The Oil Drum: Canada
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# The Future of (Natural) Gas from the Western Canada Sedimentary Basin?

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The Western Canada Sedimentary Basin (WCSB) is one of the major gas-producing areas of North America. It supplies about a quarter of all gas used by the US and Canada, and 98% of Canadian production. Current production is 450 million cubic metres a day. To put this into perspective, this volume is close to half a cubic kilometre, and the mass of this much gas is 330,000 tonnes.

The National Energy Board issues reports on various aspects of Canadian energy production and use. This is the main entry point for natural gas reports on its web site, and this is the entry point for more general energy reports that include sections on natural gas. It is instructive to study the evolution of scenarios put forward for the future of gas supply from the Western Canada Sedimentary Basin.

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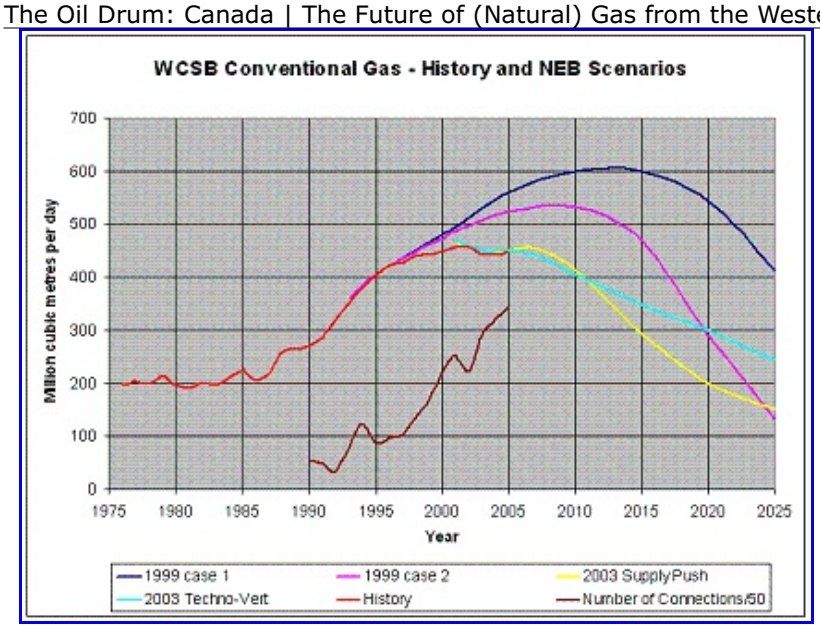
The 1999 report and the 2003 report on energy futures for Canada each show two "scenarios" for future gas production, and all four of these scenarios show a peak and subsequent decline in output of conventional gas from the basin. The major difference lies in the timing of the peak and the output at peak. In the 1999 report, the peak date is seen as being a decade away, but in the 2003 report, the peak is seen as having already passed in 2001. Assembling gas information from a number of sources (The National Energy Board, Statistics Canada and Natural Resources Canada) permits some interesting comparisons.

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In the figure, the red line shows the history of conventional gas output from the basin. This information comes from NEB gas reports for 1976 to 1990 and Statistics Canada information for 1991 on, with coal bed methane production subtracted out for the last three years. Coal bed methane production rose from zero to about 11 million cubic metres per day over those three years. The dark blue and purple lines show the future scenarios envisaged in the 1999 report (Figure 5.4). The light blue and yellow lines show scenarios from the 2003 report (Figures 5.21 and 5.23). The brown line shows the number of new conventional gas "connections" made in each year in the WCSB, divided by 50. This information is taken from the gas short-term deliverability reports. A "connection" refers to the connection of a gas well to a gas reservoir. Since some wells connect to more than one reservoir, the number is generally somewhat higher (by about 10%) than the number of successful wells.

It can be seen that while 6000 or fewer new connections per year were sufficient to get the supply up to 400 million cubic metres per day in 1995, getting to 450 million cubic metres per day in 2001 and 2002 required something like 12000 per year, and that maintaining close to that production over the last few years has required an increase to 17000 new connections per year. Two factors are at play here: the size of new gas deposits being accessed has been decreasing, and the early depletion rates for new connections have increased. This means that the initial production from a new connection tends now to fall more rapidly than in the past. This is at least in part a matter of choice - the "fracturing" of the rock around new connections makes it easier to obtain high initial gas flow rates, which reduces the number of new connections required to achieve a given total output, but at the cost of requiring more connections in future years, because the output of new connections, and thus total output, falls more quickly. The initial depletion rate for new connections now seems to have stabilised at about 40% for the first year, the decline slowing considerably thereafter, but the size of new deposits continues to decline.

This picture is very different from that envisaged in 1999:

> WCSB conventional production peaks at 21.6 billion cubic feet per day (Bcf/d) (612 million m3/d) in 2013 for Case 1 and 18.9 Bcf/d (535 million m3/d) in 2008 for Case 2 (Figure 5.4).

More startlingly:

> Successful conventional gas well completions in the WCSB rise to 7700 by 2013 in Case 1. The Case 2 completions peak at about 6000 in 2011, reflecting the lower resources assumption (Figure 5.5). The number of wells drilled will be higher because dry holes will increase the count; however, this will be partially offset by multiple completions in the same well. Based on an average success rate of 70 percent, the total wells drilled would peak at about 10000 and 8000 for Case 1 and Case 2 respectively.

This is startling for two reasons - not only does it mean that we are now drilling holes at well over twice the rate expected **at** higher and later peak production, but also that the drilling rate was already higher than predicted for peak in the year these scenarios were contemplated.

In the longer term, the basin's conventional resources (including undiscovered) were seen as nearing exhaustion by 2025:

> In both cases, about 95 percent of the established reserves are produced by 2025. In Case 1, 82 percent of the undiscovered resources is produced, whereas in Case 2, 95 percent is produced.

The 2003 report shows two scenarios, called "Supply Push" and "Techno-Vert". The bases of these scenarios are described thus:

> The Supply Push scenario represents a world in which technology advances gradually and Canadians take limited action with respect to the environment. The main theme of this scenario is security of continental energy supply and the push to develop known conventional sources of energy.

> The Techno-Vert scenario represents a world in which technology advances rapidly and Canadians take broad action with respect to the environment and the accompanying preference for environmentally-friendly products and cleaner-burning fuels.

Possible impact of the Kyoto protocol is not considered in either.

The report is somewhat equivocal on the likely size of the "resource base"

> Through exploration drilling and development, industry's knowledge of the WCSB has improved and resource estimates have generally increased. Continuous development of technology further enhances the ability to identify and exploit pools. At the same time, improved information leads to a narrower range of estimates.
>
> However, as with other basins, opinions still vary on the actual size of the WCSB resource base. As technology improves and exploration increases in both scenarios, perhaps new geological concepts can be proved that would enable further increases to natural gas resource estimates. However, recent drilling and production data suggests that the WCSB may be maturing; and changes in natural gas resource estimates may be warranted for some areas.

The basis of the gas production in "Supply Push" is described thus:

> Some resources in the WCSB are located in isolated areas or in small pools that may not be economical to develop at natural gas prices consistent with either scenario. Consequently, 64 Tcf (1,813 billion m3) or 90 percent of the available undiscovered

> resources in the WCSB was utilized for determining deliverability in SP.

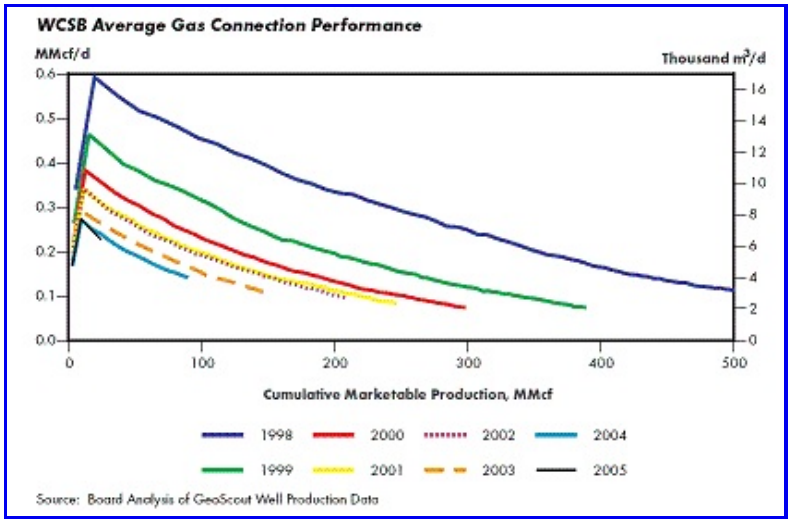
While for "Techno-Vert", the basis is:

> In TV, better economics through improved technology and higher natural gas prices, enable 92 Tcf (2,606 billion m3) or 95 percent of the available undiscovered resources to be used for determining deliverability. The larger resource base in TV also allows deliverability from the WCSB to be maintained longer than in SP.

From comparison of the graphs above, it seems that the estimates of the "Resource Base" underwent a very significant contraction between 1999 and 2003. The amount of drilling required (in either 2003 scenario) is described as follows:

> The supply profile for the WCSB assumes that drilling levels similar to those experienced in 2001 are maintained until about 75 percent of available resources have been produced. At this point, the size of the remaining resource begins to limit prospective drilling locations and constrains production. Both scenarios also assume that the producing characteristic of new wells would be similar to current wells in the same area.

One can see that drilling levels well above the 2001 numbers are now being used to achieve something like the output anticipated. It seems that the last assumption is not holding up very well. Decline rates remain stable, but the output (initial and total) of new connections has continued to fall, after briefly stabilising in 2001-2. The following figure, taken from the October 2006 short-term deliverability report, shows the output of an average connection for each of the years1998-2005. Note that this graph shows a plot of production rate vs. cumulative production, not time.

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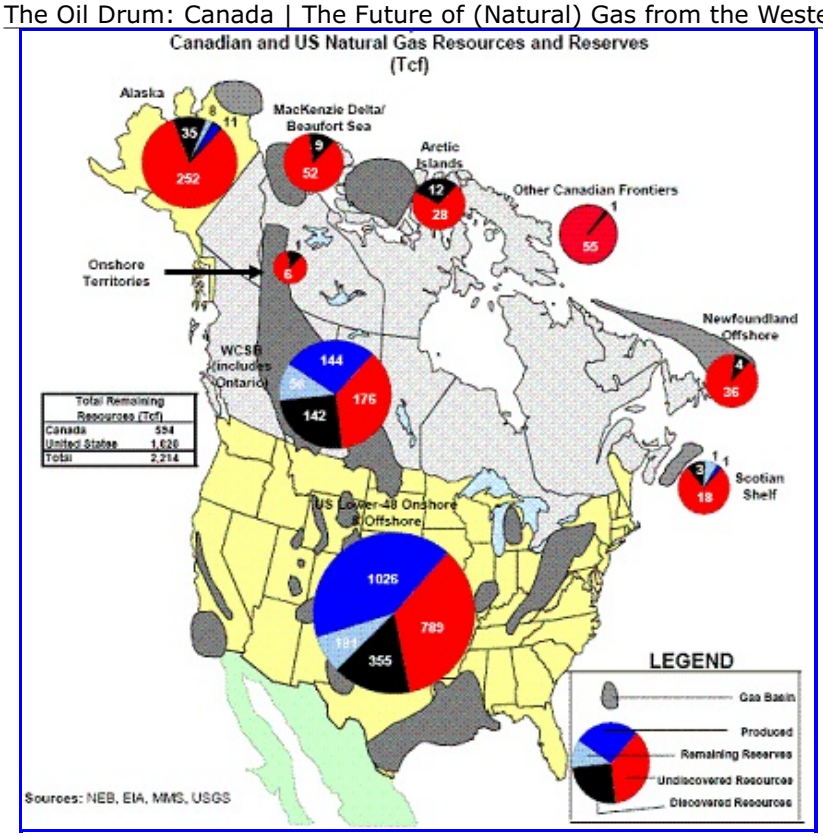
It would appear that output of conventional gas from the basin may not achieve that contemplated in either of the 2003 scenarios. If this happens, output by 2025 could be well under half of present output.

Estimates of remaining reserves and resources for natural gas in North America may be found on the web site of Natural Resources Canada.

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Figures like this lead to headlines about Canada having enough gas for 80 years (divide total claimed by current production), so one might wonder how the beginning of a considerable decline in WCSB production would square with this information. The numbers for the WCSB in this figure total 374 Tcf (10600 Bcm), but include in the "Undiscovered Resources" 80 Tcf (2300 Bcm) of coal bed methane, leaving 294 Tcf (8300 Bcm) of conventional gas. A steady decline in production from 5.8 Tcf/year (164 Bcm/year) in 2005 to half that in 2025 (roughly consistent with the NEB 2003 "Techno-Vert" scenario) would result in 87 Tcf (2450 Bcm) being used in that period. If we were to assume that the supply would continue to decline by a factor of two for each subsequent 20-year period, the total conventional gas extracted (over infinite time) would be about 174 Tcf (4900 Bcm). This is less than the "Reserves + Discovered Resources" sub-total, let alone the total including "Undiscovered Resources". Given that this estimate is based on a scenario that now seems improbable when one looks at recent drilling and output numbers, perhaps a further review of WCSB conventional resource estimates is overdue.

There are many variables that will affect conventional gas output from the WCSB. A simple "number of connections" indicator does not show whether those connections are from shallow low-output wells or riskier, deeper higher-output wells. A change in approach, perhaps in response to economic events, could result in better average new connection output. It does seem unlikely, though, that this will have a major effect at what is a relatively late stage in the game for this basin. The methods used to predict future flows assume that the output of existing wells will not be affected by drilling new ones in the same area. If gas production rates are kept up by drilling multiple wells into the same gas deposit, this assumption will break down and more rapid declines may ensue. This may well have happened with the Ladyfern deposit, for which a 70% decline in output occurred in the first year, after a huge drilling effort. Coal Bed Methane production is still at a very early stage. How well it will be able to make up for the decline in conventional production remains to be seen.

The remaining gas estimates above for the rest of Canada total 226 Tcf (6400 Bcm). By far the greater part of it is as yet in the "Undiscovered" category, and most of it is a long way (sometimes

thousands of kilometres) from existing pipes. The only area other than the WCSB that is now producing gas is the "Scotian Shelf", and both its output and the estimated size of the resource are tiny by comparison. The MacKenzie Delta will probably begin to produce gas at some time in the next few years, but this will entail a huge engineering project that will eventually deliver about 55 million cubic metres per day. Getting gas from the Arctic islands, the Newfoundland offshore or some other frontier areas may well prove even more challenging than from the MacKenzie. For more details of Canadian gas resources see another NEB report from April 2004.

WCSB conventional gas and coal bed methane will provide the bulk of Canadian production for the foreseeable future, so a very significant decline in total supply looks probable. A glance at the U.S. numbers in the figure above shows that gas situation in the lower 48 states is no less "mature" than that in the WCSB, and the likely future of production in North America as a whole is implied somewhat starkly in Jean Laherrere's work, which also shows an estimate of future Canadian CBM production - about 1 Tcf/year or 75 million cubic metres per day in 2025. It seems highly improbable that imports of LNG will make up for more than a fraction of the overall decline, so get ready to use a lot less gas a decade from now.