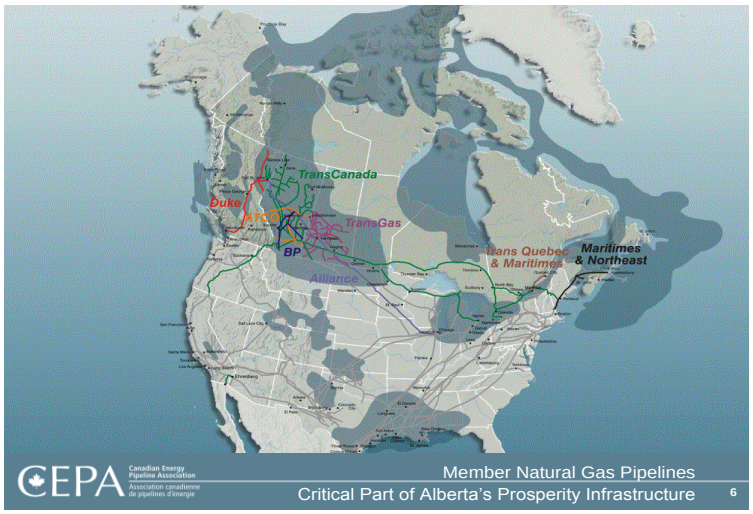
- ATCO
- Trans-Northern
- Foothills
- Trans Québec & Maritimes

Table 1 Gas and Oil Statistics for 2006

Natural gas	
Total production	17.1 billion cubic feet/day
Total exports	9.6 billion cubic feet/day
Value of net exports	$24.4billion
Total reserves	57.2 trillion cubic feet
Oil sector	
Total production	2.6 million barrels/day
Total exports	1.8 million barrels/day
Value of total exports	$39.3billion
Total reserves	179 billion barrels

Source: CEPA, An overview of the pipeline industry

Exhibit 1 Natural Gas Pipelines Map



Source: CEPA, an overview of the pipeline industry

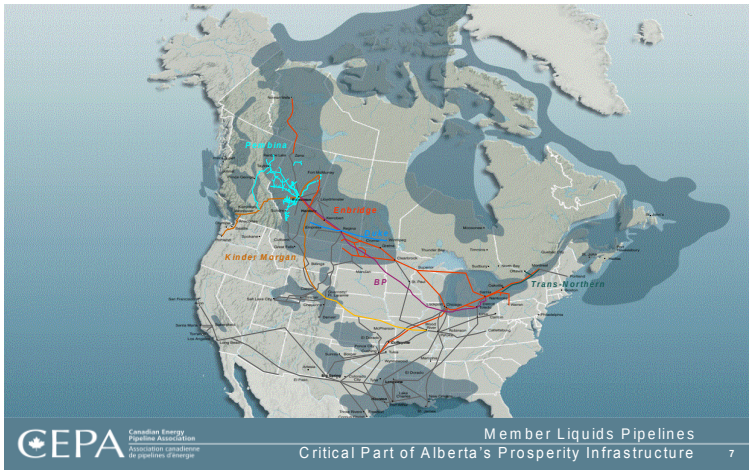


Exhibit 2 Oil Pipelines Map

Source: CEPA, an overview of the pipeline industry

Estimation of the financial costs of the pipeline industry

The estimation of the financial costs for the pipeline transport industry is based on the whole pipeline network. This includes gathering, transmission and distribution networks. In all these types of pipeline networks, transportation is involved since the product is being moved from point A to point B.

The computation of financial costs in the Full Cost Investigation Project (FCI) includes three elements: the cost of physical assets, the operating costs and the opportunity cost of land occupied by transportation infrastructures. This same approach is applied to the computation of financial costs for the pipeline industry.

As physical assets generally have a useful life of many years, there is a need to compute their annual cost with a method that makes the distinction between the investment and the consumption of capital. For the Full Cost Investigation Project, the method used was the perpetual inventory method (PIM). This method is based on historical time series of capital expenses by category of assets.

The PIM generates an estimate of the capital stock by accumulating past purchases of assets taking into account asset lives and depreciation. The essence of the perpetual inventory method is to add investment expenditures to the capital stock each year and to subtract depreciation. The PIM requires: information on the value of investment, price indexes for capital goods, mean service lives, and depreciation profiles.

The cost of capital is estimated by adding up:

1. The annual depreciation of the stock
2. The product of social opportunity cost of capital (SOCC) by the capital stock calculated by the PIM.

The perpetual inventory method is used by Statistics Canada to measure capital stocks by industry. Their results are used to have an estimate of the capital stock for the pipeline industry.

The computation of the operating costs is based on Statistics Canada data on financial expenses by Canadian firms involved in the pipeline industry.

For the estimation of the opportunity cost of land, the FCI project relied on a geographic information system. The approach is to use the location of transportation infrastructures. The value of land is then estimated depending on the unit costs of land. These unit costs, measured in dollar per squared meter, vary depending on the over-the-fence use of land (commercial, industrial, agricultural, residential).

In the case of the pipelines industry, it was found out that all pipelines regulated by the National Energy Board (NEB) are underground.

This implies that certain activities can take place on the land above the pipelines, reducing the opportunity cost of land used by pipelines. However there is still an opportunity cost of land because certain activities such as heavy construction would not be allowed on land above the pipeline nor within a given right-of-way band along the pipeline.

The pipeline right-of-way can be described as a controlled activity area that includes the surface area directly above the pipeline and some specified distance on either side of the pipeline. The right-of-way must be wide enough to permit the pipeline operator reasonable access to maintain the pipeline and to signal to others the existence of the pipeline. The right-of-way agreement between the pipeline operator and the landowner specifies activities or developments that are prohibited on the right-of-way without prior approval from the pipeline operator or that may not be allowed at all, for example buildings and other structures.

In agricultural areas, once the pipeline is in the ground, normal agricultural operations may continue unimpeded by the presence of the pipeline. However, deep-rooting vegetation should be avoided, since it could cause damage to the pipeline. Pathways, small playing fields, park areas, and golf courses are generally acceptable.

The size of the right of way varies, but is generally a strip of land 20 metres wide which contains the pipeline, while on the either side of the pipeline there is a safety zone that extends a further 30 metres from the right of way, and on which activities are controlled.

Generally, activities taking place in the pipeline right of way are restricted. Under the NEB Act, anyone proposing to construct a facility across, on, along or under a pipeline, or excavate to a depth greater than 30cm using power equipment or explosives within 30 metres of a pipeline right of way must obtain prior approval of the pipeline company.

Usually, companies tend to be accommodating when it comes to allowing activity on right of ways, but they require to be notified of any activity for security reasons, so they can approve it.

The geographic information data on the location of pipelines has not yet been identified. Thus, it has not been possible to generate numerical estimates of the opportunity cost of land used by the pipeline industry yet.

It is expected that the opportunity cost of land varies depending on the location of the pipeline. If for example, the pipeline is under agricultural land, the opportunity cost is low since most of the farming activities can carry on. The cost is higher when the land is residential or industrial because heavy structures above the pipeline are prohibited. A certain number of commercial activities non-involving heavy structures can be allowed above and around the pipeline location.

The cost of capital

Statistics Canada used the perpetual inventory method to calculate the value of the capital stock for the pipelines transportation industry.
For year 2000 the estimation for the capital stock is $ 32,567.3 million. This value is in current dollars of 2000. This is equivalent to constant dollars of 2000. The value of depreciation was computed using straight-line depreciation. The value for the year 2000 is $ 2,228.2 million. [2]
The annual cost for capital is estimated using the following formula:

Annual Cost = depreciation + (capital stock x social
Opportunity cost of capital (SOCC) rate)

[2] The value for the capital stock and depreciation are found in: Statistics Canada, Fixed capital flows and stocks, pipeline transportation.

The social opportunity cost of capital measures the opportunity cost of using capital for constructing pipelines. Society could use this capital for other economic activities.
The value used for the SOCC by the FCI was 7.3% plus or minus 1.3% for sensitivity analysis.

Applying the above formula, the annual cost of capital lower value is:

$32,567.3 million x 6% +$2,228.2 million = $4,182.2 million

The base value is:

$32,567.3 million x 7.3% + $2,228.2 million = $4,605.6 million

The higher value is:

$32,567.3 million x 8.6% + $2,228.2 million = $5,028.9 million

The value of the capital stock estimated by Statistics Canada applies to the whole pipeline transportation industry. There is no distinction made between pipelines transporting natural gas and those transporting oil.

In the present project we want to make the distinction between those two types of pipelines. Gas pipeline companies may have to spend more in capital equipment. For instance sometimes natural gas has to be liquefied and transported as liquefied natural gas (LNG). This method requires large facilities and specialized storage tanks.

The task of distinguishing the capital cost of natural gas and oil pipelines companies is difficult because some companies are involved in both sectors of activity. It is not possible to make the difference between assets of the gas sector and assets of the oil sector.

A possible solution would be to estimate the capital stock of major companies by using information contained in their financial statements. It would be possible to make a distinction from the

companies data and decide which part of the assets is allocated to the gas sector and which part is allocated to the oil sector. However this is made difficult by the fact that this information is often only available for the most recent year and it's not available at all for some companies.

Finally, the solution has been to use information from the financial data of Statistics Canada, where they publish separate financial results for companies involved in natural gas pipeline transportation and those active in the oil pipeline transportation sector. In the year 2000 the value of the net stock of capital at the book value for the gas transportation sector was $34,940.3 million and it was $5,464.5 million for the oil transportation sector.[3] The value of the capital stock estimated using this methodology is higher than the value obtained from the PIM method.

The reason is that the calculations in the second methodology are based on all the assets of the companies involved in the survey including non-transportation assets while the estimation based on the PIM method involves only pipeline transportation assets. These results imply that 86% of the capital stock belonged to gas transportation companies and 14% to oil transportation companies. This percentage is used to allocate the total capital stock estimated by Statistics Canada with the PIM between gas companies and oil companies:

Table 2 Estimated Annual Cost of Capital for Gas Pipeline Sector and Oil Pipeline Sector (In 2000 $ million)

Sector of activity	Low scenario	Base scenario	High scenario
Gas sector	$3,596.7	$3,960.8	$4,324.9

[3] This information comes from Statistics Canada, natural gas transportation and distribution, catalogue no57-205-XIB and Pipelines transportation of crude oil and refined petroleum products, catalogue no 55-201-XIB.

Oil sector	$585.5	$644.8	$704.1
Total	$4,182.2	$4,605.6	$5,029.0

Operating costs and total financial costs

Information on the operating costs for the gas pipelines transportation sector and the oil pipelines transportation sector was derived from Statistics Canada financial database.

Table 3 Operating Costs of the Natural Gas Pipelines Sector (in 2000 $million)

Transmission operations	$1,167,026.0
Distribution operations	$300,011.0
General and administrative	$1,003,918.0
Maintenance expenses	$239,329.0
Other expenses	$571,252.0
Total expenses	$3,281,536.0

Source: Statistics Canada, Natural gas transportation and distribution, catalogue no 57-205-XIB

For the FCI project, depreciation expenses are subtracted from the operating costs, because they are accounted for in the capital costs. Similarly, the amount of $1,494.4 million has been subtracted from the total expenses amount.

The operating costs for the oil pipelines transportation sector are estimated in the same way:

Table 4 Operating Costs of the Oil Pipeline Sector (in 2000 $ million)

Salaries and wages	$127,734
Operating fuel and power	$138,707
Materials and supply	$61,385
Outside services	$76,238
Other expenses	$135,708
Taxes other than income taxes	$98,439
Total operating expenses	$638,211

Source: Statistics Canada, Pipeline transportation of crude oil and refined petroleum products, catalogue no 55-201-XIB

To estimate the total financial cost, we have to add up the capital cost and the operating cost.

Table 5 Estimated Total Financial Costs for the Pipeline Transportation Industry (In 2000 $ million)

Sector of activity	Low scenario	Base scenario	High scenario
Gas sector	$6,878.3	$7,242.4	$7,606.5
Oil sector	$1,223.7	$1,283.0	$1,342.3
Total	$8,102.0	$8,525.4	$8,948.7

Estimation of the unit cost for the gas and oil pipeline transportation sectors.

To estimate the cost per unit, we need to know the volume of the total traffic of gas and oil transport systems in the year 2000. For the gas transportation sector it was estimated at 259626 billion cubic metre-kilometres and for the oil sector it was 107.2 billion cubic metre-kilometres.[4]

Table 6 Estimated Unit Cost for the Gas and Oil Pipeline Transportation Sectors (in $ per cubic metre-kilometre)

	Low scenario	Base scenario	High scenario
Gas sector	$0.000026	$0.000028	$0.000029
Oil sector	$0.011415	$0.011968	$0.012521

As pipelines allow transporting very large quantities of gas and oil on very long distances the unit cost of this transportation activity is very low, almost zero as it is displayed in Table 6. For the gas pipeline transportation sector the unit cost per cubic metre-kilometre is $0.00006 in the base scenario. For the oil pipeline transportation, the unit cost is $0.02 per cubic metre-kilometre.

Oil and natural gas can be transported by pipeline, road, rail or ship. The most important determinant of the transportation mode is cost effectiveness and accessibility. Gas and oil are transported in large quantities and over long distances. For this reason, pipelines are the most cost effective, energy efficient and safest means of transportation.

Oil is generally transported by road or rail over shorter distances when it is being gathered from production sites and when it is

[4] These estimations are from Statistics Canada, Natural Gas Transportation and Distribution, Cat no 57-205-XIB and Pipeline Transportation of Crude Oil and Refined Petroleum Products, Cat 55-201-XIB, 2001

distributed to consumers. On shorter distances rail or road can be more cost effective when transporting relatively small quantities of the product. For natural gas, pipelines are by far the dominant way when moving product from all phases of production: gathering from producing regions to transmission /storage and to distribution to the consumer.

The only other alternative to transporting natural gas by pipeline is to compress and liquefy it under a great deal of pressure, and then transport it in this state as what is called liquefied natural gas. This procedure requires large facilities and specialized storage tanks and is only economically viable when the quantity of gas is very large. This method is used when it is not feasible to move natural gas by pipeline, and generally involves natural gas being liquefied at a terminal close to the site of production, transported by ship to a receiving terminal where it is re-gasified and transported in a pipeline network to the consumer. This method is still uncommon and by far the largest volume of natural gas is transported exclusively in pipelines.

Conclusion

The objective of the present study is to estimate the total financial costs of the pipelines transportation industry. In the FCI project these costs included capital costs, operating costs and the opportunity cost of land. Because of the lack of information on the location of pipelines it has not yet been feasible to compute numerical estimates of the value of the land used for pipelines construction. Our estimate of the financial costs accounts for the capital costs and the operating costs. According to our estimates the total financial cost for natural gas pipeline transportation companies varies from $ 6.8 billion and $ 7.6 billion with a base value of $ 7.2 billion. The financial costs for oil pipeline transportation companies vary between $1.2 billion and $ 1.3 billion with $ 1.28 billion as the base value.

References

Canadian Standards Association, Land use planning for pipelines: a guideline for local authorities, developers, and pipeline operators, 2004.

CEPA (Canadian Energy Pipeline Association), An overview of the pipeline industry, 2006. Available at: http://www.cepa.com

International Business Strategies, Pipelines in Canada, 2005. Available at: http://www.internationalbusinessstrategies.com

Natural Resources Canada, Energy in Canada 2000. Available at http://www2.nrcan.gc.ca/es/ener2000/online/html/chap3_e.cfm

National Energy Board, 2006 Annual Report to parliament. Available at http://www.neb-one.gc.ca/abouus/company_e.htm

Statistics Canada, Pipelines transportation of crude oil and refined petroleum products, catalogue no55-201-XIB, 2001

Statistics Canada, Natural gas transportation and distribution, catalogue no57-205-XIB, 2001

Statistics Canada, Investment flows and capital stocks, methodology, 2001.

Statistics Netherlands, Perpetual inventory method, service lives, discards patterns, and depreciation methods, 1998.