

CANADIAN NATURAL GAS RESOURCES

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ABSTRACT

The Canadian Gas Potential Committee released its second assessment of Canadian natural gas resources 'Natural Gas Potential in Canada – 2001' (CGPC-2001) in September 2001. The Report concludes that the Western Canada Sedimentary Basin (WCSB) is by far the largest repository of natural gas both of discovered reserves through 1998 and of potential future discoveries. Frontier basin supply can augment the maturing WCSB supply, but the Committee's frontier basin resource assessment is very much lower than commonly referenced studies dating back nearly thirty years. Remote frontier basins such as the high Arctic have yielded some excellent discoveries but their distance from markets make early exploitation of their reserves highly unlikely. While non-conventional resources are large, they will require considerable research and testing to determine economic levels of production. The era of low-cost gas supplies has now effectively ended: new supplies will require high levels of exploration, development, transportation and other capital expenditures.

INTRODUCTION

In September 2001 the Canadian Gas Potential Committee released its second assessment of Canadian natural gas resources 'Natural Gas Potential in Canada – 2001' (CGPC-2001). This report is the most comprehensive and detailed examination of Canada's resources completed to date. It includes assessments of 102 established plays and 12 conceptual plays, descriptions and ranking of 65 additional conceptual plays and discussion on non-conventional gas resources.

This paper discusses some of the findings of CGPC-2001. Excluding non-conventional resources it was found that the Western Canada Sedimentary Basin (WCSB) is by far the largest repository of natural gas both discovered and undiscovered. Frontier basins will augment WCSB supply but the assessment of their potential in CGPC-2001 is much lower than earlier estimates by other groups. Non-conventional gas resources are potentially large, but will require further research before there can be significant levels of commercial production.

BACKGROUND

The Canadian Gas Potential Committee (CGPC) is a volunteer group of senior geoscientists from industry and government formed in 1991 to conduct independent assessments of the undiscovered gas potential in Canada. The Committee is supported by industry organizations, petroleum companies and government agencies, but functions at arm's length from its supporters. It released its first Report 'Natural Gas Potential in Canada – 1997' (CGPC-1997) based on 1993 data and its second Report 'Natural Gas Potential in Canada – 2001' (CGPC-2001) based on year-end 1998 data.

An experienced volunteer team of about 40 exploration professionals conducted assessments of undiscovered gas potential over the four-year period between Reports. Before the final assessments were adopted by the CGPC, large numbers of confidential peer review meetings were held with petroleum companies which have specific expertise in particular Play Groups, and with government regulatory authorities. However, the Committee is responsible for its final resource estimates.

CGPC-2001 may be purchased on a CD ROM which, at the purchaser's option, includes not only the Report but all important data input and output of the resource assessment. Using these data, independent analyses can be undertaken.

WHY ASSESS RESOURCES?

For many years resources were assessed by government bodies such as the Geological Survey of Canada (GSC) and regulatory authorities such as the Alberta Energy and Utilities Board (EUB) and the National Energy Board (NEB). These reports were expensive undertakings and they suffered when financial and staffing reductions were initiated by governments. The CGPC recognized the importance of consistent, realistic resource assessments as an aid to developing exploration strategies and forecasting future gas supplies. The founders of the Committee decided that an independent body comprised of volunteer geoscience professionals acting in concert with governments and industry would be an appropriate model for serving these objectives.

Natural gas supply is a function of Canadian natural gas resource endowment and producer activity in exploring, developing and producing gas. The more depleted Canadian basins become, the more future gas supply will be constrained by remaining resources and, consequently, the more important will become the accuracy of resource assessment. For this reason the CGPC will continue to perform resource assessments on a regular basis: we presently contemplate producing a comprehensive, national assessment on a four-year cycle.

Resource assessments are based on exploration plays. As this is the level that most producers use in developing their exploration strategies, the Committee's Reports assist industry's ability to judge play potentials and improve the overall exploration effort.

Resource assessments can also influence government policy. For example, Governments attempt to determine the optimum use of lands and resources but these are often in conflict. Setting aside land for a national or provincial park will normally preclude the possibility of resource exploitation on that land. In order to weigh the costs and benefits of the park, it is necessary to gain an accurate as possible estimate of the resources made unavailable by creating the park.

In summary, there are a number of reasons why resource assessment is important. The beneficiaries are the citizens of Canada, governments and the petroleum industry.

CGPC-2001 REPORT ENHANCEMENTS

The CGPC-2001 Report incorporates five more years of data than the preceding CGPC-1997 Report. The period from 1993 to 1998 was characterized as a transition from very low exploration activity in 1993 to record exploratory drilling in 1994 followed by high levels of activity thereafter. Many small pools were discovered in the WCSB during this period.

In addition to new reserve data CGPC-2001 was enhanced to include exploratory drilling information. These data aid in understanding the discovery process of a play and to making more reliable estimates of a play's ultimate potential.

There is increased interest in potential gas supply from frontier regions and the need for transportation systems to bring the gas to market. CGPC-2001 contains updated frontier gas resource estimates made using the latest available information. Some of the earlier estimates by other agencies have not been reviewed for over 25 years.

A reserve appreciation study was undertaken for the WCSB. CGPC-1997 simply adopted a grossed up estimate of the EUB 1992 'Gas Resource Category 1' as being representative of appreciation. Hindsight has shown that only a portion of the resources in Gas Resource Category 1 represents appreciation.

SOME DEFINITIONS

While most of the terminology used in this paper will be familiar to those in the gas industry, a few key terms are discussed here to clarify their use by the CGPC.

Resources are volumes of gas, discovered or undiscovered, that exist in subsurface accumulations. This is an entirely physical concept independent of factors such as accessibility, economics or technology as is the case for *reserves*. The sum of all resources is Canada's **endowment**.

All assessments by the CGPC are of resources, but for convenience in comparative analyses, the volumes are often provided in nominal marketable volumes. Resources are estimated on the basis of available information which is limited by such factors as accessibility, economics and technology. Producers are not inclined to report discoveries which they believe to be uneconomic. Consequently, information on the resource distribution and magnitude of very small pools is limited and is a subject of some discussion in the resource assessment methodology community.

Nominal marketable gas is a phrase introduced for the first time in CGPC-2001 to better explain the relationship between resource assessments and potential supply. It is simply the gas in place in undiscovered prospects converted to 'marketable' volumes by applying average recovery and surface loss factors of the discovered pools in the play. It does *not* imply that the gas is marketable in the sense that the gas will ever reach a market. Hence it is nominal (in name only). The gas may not be accessible because it is under cities or within parks or other areas where exploration is not permitted. A gas pool may remain undeveloped as it may be simply too small to produce economically. An undiscovered pool may never be discovered or, if discovered, may be so remote from a

transportation system that it is never connected. Such pools contain nominal marketable gas but will probably never supply a market.

An **exploration play** is a geological configuration, within a defined area, which combines source rock, reservoir, trap, migration and preservation in such a way that the critical factors that control the occurrence of oil and gas are essentially similar. Defined in this manner an exploration play is a coherent unit in that the discovered pools in the play are a statistically meaningful sample (albeit, biased) of the underlying population distribution. An **established exploration play** is one in which there have been significant discoveries while a **conceptual exploration play** contains no significant discoveries, but which has favourable geology that could result in petroleum discoveries. No estimates of marketable gas have been made by the CGPC for conceptual plays.

CANADIAN BASINS

Figure 1 identifies the location of sedimentary basins in Canada. The estimated nominal remaining marketable gas resource in each basin is noted in the boxes. The total nominal remaining marketable gas is 233 Tcf.

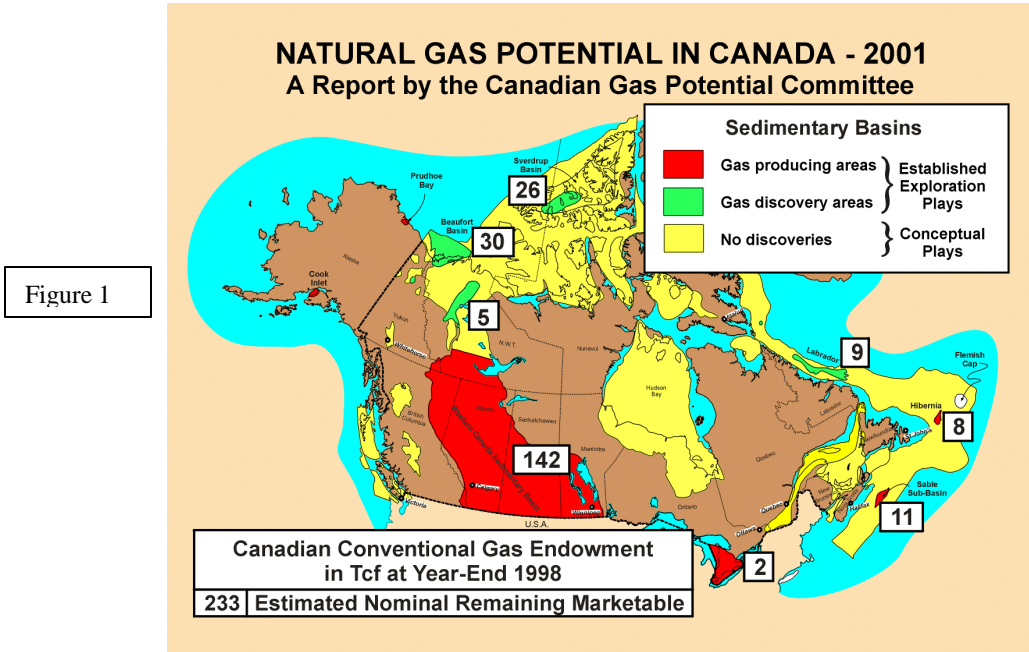


Figure 1

Figure 2 shows the distribution of the endowment of the basins, aggregating 592 Tcf gas in place. Because of their remoteness, technological challenges and economic considerations, the Arctic Islands, Newfoundland, Labrador and Hudson Bay basins are unlikely sources of gas supply. The Western Canada Sedimentary Basin (WCSB) holds the great bulk (over 71%) of Canada’s endowment.

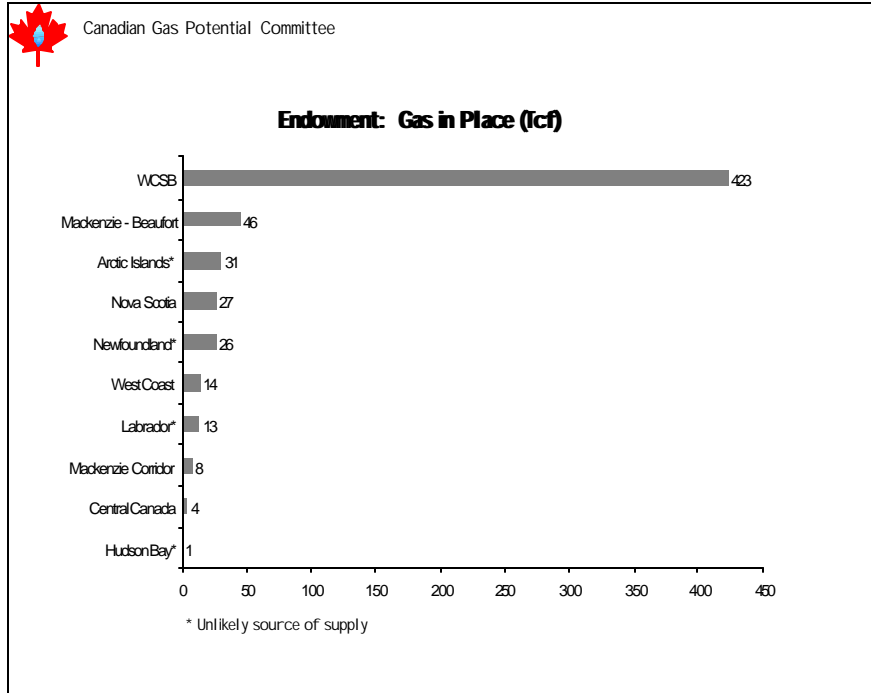


Figure 2

The WCSB is still the dominant basin when comparing nominal remaining marketable gas, which aggregates 233 Tcf (Figure 3). As there have been no discoveries in the West Coast basins, all the plays are conceptual, and no estimate of nominal remaining marketable gas has been made. In this figure the WCSB represents 61% of the total but when the unlikely sources of supply are removed, this increases to 76%.

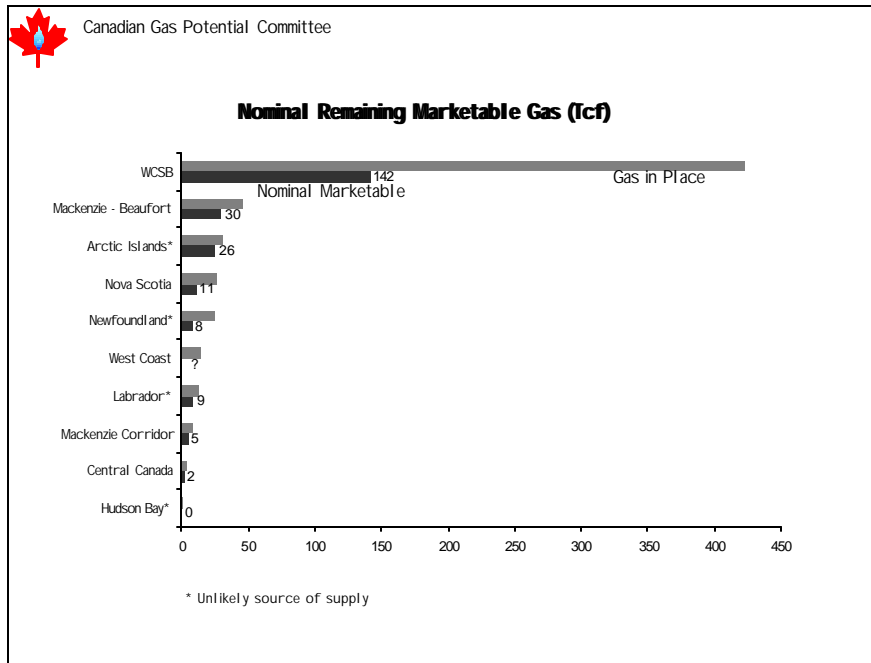


Figure 3

THE WESTERN CANADA SEDIMENTARY BASIN

The distribution of remaining nominal marketable gas resource (discovered and undiscovered) for Play Groups in the WCSB is shown in Figure 4. The Lower Cretaceous Play Group contains 42% of the endowment and continues to be the main source undiscovered potential. The challenge of the Lower Cretaceous resource is that the undiscovered pools will be small (it is estimated that there are over 155,000 undiscovered pools under 1.0 Bcf gas in place), and many will be uneconomic when gas prices are low.

The Foothills Play Group contains the largest undiscovered gas prospect (1.5 Tcf gas in place) in the WCSB. This Play Group is characterized by complex geology, land access constraints and sour gas environmental hurdles. Most producers have been reluctant to become involved in this high risk/high reward area.

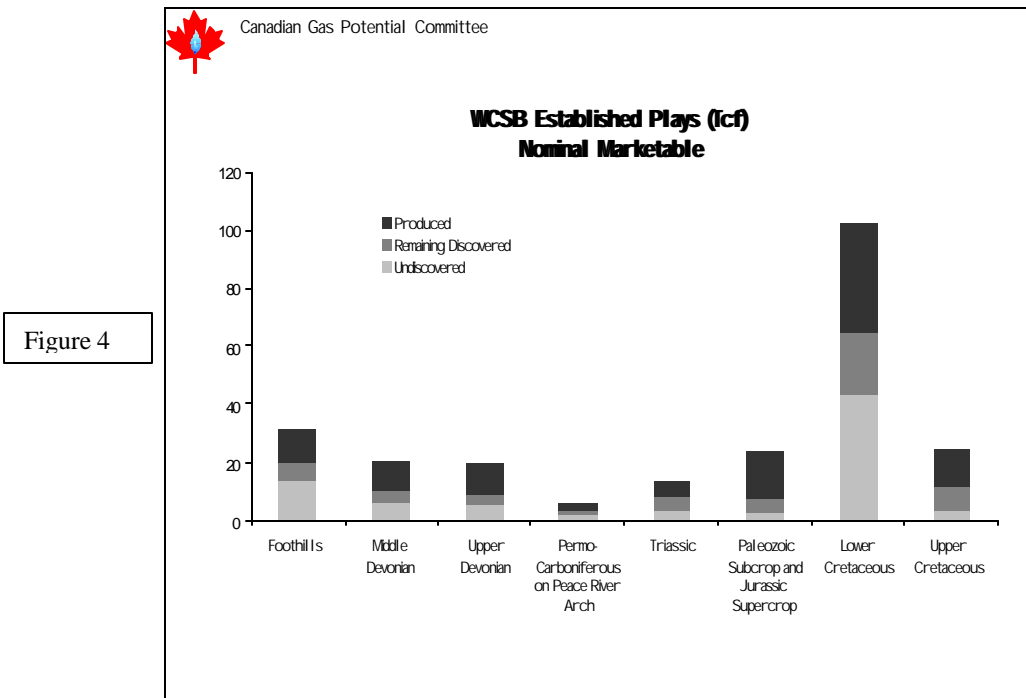


Figure 4

Figure 5 presents the distribution of WCSB resources by pool size classes. The bar for 4,000 Bcf represents the nominal marketable gas for all pools in the WCSB having an original gas in place of between 1,000 and 4,000 Bcf. This class size contains few undiscovered pools while the 16,000 Bcf class size contains no undiscovered gas pools.

This Figure shows that production to date has been from the largest pools in the basin while the bulk of the new discoveries will come from smaller pools. Gas resources in the two smallest class sizes would be considered uneconomic at current gas prices.

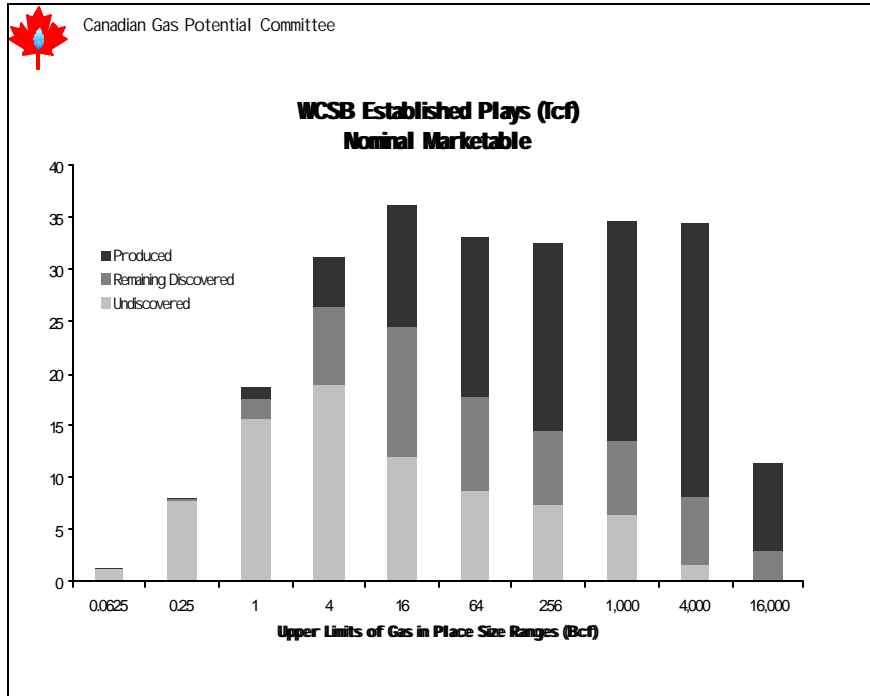


Figure 5

The relationship between historic reserve discoveries and exploratory drilling is illustrated in Figures 6 and 7. The star in Figure 6 represents the CGPC's estimate of the WCSB endowment (including appreciation). If new discoveries were to continue to be made at the same rate as during the 10 year period from 1988 through 1997, all predicted pools would be discovered within 36 years, the 'Basin Life Index'.

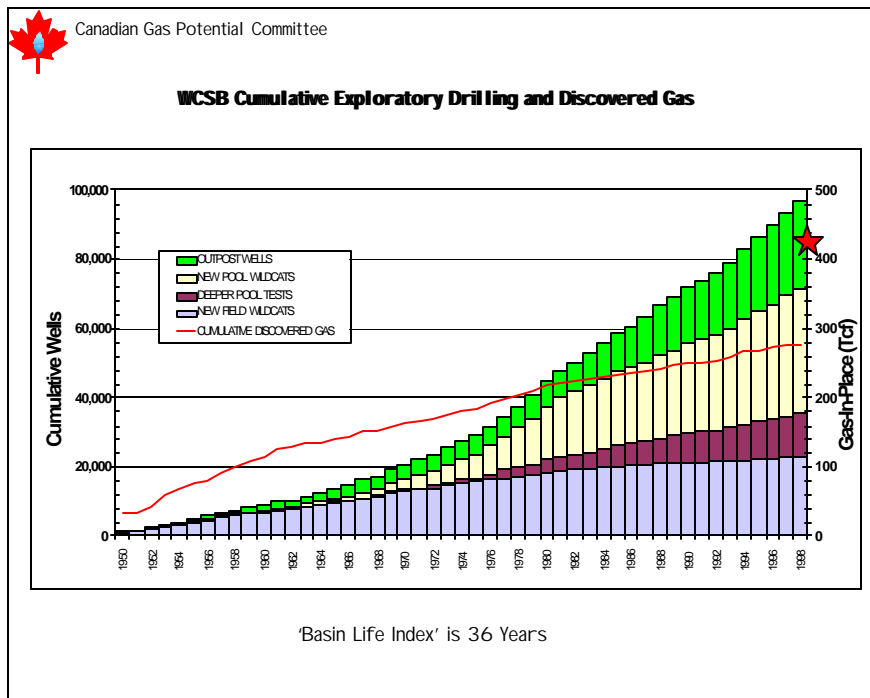


Figure 6

Figure 7 credits all discoveries in a play back to the date of the first pool discovered in the play (appreciation is not included). This portrays the contributions of new plays over time. It is clear that the very few new plays that have been discovered since 1962 have not added appreciably to the reserves of the basin. Reserves additions can be expected from future discoveries in established plays rather than from discoveries in conceptual plays.

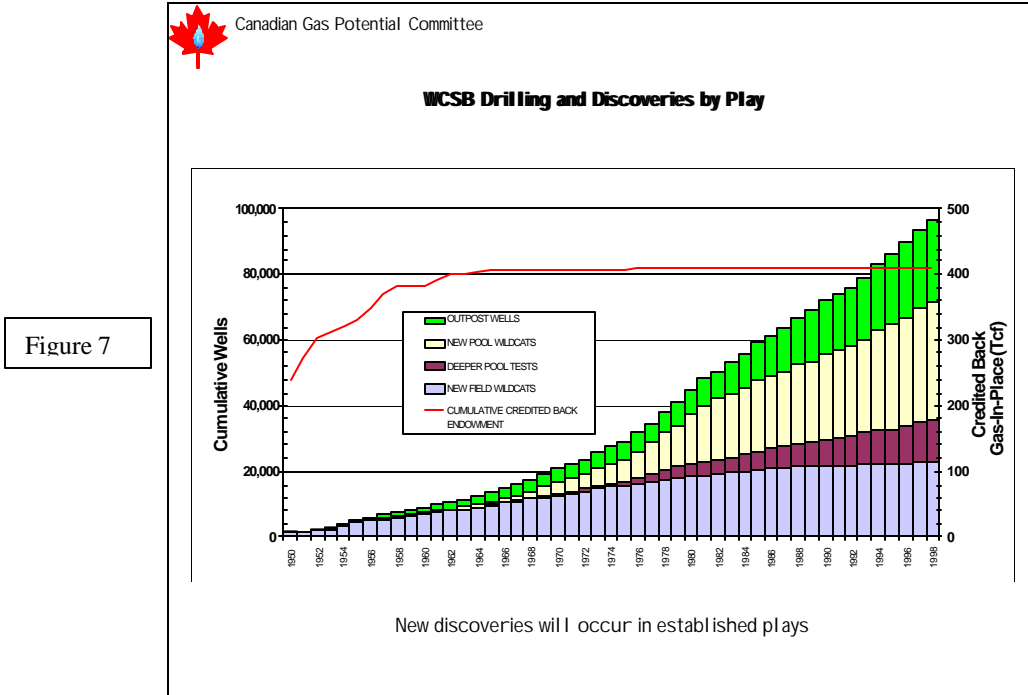


Figure 8 shows the differences between the CGPC-1997 and CGPC-2001 Reports for established plays in the WCSB. As expected, there has been an increase in reserves discovered but a decrease in the remaining undiscovered. In total, the Committee assessed the WCSB as containing a slightly lower gas endowment in CGPC-2001 than in CGPC-1997. While the assessment of the Lower Cretaceous Play Group increased, this was more than offset by reductions in the Devonian plays and, especially, by a reduction in the assessment of appreciation.

The nominal remaining marketable gas declined due both to production and the change in resource assessment. This remaining gas will be about 124 Tcf at year-end 2001 but this figure includes inaccessible and uneconomic volumes and assumes that all of the predicted gas will be found and connected.

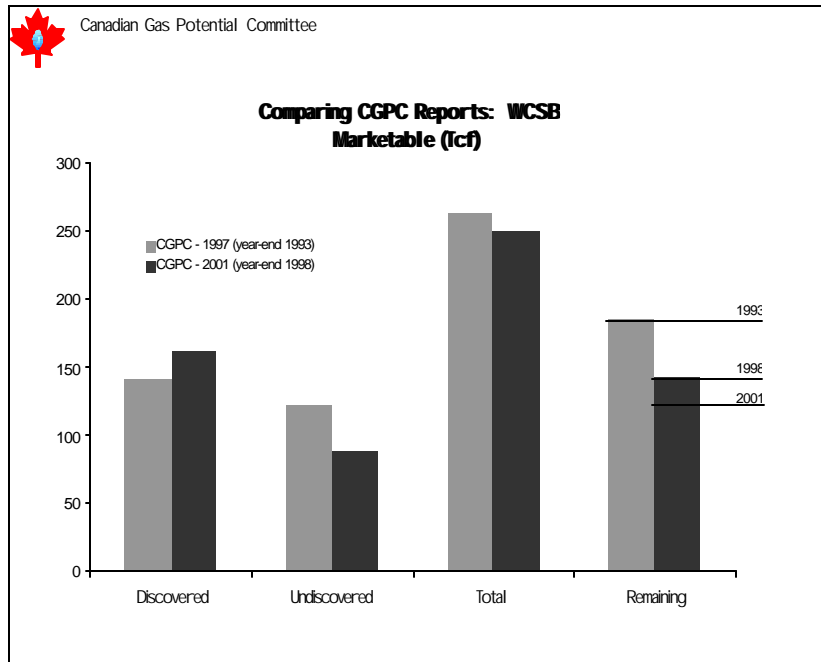


Figure 8

CANADA'S FRONTIERS

CGPC-2001 includes a more detailed examination of Canada's frontier basins than CGPC-1997. The result is a major difference from the estimates of the 1999 NEB report 'Canadian Energy Supply and Demand to 2025'. The two Reports are compared in Figure 9. The NEB frontier estimate appears to rely heavily on the assessments performed by the Geological Survey of Canada up to some 30 years ago. The Committee examined the latest data available and the geological assumptions used by the Survey and determined that the earlier estimates significantly overstate expected resources. In addition, diagnostic tests of some conceptual plays have been drilled without success. The NEB estimate is 230 Tcf of marketable gas higher than the CGPC estimate.

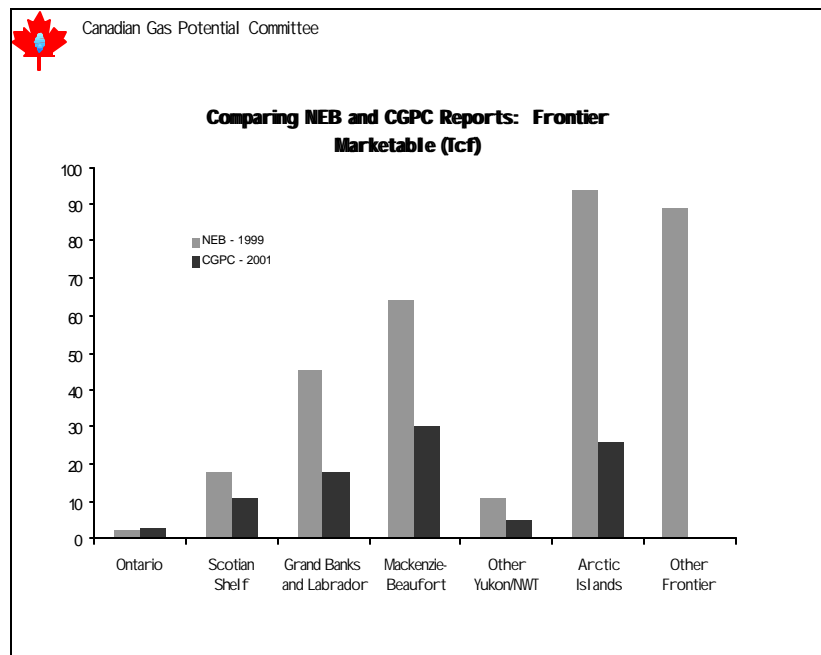
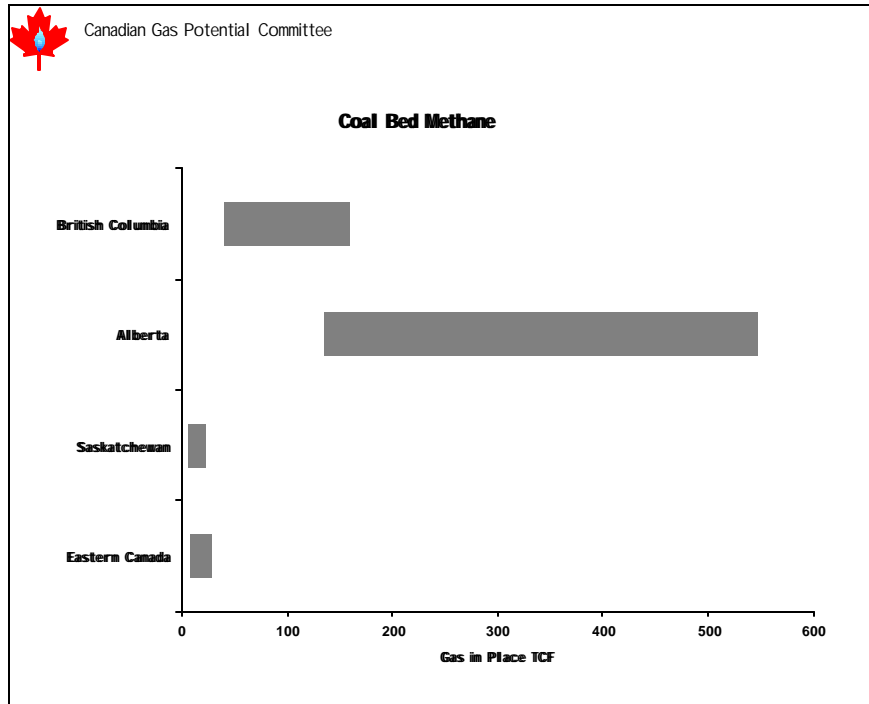


Figure 9

COALBED METHANE POTENTIAL

CGPC-2001 discusses all forms of non-conventional gas but includes estimates only for Coalbed Methane (CBM). No attempt was made to estimate marketable volumes but gas in place volumes of CBM are presented in Figure 10. As with all types of non-conventional gas, gas in place is a very poor indicator of volumes that might be available as supply. While the volumes of gas in place are impressively large, technological advances will be required to extract gas from non-conventional sources at rates and costs that are attractive to investors.

Figure 10



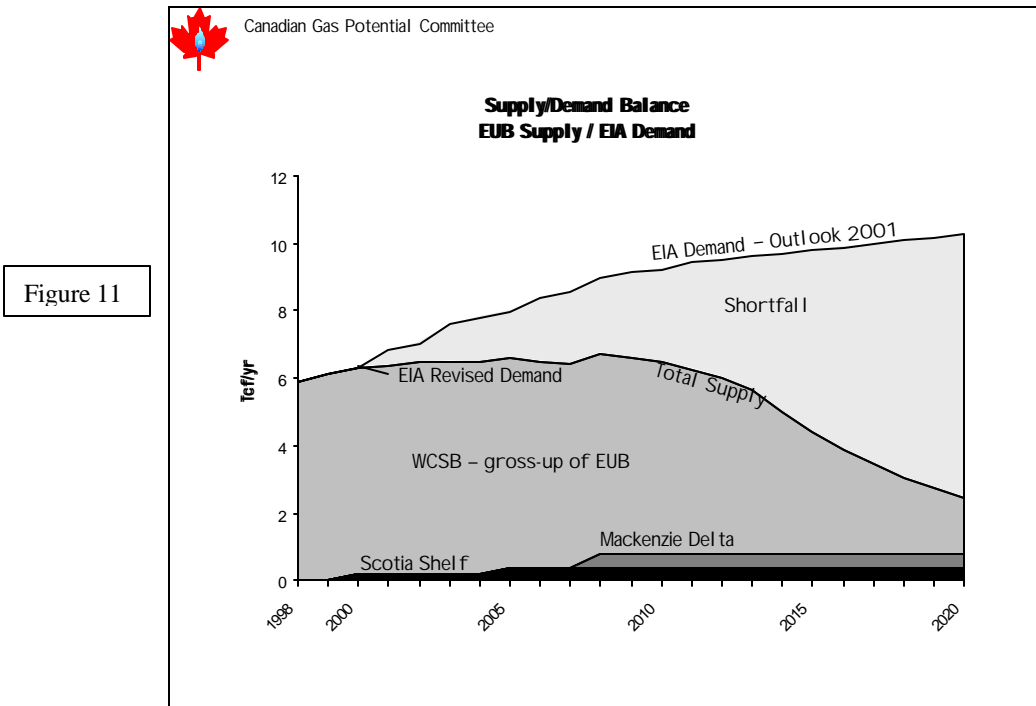
A SUPPLY SCENARIO

The Committee does not perform gas supply/demand forecasts but resource information is critical for supply studies. Figure 11 is an example of the application of CGPC resource estimates to a supply/demand scenario. The assumptions in the preparation of the supply/demand scenario below are:

1. U.S. demand for Canadian gas is taken from the Energy Information Administration (EIA) 2001 Outlook forecast.
2. The relationship between U.S. demand for Canadian gas and Canadian demand for Canadian gas will remain constant at the relationship in 2000.
3. Alberta supply will be as forecast in the EUB 2001 Reserves Report which envisages production gradually rising through 2003 then slowly declining, and this has been grossed up to represent the total WCSB, recognizing that this may not reflect the potential of northeast B.C.
4. Beyond the forecast period of the EUB report, supply will decline so that 85% of the CGPC endowment is produced. The 15% is an arbitrary discount factor used by the Committee to provide for the gas that is inaccessible, uneconomic, will never be found or will never be connected.
5. Scotian Shelf production will double in 2005 as a result of Panuke and not decline over the scenario.
6. Mackenzie Delta and Corridor will be connected in 2008 and production will not decline over the scenario period.

It is seen from Figure 11 that these assumptions produce a supply scenario incompatible with the demand outlook. It will be noted that the EIA reduced their demand forecast for 2001, presumably to reflect the effects on demand of very high prices in the early part of the year and, later, the effects of economic recession.

The supply/demand scenario presented is strictly illustrative. A proper supply forecast would examine producer exploration and development activity in the exploration plays, would take into account technology factors, would include accessibility, economic, ultimate discoveries etc. This is beyond the capability of the CGPC but the Committee supports efforts by others to apply these considerations and provides the resource assessments for their inclusion.



CONCLUSIONS

The conclusions reached by the CGPC in the 2001 Report are:

- The Western Canadian Sedimentary Basin will be the primary source of future Canadian gas supply.
- Near frontier regions (Nova Scotia and the Mackenzie Delta and Corridor) will supplement WCSB supply.
- Remote frontier regions are technologically and economically inaccessible as a gas supply source.
- Non-conventional resources hold promise, but will require further research.
- New gas supplies will require high levels of exploration, development and other capital expenditures.

Not too long ago the WCSB could always be relied upon to provide very low cost gas. This is no longer the case. The 'quick gas' Cretaceous Play Groups are mature and yield smaller and smaller pool sizes that decline rapidly. The less mature Foothills and Devonian plays are higher risk, more geologically challenging and expensive to explore. Northern frontier gas, including transportation, will only be available at a higher price level than we have been used to. The era of surplus WCSB producing capacity and relatively cheap gas is coming to a close.