ST110-2012

Alberta Fuel Gas Efficiency in the Upstream Gas and Conventional Oil Industry

March 2012

Energy Resources Conservation Board

ACKNOWLEDGEMENTS

One of the goals of the Fuel Gas Efficiency Benchmarking Committee is to share and report fuel gas efficiency project results, successes, and failures/barriers for the top 20 fuel gas consumers. We acknowledge the efforts of the committee for their valuable contributions to this report with respect to the survey design, responses, and report content.

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ENERGY RESOURCES CONSERVATION BOARD
ST110-2012: Alberta Fuel Gas Efficiency in the Upstream Gas and Conventional Oil Industry

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Executive Summary

The Energy Resources Conservation Board (ERCB) has been working with the Fuel Gas Efficiency Committee since 2006 to evaluate fuel gas use in the upstream gas and conventional oil industry. This fuel gas use is large and represents a significant opportunity for companies to improve in both efficiencies and savings. Fuel gas required to produce, gather, and process natural gas and conventional crude oil currently represents about 7 per cent of total raw gas production.

Alberta's declining gas and conventional oil resources provide challenges to producers because declining reservoir pressures and production generally result in facilities with lower throughput.

Fuel gas consumption in the upstream sector has been declining since 2007 following the decline in gas and conventional oil production; however, fuel gas use per unit of production (a measure of intensity) continues to increase. Lower reservoir pressures require more compression in the field. This has a major impact on fuel use and generally results in higher fuel use per unit of production.

Unconventional resources such as tight gas and shale gas are being targeted for production using horizontal drilling and reservoir fracturing techniques, which may increase production and throughput of facilities and, in turn, affect the rate of increase in fuel use per unit of production.

The ERCB published its first report on fuel gas efficiency, entitled *Fuel Gas Efficiency in the Upstream Gas and Conventional Oil Industry*, in April 2010 to communicate trends in fuel gas use and to report on the success that industry is having in this area. This second report provides an update on fuel gas use trends and reports 2011 industry survey results. The report provides a detailed analysis of fuel gas use in the province by facility type.

The ERCB surveyed the largest fuel gas consumers, representing 76 per cent of fuel gas consumption in the upstream sector (20 companies) for 2010 and asked them to share their successes and the challenges they are having with fuel gas efficiency programs. Seventeen companies responded to the survey, representing just over 72 per cent of fuel gas consumption.

Of the 17 companies that replied to the survey, 11 companies reported spending $29 million on fuel gas reduction projects in 2010, and 12 companies reported fuel gas savings of about 460 thousand cubic metres per day (10^3 m^3/d), or 16 million cubic feet per day (mmcfd).

For 2011, 11 of the companies that replied to the survey reported investing a total of $67 million in fuel gas reduction projects. Two large projects, accounting for $37 million of this investment, are in the categories of plant consolidation and compression. Not counting these two projects, an amount similar to what was spent in 2010 was estimated for 2011.

Companies provided suggestions on how to make fuel gas efficiency projects successful, including engaging fuel/operations staff early in the process, considering more than just fuel gas savings in evaluating project candidates, and getting management and organizational commitment early on.

As reported by the 17 companies, an average of about 59 per cent of total fuel gas in the upstream sector was used by compressors, 31 per cent was used by heaters, boilers, or treaters, and the remaining was attributed to flare and incinerator fuel use.

Companies reported that they generally use the same decision criteria for fuel gas efficiency projects as they use for other corporate projects. In many cases, energy efficiency projects were combined with equipment upgrades, turndown, and reliability improvement projects.

In 2010, the top number of successful project areas reported by companies were in the areas of fired heaters, leak detection and repair, and chemical injection pumps. For 2011, the top areas reported by companies were in the areas of engines, waste heat recovery, and leak detection and repair. The areas of largest planned project investment were in consolidation and evaluations, compressors, and waste heat recovery.

All but one company surveyed were aware of the fuel gas best management practices (BMPs) that were developed by the Fuel Gas Efficiency Committee. All of the BMPs are being used as a resource by at least some of the companies. In general, about a third of the companies were using individual BMPs as a resource. The BMPs with the most use were ones focused on engines, pneumatics, compressors, and glycol dehydrators. Six companies suggested new BMPs for methods of tracking and estimating project energy efficiency and use, waste heat recovery, opportunities for fuel gas vent reductions, and economic screening tools.

Introduction

The upstream oil and gas industry uses natural gas to fuel equipment when producing, gathering, and processing natural gas and conventional crude oil. Natural gas is often the most convenient form of fuel available and is clean burning when compared with other options. Some equipment—compressors, for example—are fuelled by electric power, depending on their location. This report focuses solely on natural gas used as fuel.

Oil sands operations—in situ, mining, and upgrading—have not been examined as part of this report. This report was undertaken at the request of the Fuel Gas Efficiency Committee and is focused on the upstream oil and gas industry (excluding oil sands operations). While we expect that larger volumes of gas are being consumed in the oil sands area, the examination of fuel consumption and efficiency in this area is out of the scope of this study. To focus solely on gas use in this area is likely insufficient given the other types of fuel in use—diesel, coke, bitumen, and electricity, for example. Such a focus would require that the issue be examined by experts in the processes of oil sands operations rather than by experts in the upstream oil and gas industry.

The amount of fuel gas used by the upstream oil and gas industry is significant, amounting to about 27 million cubic metres per day (10^6 m^3/d) or just under 1 billion cubic feet per day. A 10 per cent savings (more than 100 mmcfd) is enough gas to heat more than 300 000 homes in a year.[1] By providing data on fuel consumption and by reporting on the areas in which companies are having success in reducing fuel gas use, it is expected that others will benefit and work to reduce fuel consumption and improve efficiencies. While this report focuses on fuel gas, it is meant to support and complement processes focused on reducing greenhouse gases (GHG). The committee's first task was to develop a series of BMPs to identify fuel gas efficiency opportunities for industry. The BMPs, which were released in May 2008, are available on the Canadian Association of Petroleum Producers (CAPP) website www.capp.ca.

The ERCB has been working with the Fuel Gas Efficiency Committee to report on fuel use and to provide leadership in improving upstream industry fuel gas efficiency. This committee, chaired by Alberta Energy, includes representation from Alberta Environment and Water, Natural Resources Canada, CAPP, and the Gas Processing Association Canada (GPAC). The committee was established in April 2006. See **Appendix A** for the Terms of Reference.

The work being done by the committee has been promoted in workshops and presentations to CAPP, GPAC, and the Petroleum Technology Alliance of Canada (PTAC) in an effort to encourage and promote more efficient use of fuel gas. The purpose of the BMPs is to identify opportunities to improve fuel gas efficiencies in the upstream oil and gas industry, often with minimal or no capital investment, and thereby contribute to improvements in energy efficiency and the reduction of GHG emissions.

The committee's current work includes communicating and monitoring fuel gas efficiency and use in the Alberta upstream oil and gas industry and examining the success that the industry is having in this area. As part of that work, the Fuel Gas Efficiency Benchmarking Committee recommended that the ERCB survey the larger fuel gas consumers (the top 20 companies) and asked them to share their successes and challenges. The ERCB published a

[1] Assuming an estimate of 120 gigajoules (GJ) per year for an average residential household.

report in 2010 with survey results based on 2008 data. A second survey conducted in July 2011 asked for similar information based on 2010 data.

The report contains two major parts. Part 1 is provincial statistics largely summarized from Petroleum Registry of Alberta (PRA) data, and Part 2 contains information from a survey of the top 20 fuel gas consumers.

Data Source for Figures and Tables

Most of the data for the report was sourced from the PRA and from ERCB publications. The survey information (see **Appendix C** for the survey) was gathered from 17 of the top 20 fuel gas consumers in Alberta.

1 Provincial Fuel Gas Use in the Upstream Sector

This report focuses on fuel gas use in the upstream sector and reports on oil and gas batteries, gas gathering systems, and gas plants. It does not include straddle plants, commercial gas storage injections and withdrawals, and oil sands operations (in situ, mining, and upgrading).

1.1 Overall Fuel Gas Use Statistics

Table 1 details the average daily fuel gas use by upstream sector activity. The data in **Table 1** are presented graphically in **Figure 1**.

Table 1. Fuel gas consumption in the upstream sector by activity (10^3 m^3/d)

	2003	2004	2005	2006	2007	2008	2009	2010
Oil batteries	2 006.2	1 989.9	1 934.5	1 871.6	1 940.3	1 945.1	1 994.3	1 986.9
Gas batteries	3 454.4	4 007.1	4 389.4	4 702.6	5 015.4	5 079.8	4 912.1	4 849.6
Gas gathering systems	8 452.2	8 792.6	9 194.6	9 960.5	10 113.0	10 082.5	9 136.1	9 033.5
Gas plants	12 356.2	12 328.0	12 374.7	12 371.9	12 228.5	11 765.3	11 342.9	11 028.0
Total	26 269.0	27 117.6	27 893.2	28 906.6	29 297.2	28 872.8	27 385.4	26 898.1

*2003-2010 data is sourced from data reported to the Petroleum Registry of Alberta

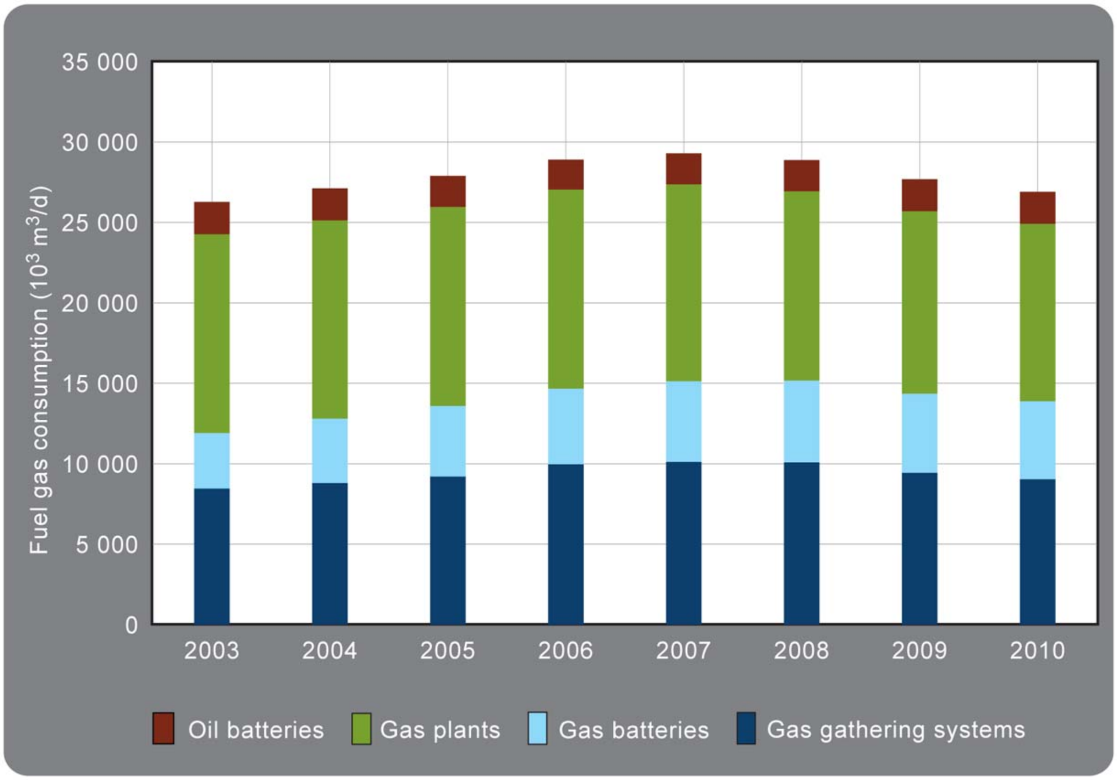


Figure 1. Fuel gas consumption in the upstream sector by activity (10^3 m^3/d)

As **Table 1** and **Figure 1** show, fuel gas consumption increased from about 26 300 10^3 m^3/d in 2003 to about 29 300 10^3 m^3/d in 2007. Thereafter, it has been on a moderate decline, and was roughly 26 900 10^3 m^3/d in 2010.

Fuel gas use as a percentage of raw gas production is shown in **Figure 2**. This percentage has increased from 5.8 in 2003 to 7.0 in 2010.

Figure 2 also details the percentage of fuel gas use by upstream activity. The data show that gas battery and gas gathering system fuel gas use grew from 2.6 per cent in 2003 to 3.6 per cent in 2010, while gas plant fuel gas use increased to 2.9 per cent in 2010 from 2.7 per cent in 2003. Fuel gas use by oil batteries amounted to 0.45 per cent of total fuel gas use in 2003, decreasing slightly until 2006, and has since increased to 0.52 per cent in 2010.

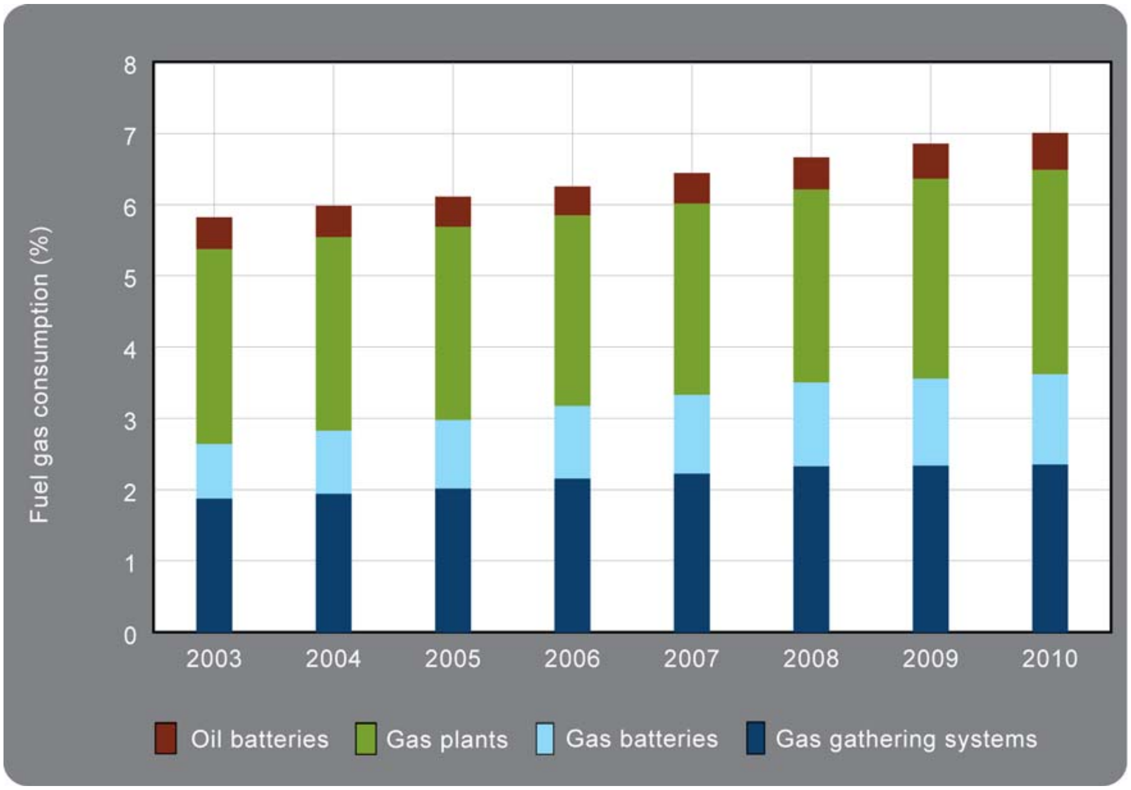


Figure 2. Fuel gas consumption as a percentage of raw gas production

Figure 3 provides a percentage breakdown of total fuel gas use by upstream activity. From 2003 to 2010, gas plant fuel use decreased from 47 per cent of total fuel gas use down to 41 per cent.

Over the same period, gas battery and gathering system fuel gas use increased from 45.3 per cent to 51.6 per cent of total fuel gas use. Oil batteries consumed 7.6 per cent of fuel gas in 2003, decreasing to 6.5 per cent in 2006 and increasing to 7.4 per cent in 2010.

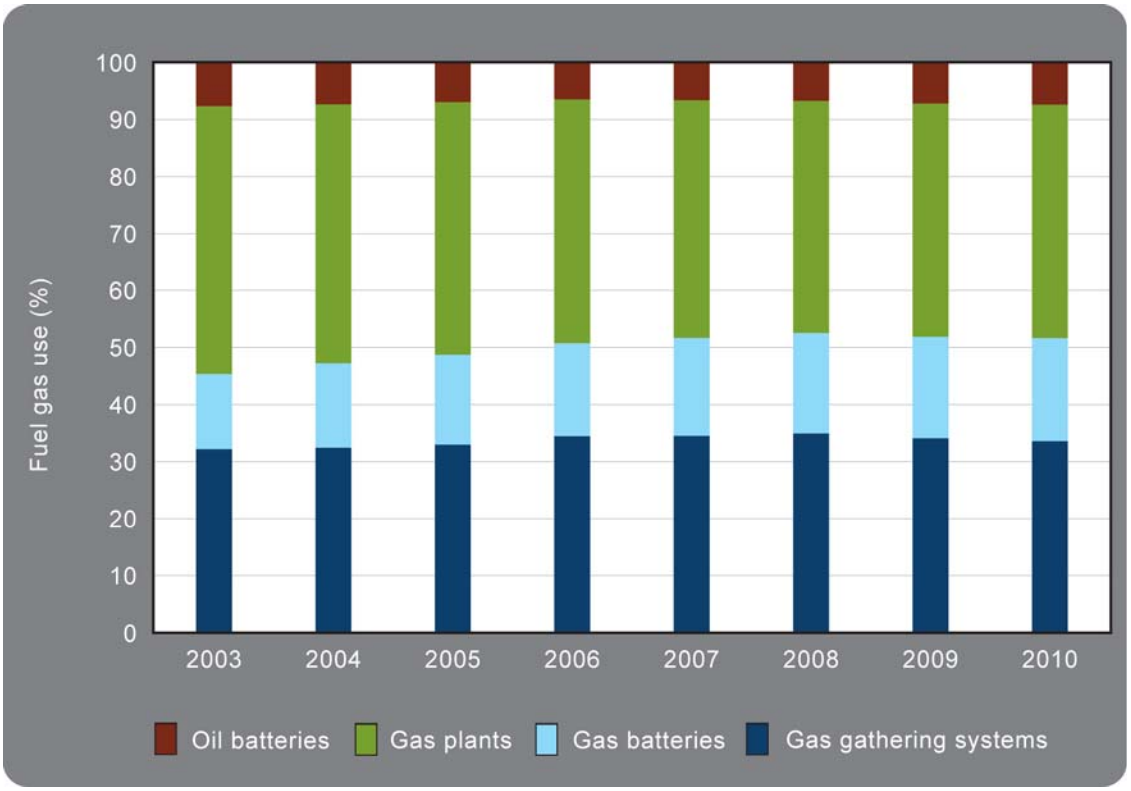


Figure 3. Fuel gas use by upstream activity

1.2 Overall Gas and Oil Production Trends

Fuel gas trends in the upstream oil and gas sector reflect the underlying conventional crude oil and natural gas production trends. **Table 2** lists total provincial raw gas and conventional crude oil production and gas plant receipts for comparative purposes. Note that raw gas production equals reported Alberta gas production plus gas imports minus gas withdrawals from commercial storage pools.

Table 2. Total gas production, gas plant receipts, and conventional crude oil production (gas [10^3 m^3/d]; crude oil [m^3/d])

	2003	2004	2005	2006	2007	2008	2009	2010
Total gas production	451 036.4	452 960.9	456 259.8	461 964.4	454 556.0	433199.8	403 650.4	383 800.3
Gas plant receipts	370 027.8	373 029.4	371 561.1	361 860.8	356 341.6	338 847.9	318 019.3	308 508.0
Conventional crude oil production	99 966.5	95 323.8	90 806.4	86 310.7	83 359.8	79 930.1	73 257.1	72 957.0

*2003-2010 data is sourced from the ERCB's *ST-3: Alberta Energy Resource Industries Monthly Statistics* and *ST-13A: Alberta Gas Plant/Gas Gathering System Activities—Annual Statistics*.

Figure 4 shows historical raw gas plant inlet receipts and conventional crude oil and natural gas production in Alberta from 2003 to 2010.

Annual gas production and gas plant receipts held fairly steady until about 2006 before declining year over year. Annual conventional crude oil production, however, has been on pronounced decline, year over year, until 2010 when production held flat. Fuel gas at oil batteries accounts for the smallest amount of fuel use in the areas examined. These production trends have important implications for fuel gas use.

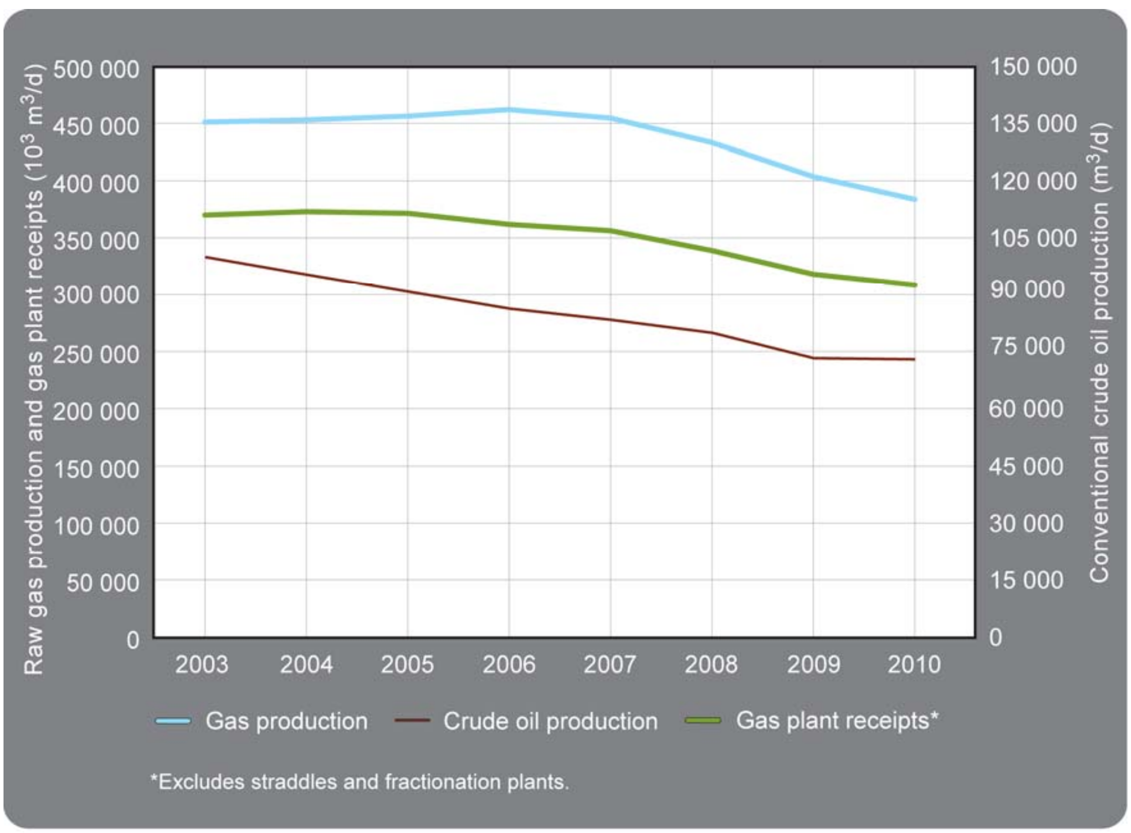


Figure 4. Alberta gas plant receipts and conventional crude oil and raw gas production

1.3 Top Natural Gas Producers

Figure 5 lists the top 20 natural gas producers in Alberta and ranks them based on their raw gas production as a percentage of the total raw gas production in the province. Midstream operators are not included in this figure as they process significant third-party gas production. The 2010 data for oil and gas companies is sourced from the PRA.

The top 20 producers are responsible for roughly 71 per cent of total Alberta raw gas production, with the top 6 accounting for about 40 per cent of the total production.

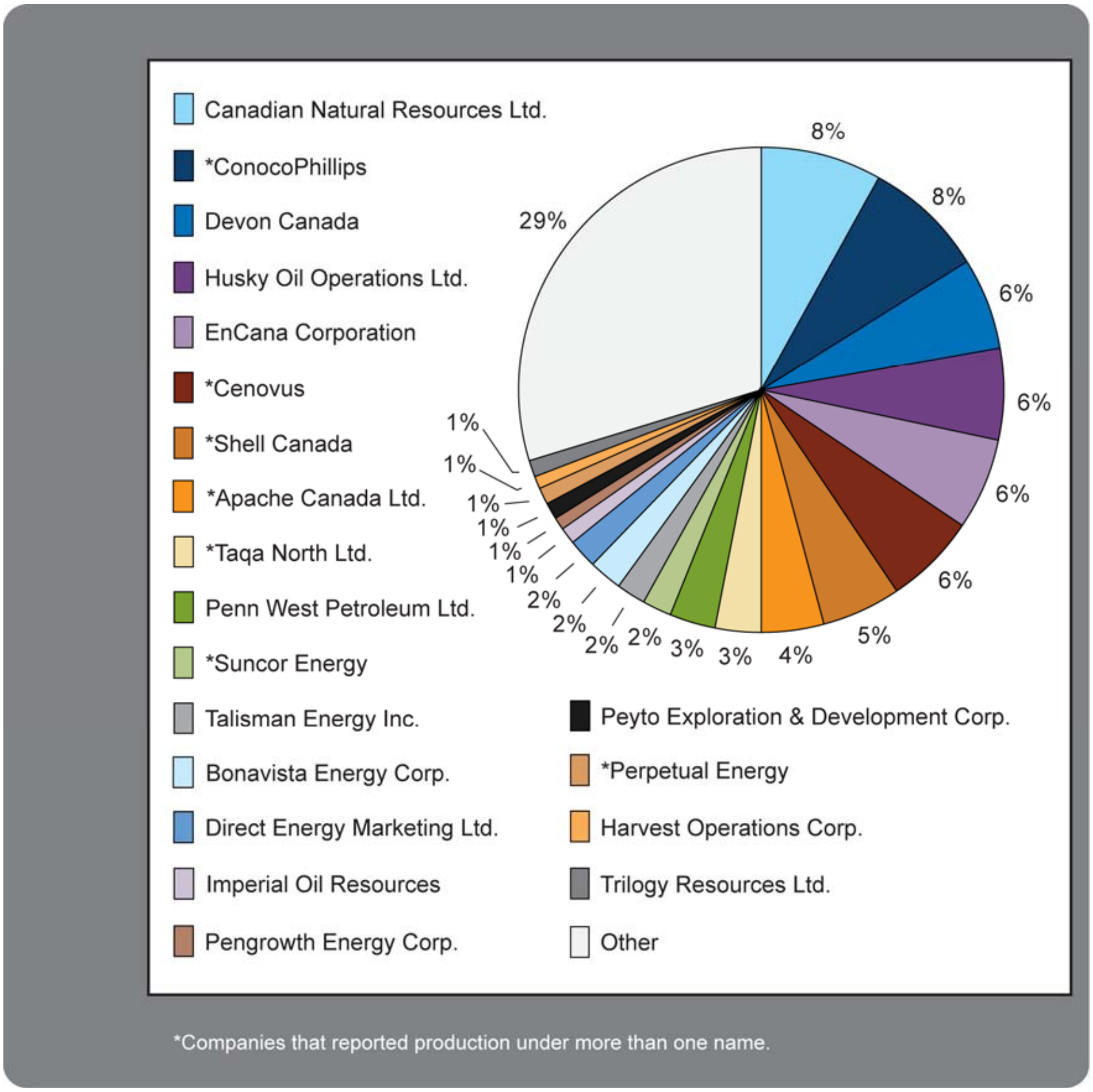


Figure 5. Top 20 natural gas producers (percentage of provincial total) in 2010

1.4 Top Fuel Gas Users by Operator

Figure 6 shows total fuel gas use by the top 20 fuel gas consumers in the province. This breakdown in fuel gas use includes mid-stream operators that are not gas producers and therefore have not been included in **Figure 5**.

The top 20 operators consume nearly 76 per cent of the fuel gas in the province. The top five operators account for about 35 per cent of the fuel gas use.

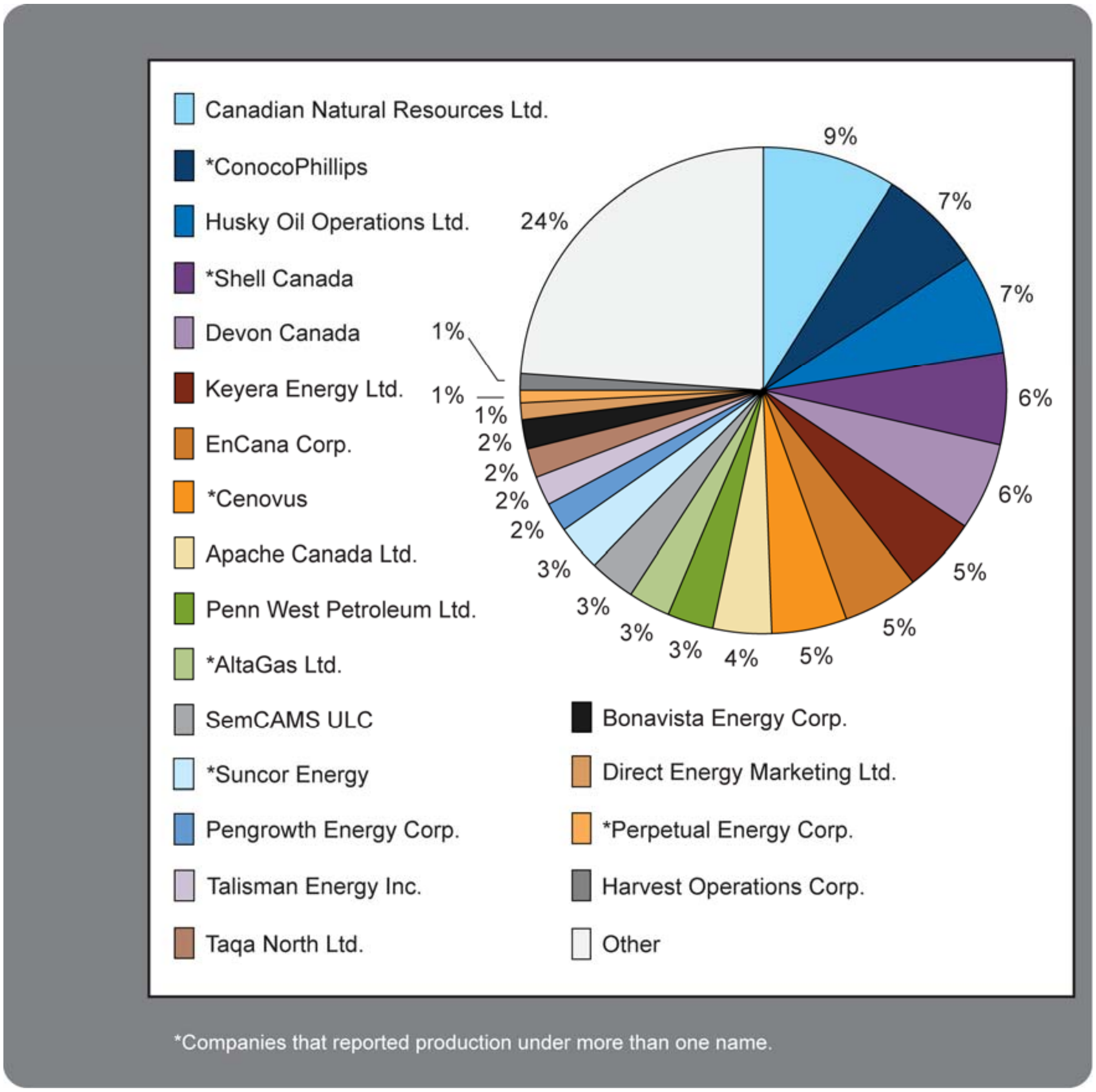


Figure 6. Top 20 fuel gas users by operator (percentage of provincial total) in 2010

1.5 Regional Distribution of Fuel Gas Use

The map in **Figure 7** shows fuel consumption by township. All townships with fuel consumption over 5000 10^3 m^3/yr (500 thousand cubic feet per day [mcfd]) are represented in red. The red areas stand out, revealing where fuel gas consumption and, therefore, where oil and gas production are more prevalent.

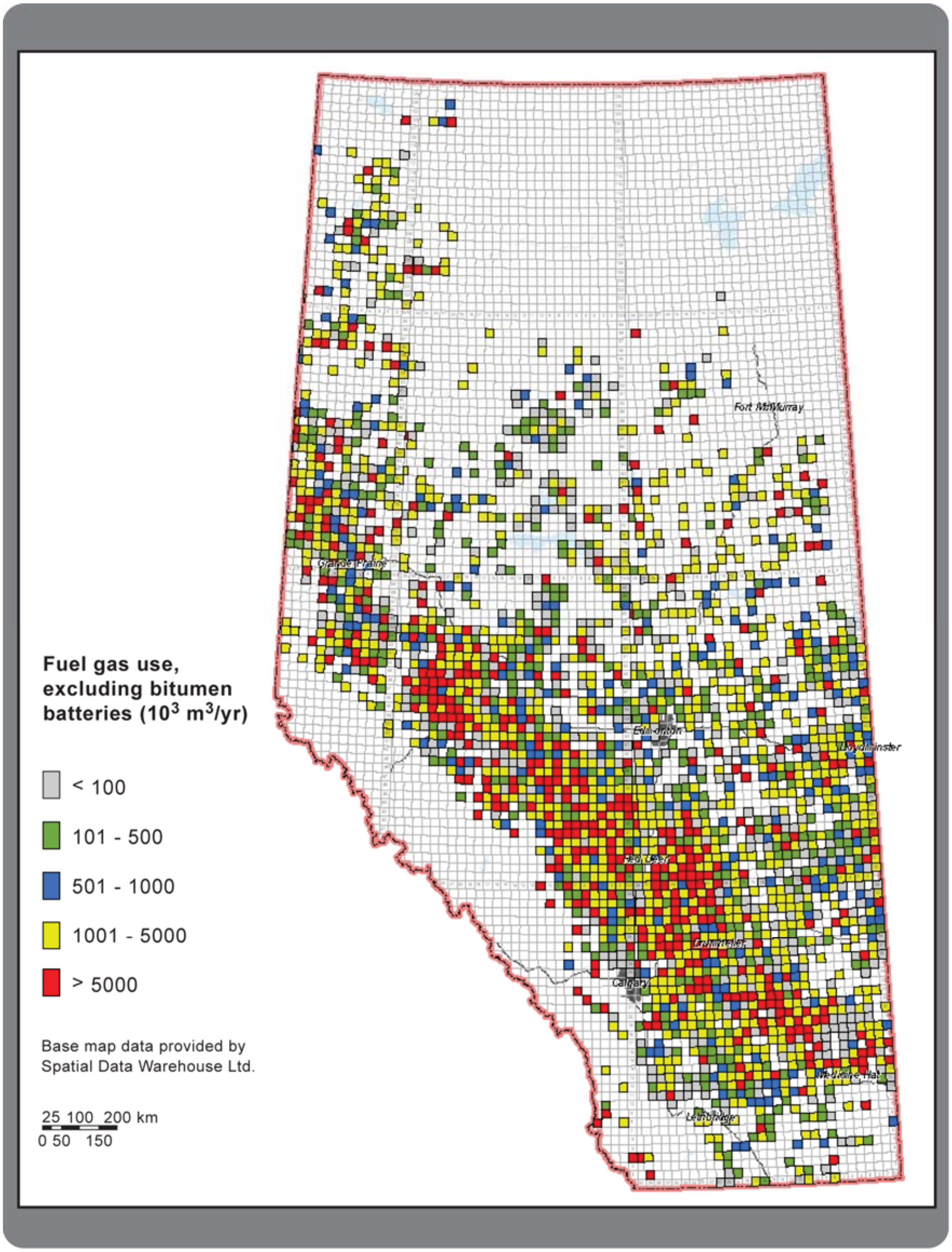


Figure 7. Geographical distribution of fuel gas use, 2010

The map in **Figure 8** shows the change in fuel gas consumption by township from 2008 to 2010. All townships with fuel consumption increasing year over year by greater than 5000 $10^3\ m^3$ (500 mcfd) are represented in red, and those decreasing by more than 5000 $10^3\ m^3$ are represented in green.

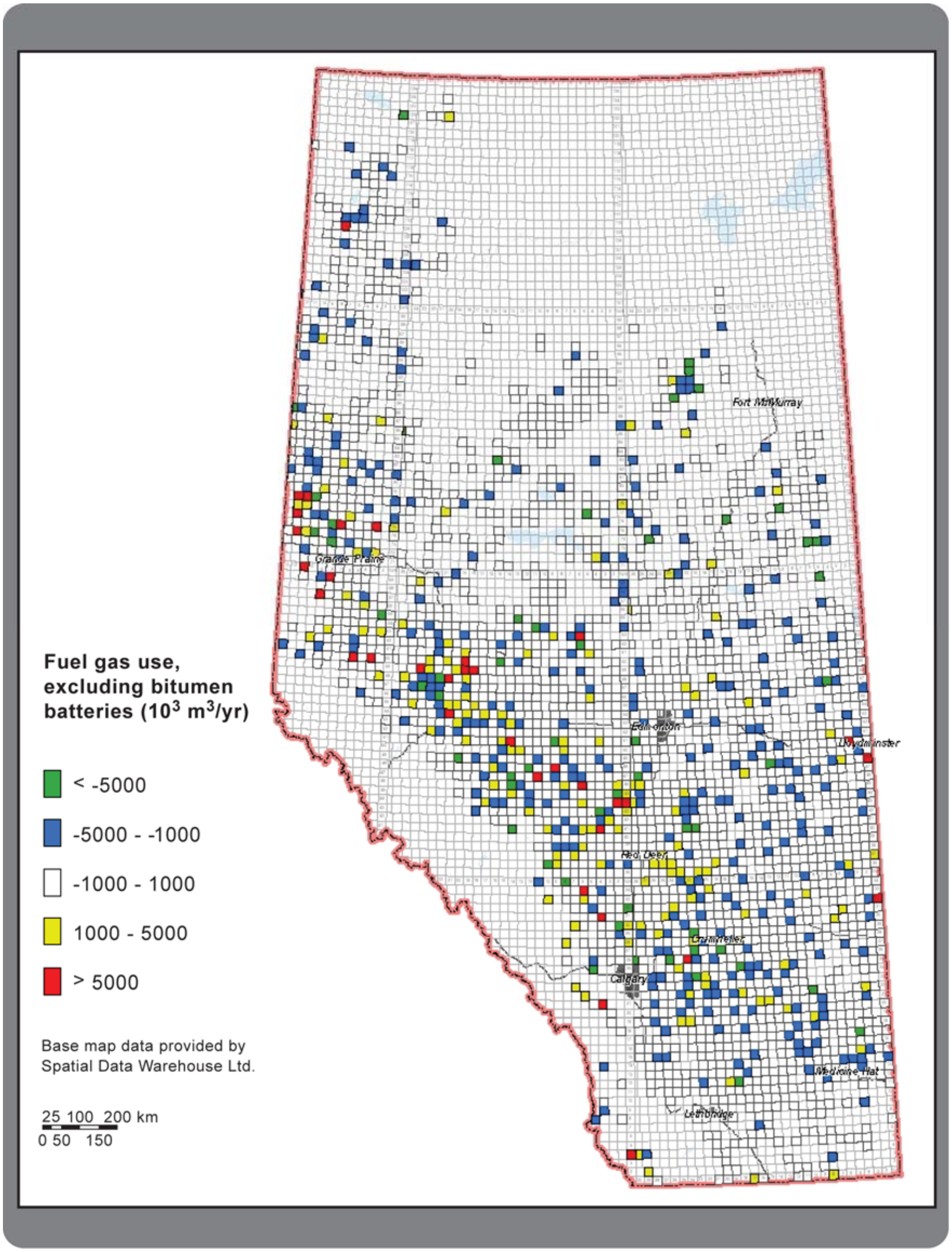


Figure 8. Change in fuel gas use by geographical area, 2008-2010

The map in **Figure 9** shows ratios of fuel gas use to raw gas production by areas identified by the Petroleum Services Association of Canada (PSAC) as similar in geological nature for determining well cost estimates.

Fuel gas to production ratios are highest in east-central (Area 4) and northeastern Alberta (Area 6), averaging 11.4 per cent, and are the lowest in the Foothills area (Area 1), averaging 5.9 per cent.

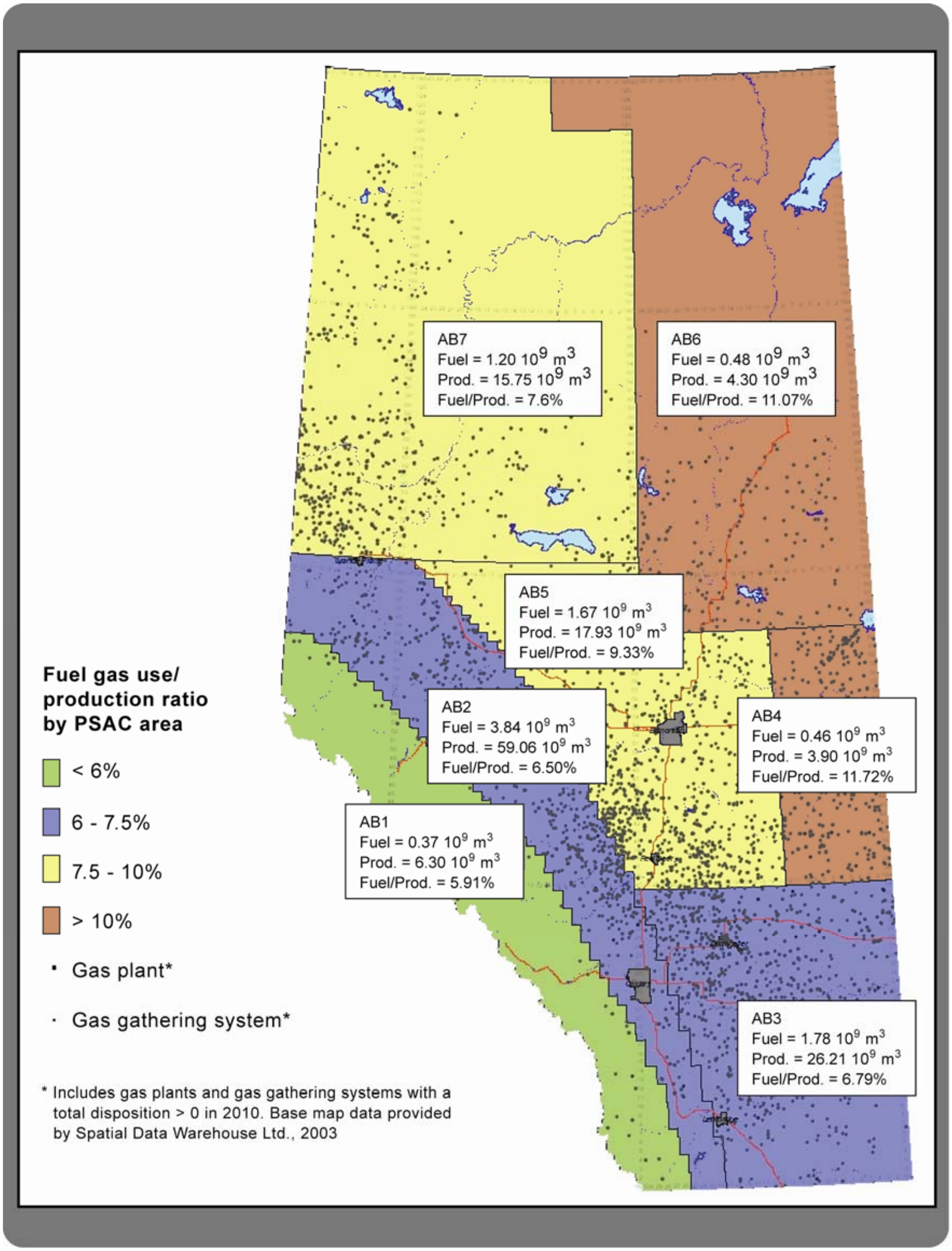


Figure 9. Fuel gas use to production ratio by PSAC area, 2010

1.6 Historical Trend in Fuel Gas Use and Raw Gas Production

Shown in **Figure 10** is the fuel gas use in the upstream conventional crude oil and gas sector plotted against total raw gas production for the 2003-2010 period. Note that this figure does not include crude oil production.

Since 2007, both fuel gas use and gas production have been declining. The decline in fuel gas consumption has been at a lower rate than the decline in raw gas production. The increasing fuel gas use to production ratio is expected in a mature resource basin as pressures decline.

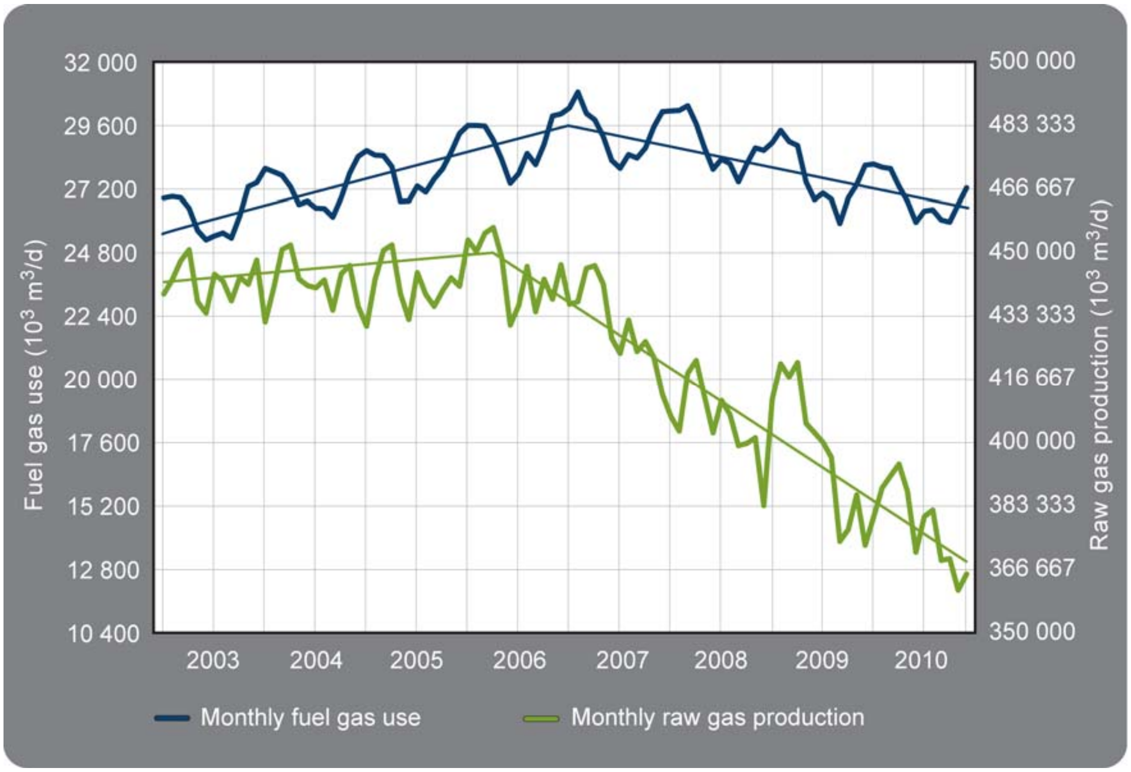


Figure 10. Fuel gas use and raw gas production trends

1.7 Impact of Seasonal Temperature on Fuel Gas Use

Figure 11 compares fuel gas use in the upstream conventional crude oil and gas sector and the average monthly mean temperatures in Alberta.

The figure shows that seasonal temperatures affect the fuel gas use rate, with fuel gas use decreasing on a monthly basis as temperatures increase in the summer months and decrease in the winter months. This figure also shows that even though the cycle of average mean temperatures in Alberta has remained fairly constant on an annual basis, the fuel gas use rate has been declining since early 2007.

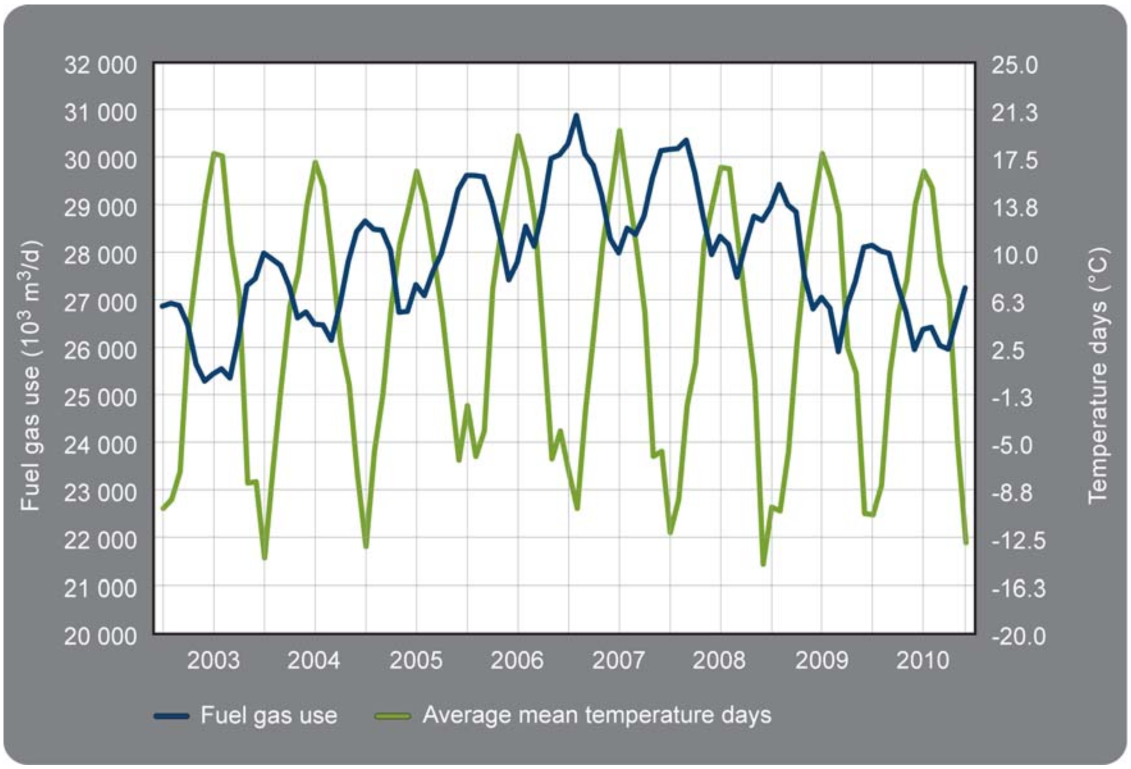


Figure 11. Fuel gas use and average mean temperature days

Average mean monthly temperatures were determined based on the average monthly mean temperatures in each of the following major centres in Alberta weighted evenly: Calgary International Airport, Edmonton International Airport, Grande Prairie Airport, and Medicine Hat Airport.

1.8 Impact of Price on Fuel Gas Use

The Alberta reference price for natural gas is compared to the total fuel gas use on a monthly basis in **Figure 12**.

As illustrated, both total fuel use and gas prices show an increasing trend from early 2003 through to 2005. Fuel gas use continued increasing for another two years before decreasing year over year. The gas price fluctuated over the 2006-2008 period before declining to levels as low as $2.48/GJ in September 2009. Low gas prices have led to decreasing fuel gas use, largely as a result of lower gas production.

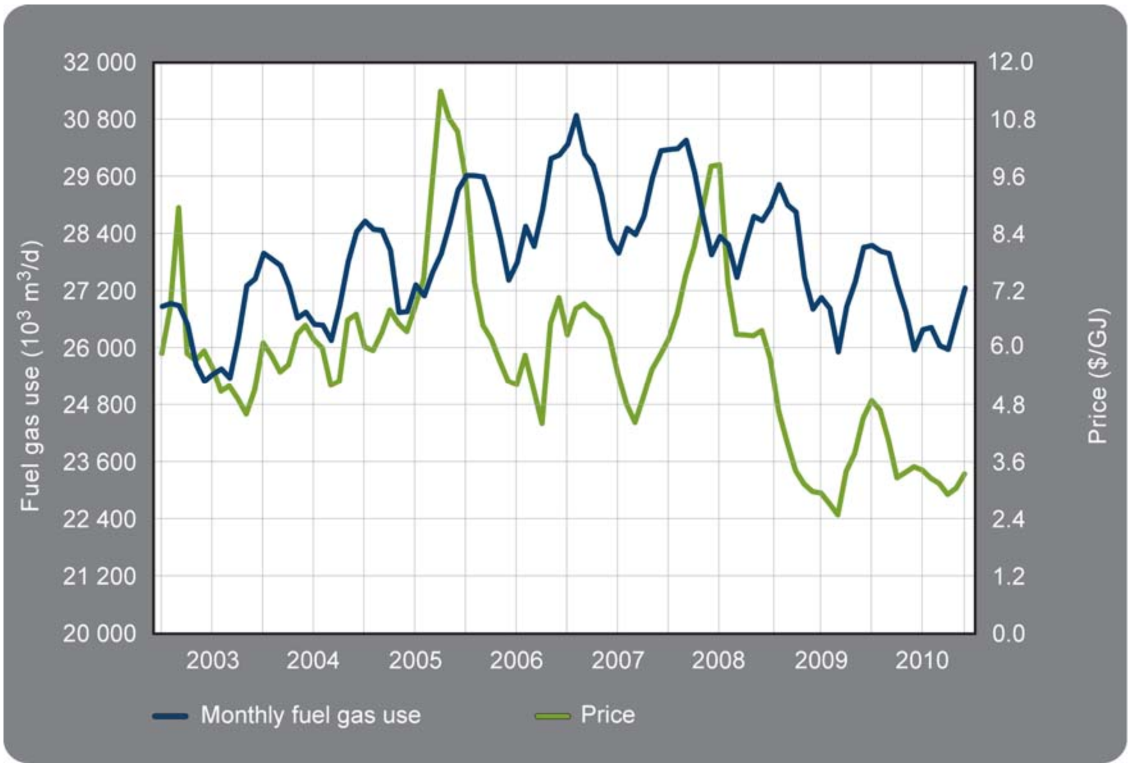


Figure 12. Fuel gas use and Alberta gas price

1.9 Fuel Gas Intensity

Fuel gas intensities for 2010 were determined for the top fuel gas consumers (top 20 operators minus the midstream companies) and illustrated in **Figure 13**. The intensities were calculated by dividing the fuel gas consumed (by oil and gas batteries, gas gathering systems, and gas plants) by the raw gas production for each company. Companies producing large volumes of oil relative to gas, which was not factored in, can appear less efficient.

This is a simple method of looking at the fuel intensities of companies and does not take into account the complexity of operations, which may be quite different for different companies.

It is important to note that "fuel gas intensity" is not the same as "fuel gas efficiency" or "energy efficiency," since numerous factors will cause increased or decreased fuel gas intensity, in addition to energy efficiency considerations.

Other factors that influence fuel gas intensity include[2]

- the amount of company oil production (oil production is less energy intensive);
- sweet gas versus sour gas production (sour gas is more energy intensive to produce);
- the amount of electrically driven compression;
- the type of product recovery (e.g., energy intensive cryogenic processes to recover NGLs, sulphur production, etc.);
- maturity of the reservoir (older reservoirs take more energy to produce due to the decline in pressure); and
- the amount of third-party gas that is processed by the operator.

Midstream operators have been excluded from the figures below because the production for their facilities comes largely from third parties.

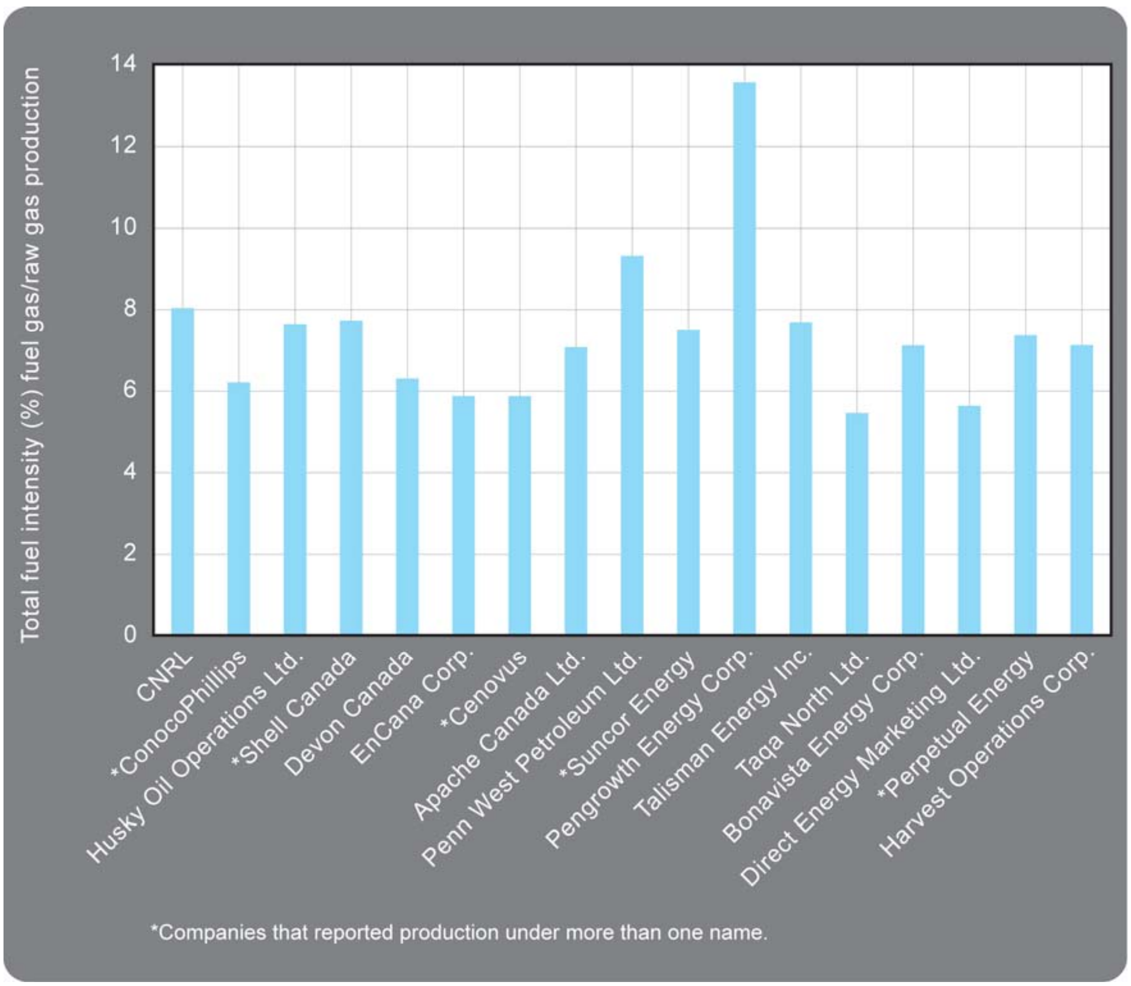


Figure 13. Fuel gas intensity for the top fuel gas consumers, 2010

[2] These factors were not considered in determining the fuel gas intensity for the top fuel gas consumers in 2010 shown in Figure 13.

Figure 14 shows oil and gas production for each company and provides some additional context to the companies' operations.

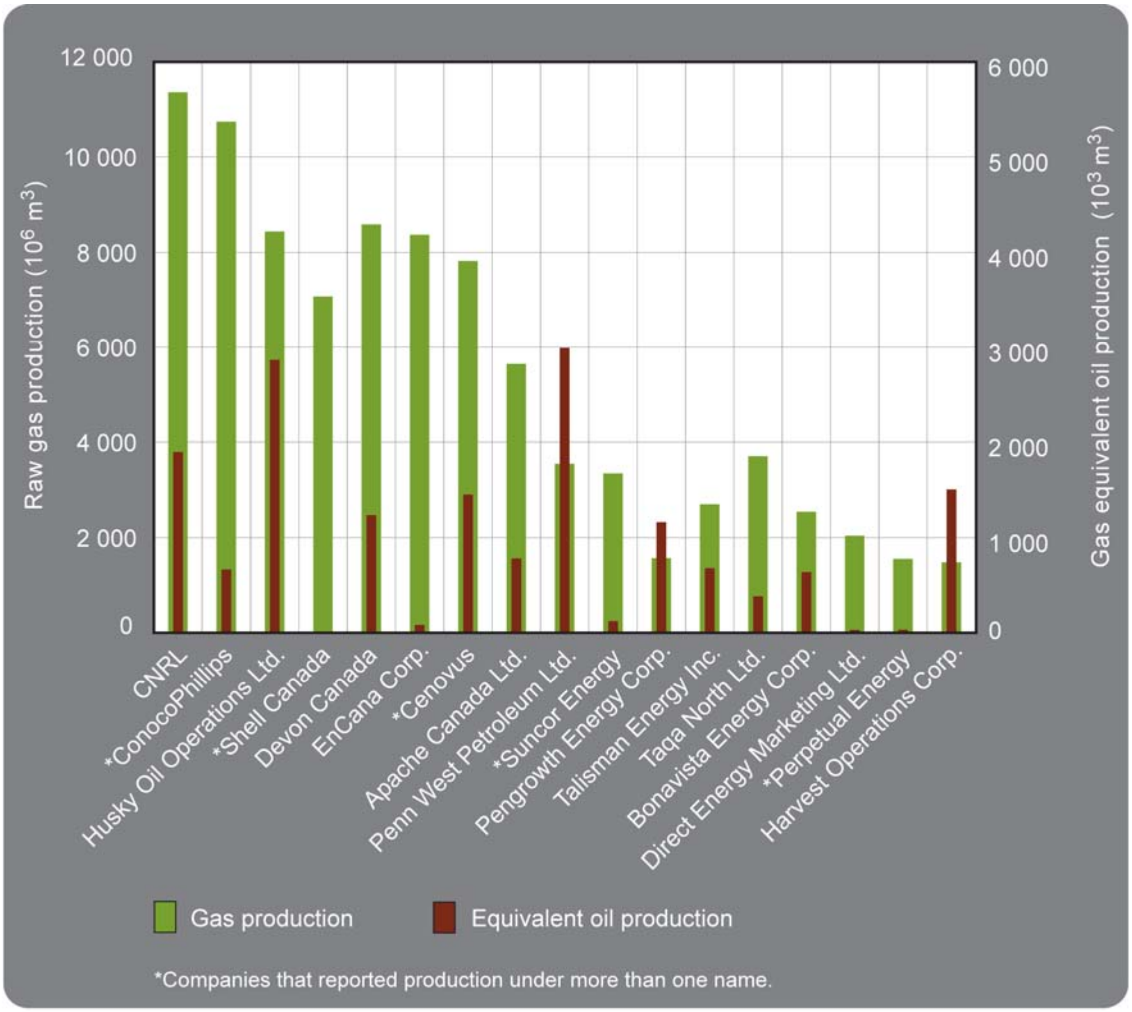


Figure 14. Gas and gas equivalent of crude oil production for the top fuel gas consumers, 2010

Figure 15 shows fuel gas intensities for the top fuel gas consumers (top 20 operators minus the midstream companies), with oil included in the gas production using the gas equivalent of oil[3] (6 mcf of gas per bbl of oil). The figure shows that fuel gas intensities for the companies with higher oil production improve considerably when the energy value of the oil is included. Based on historical data, fuel gas used to produce oil is generally less than that used to produce gas, given the extra energy used for compression and gas processing.

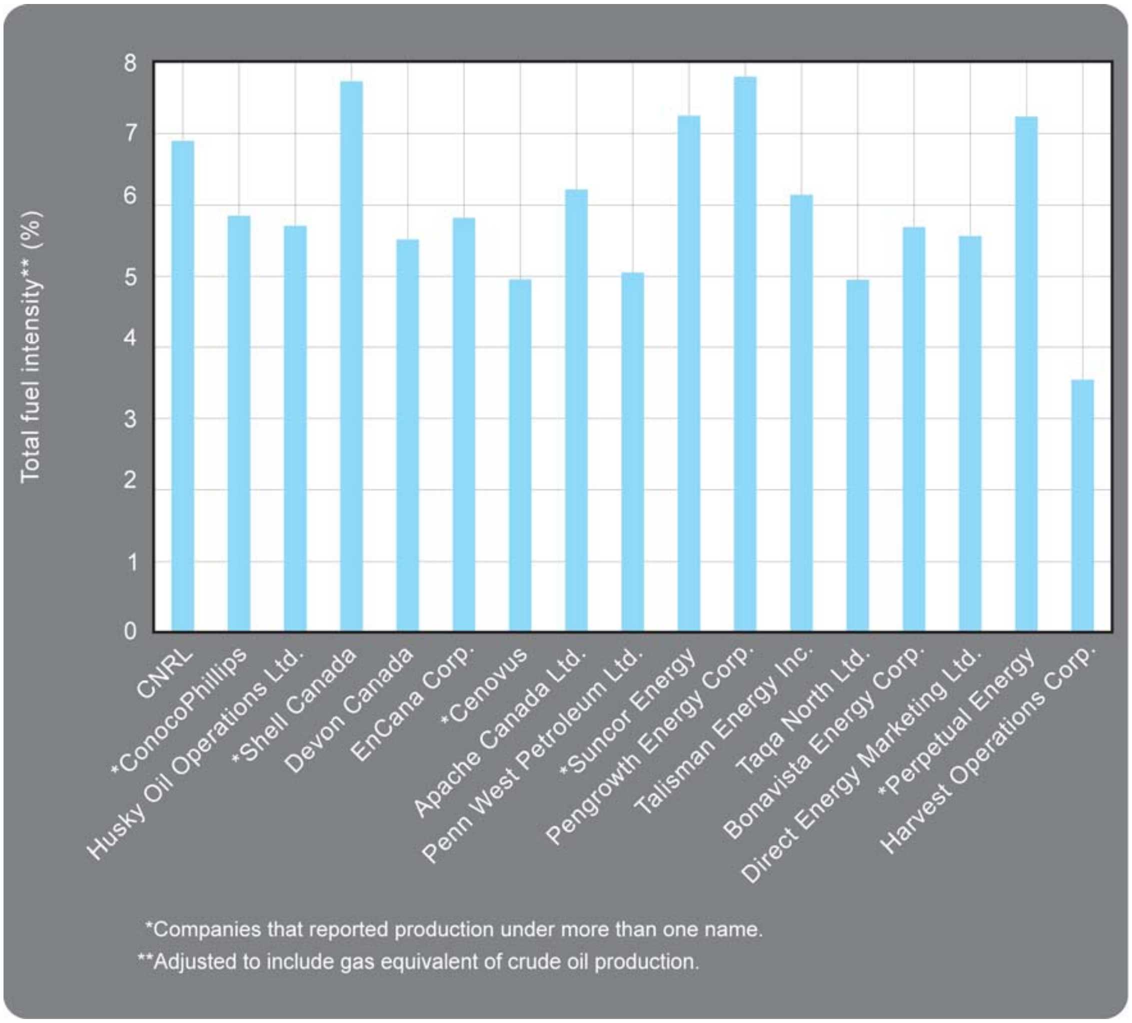


Figure 15. Fuel gas intensity for the top fuel gas consumers (adjusted), 2010

1.10 Fuel Gas Use by Upstream Activity

Detailed information and analysis on fuel gas use at gas batteries, gas gathering systems, gas processing plants and oil batteries is included in **Appendix B.**

For gas plants, fuel gas use per unit of receipts has remained fairly constant over time while capacity utilization of plants has decreased. While much of the gas in the province is processed at older plants built prior to 1981, this does not have a significant impact on fuel intensity. Sulphur recovery plants in Alberta use the largest portion of fuel, compared to other

[3] The natural gas equivalent of a barrel of oil is a unit of energy based on the approximate energy released by burning one barrel of crude oil. Typical natural gas is 6 mcf per barrel of oil as given by the United States Geological Survey.

categories of gas plants. Also, when comparing large plants with smaller plants, generally, the larger plants use less fuel gas per unit of gas processed.

Fuel gas use and throughput is declining at gas gathering systems; however, fuel gas use per unit of production is increasing.

For both oil and gas batteries, production continues to decline and fuel gas use per unit of production is increasing.

2 Survey Results—Top 20 Fuel Gas Consumers in the Upstream Sector

In July 2011, the ERCB surveyed the top 20 fuel gas consumers, representing 76 per cent of the fuel gas consumed in the upstream gas and conventional oil industry. These top 20 fuel gas consumers were asked to share how they were making decisions on fuel gas efficiency projects and describe the successes and challenges they have had while improving fuel gas efficiency and reducing fuel gas use. Seventeen of the 20 replied. These 17 consumers accounted for just over 72 per cent of the fuel gas consumed by this segment of the industry in 2010. The survey form sent to the top 20 fuel gas consumers is shown in **Appendix C**.

In 2010, the ERCB first published survey results based on 2008 data. The 2011 survey was for 2010 data. As in the earlier report, the company-specific responses to the survey were collected and held in confidence by the ERCB on behalf of all responders and the committee as a whole. To encourage a complete response to questions, aggregate and individual results were reported, but responses were not attributed to specific companies.

2.1 Fuel Gas Use Estimation

Companies were asked to estimate fuel gas use by category based on gross operating fuel gas use. The categories and summary statistics based on responses from 15 companies are given in **Table 3**.

Table 3. Fuel gas use estimation, 2010

Category	Number of responses	Average value % of fuel	Minimum % of fuel	Maximum % of fuel
Compressors and engines, turbines, and generators	15	59.2	7.0	95.0
Boilers, heaters, and furnaces	15	31.0	1.0	68.0
Fuel to flare and incinerator	15	7.1	0.0	30.0
Fuel venting	15	2.7	0.0	10.0

One company was unable to provide data for this question as its programs to monitor fuel gas use were still in the formative stages. Data of one other company was excluded from the statistics as it was unable to provide a breakdown between the first two categories.

Figure 16 presents the feedback of the 17 companies on their breakdown in fuel gas by category, as a per cent of total fuel use in 2010.

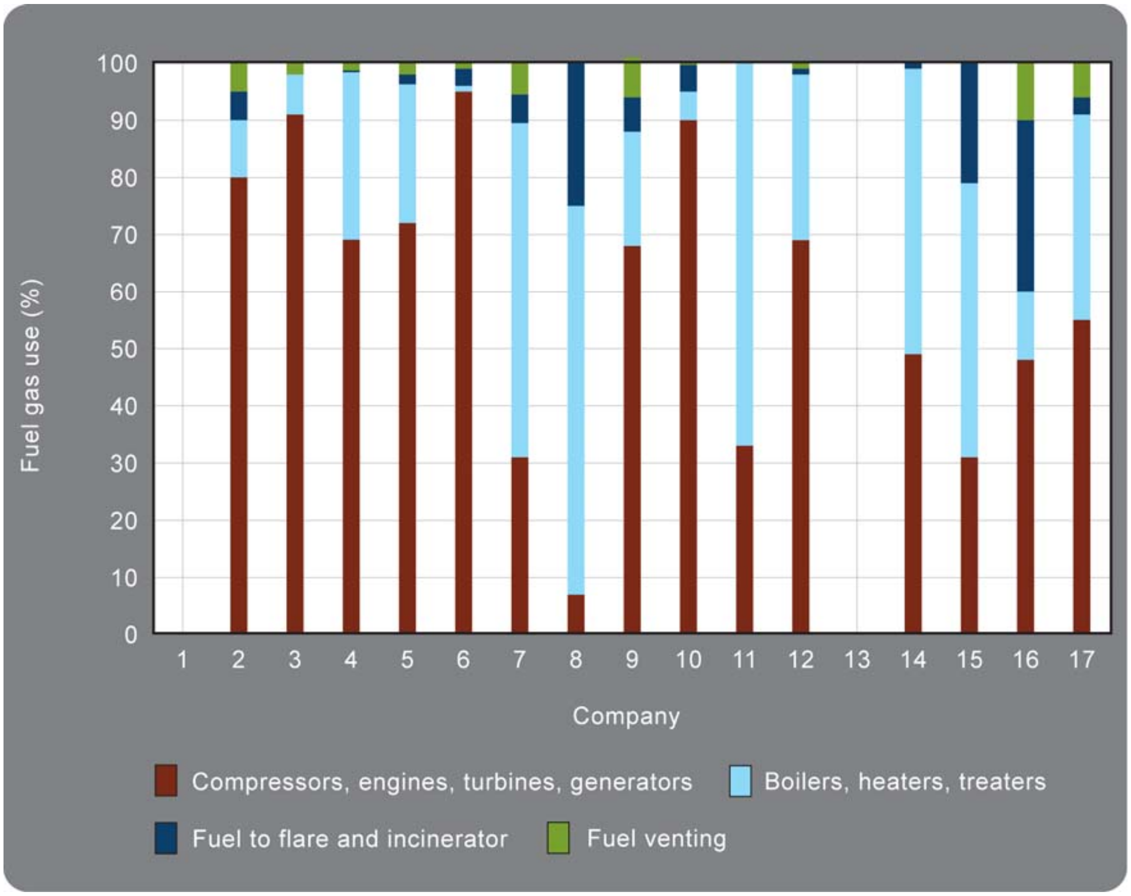


Figure 16. Fuel gas use by category, 2010

As shown in the chart, the largest category of fuel gas use reported by companies is for compressors, engines, turbines, and generators. Companies reporting low fuel gas use in this category may consume electricity rather than gas to fuel compressors, or the companies could be mid-stream operators that rely on others for fuel gas for field compression.

Boilers, heaters, and treaters make up the second largest fuel gas use category. Incinerator and vented fuel volumes are small. The incinerator category in addition to fuel to flare includes fuel to sulphur plant incinerators which are a major fuel gas consumer in gas plants with sulphur recovery.

Companies commented that in many cases individual pieces of equipment are not metered separately and the information provided is an estimate.

2.2 Decision Criteria for Fuel Gas Efficiency Projects

Companies were asked to provide the decision criteria used to determine fuel gas efficiency projects in 2010.

Figure 17 shows the reported minimum before-tax rate of return that companies would require to proceed with fuel gas efficiency projects. In this chart, companies that reported this information have been sorted in ascending order of rate of return to ensure data confidentiality.

The company numbers and their order on the x-axis for all other figures in this section are consistent with those in **Figure 16**.

Of the 17 companies surveyed, 10 reported numbers for rate of return. Companies reported that between 10 per cent and 30 per cent before-tax rate of return would be required to go forward with a fuel gas efficiency project, with the average being 17.2 per cent.

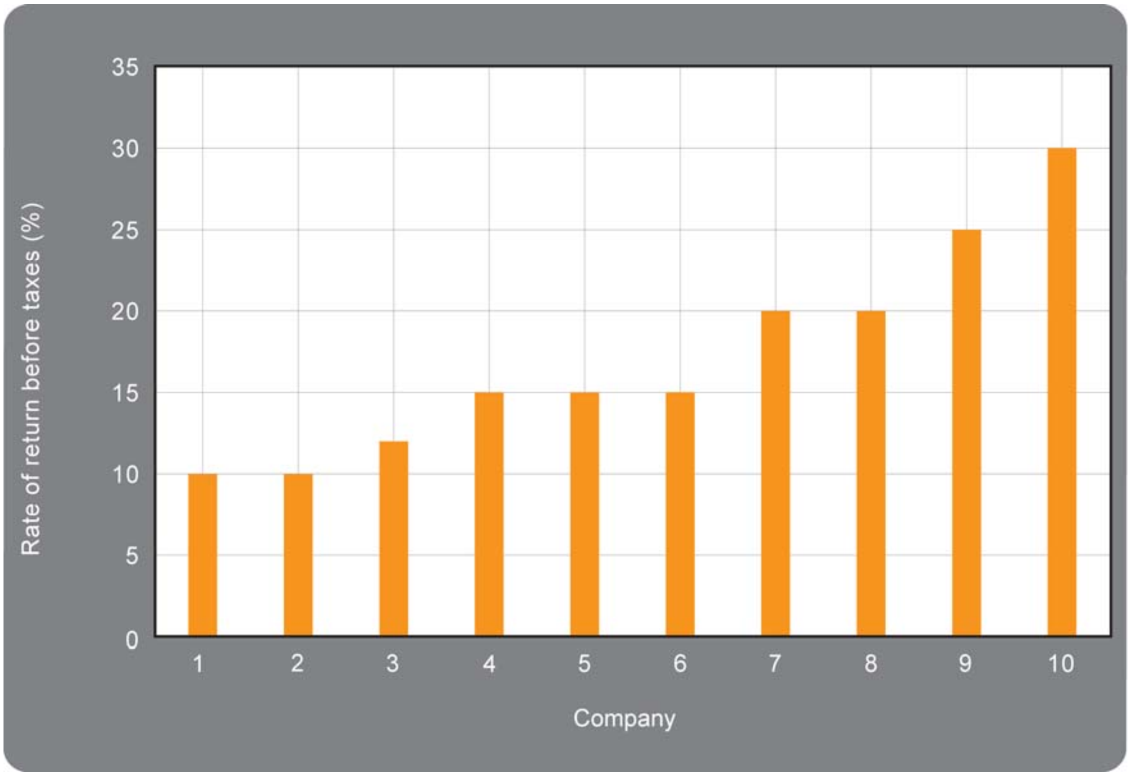


Figure 17. Rate of return for fuel gas efficiency projects

Of the 17 companies that reported survey information, 9 reported required payback periods ranging from 0.75 to 8 years, with an average payback period of 3.0 years. According to one company, short payback periods generally reflect smaller projects completed by operational staff while the rate of returns presented in **Figure 17** relate to larger capital projects.

Out of the 17 companies that responded, 15 considered GHG emission reductions as a factor in their evaluations of fuel use efficiency projects and 12 included the cost of GHGs when evaluating fuel gas efficiency projects. In many cases, operators conducted energy efficiency projects in combination with equipment upgrades, turnarounds for plant maintenance, and reliability improvement projects. For some of these projects, fuel savings alone were not enough of a reason to justify the project. These other motivating factors were not reflected in the economics of the fuel gas efficiency projects.

The general response from companies was that the same decision criteria were used for fuel gas efficiency projects as for all corporate projects.

One company reported that it created an energy efficiency and emissions reduction project portfolio, which provides a funding mechanism with alternative financial hurdles to those used in conventional capital programs in order to encourage implementation. One of the project metrics reported to be considered by the energy efficiency fund was production efficiency (PE), which is simply project investment divided by the daily volume of gas, or gas equivalent, in mcfd conserved by the project. For its projects, the company set the requirement for the PE to be less than \$360 000 capital per 10^3 m^3 (\$10 000/mcf) for a project to get funding.

2.3 Fuel Gas Reduction Projects

Of the 17 companies that provided information on fuel gas reduction projects, 11 were able to quantify 2010 capital investment for fuel gas investment projects, for a total of \$29.0 million. Three companies reported that they had not invested in fuel efficiency projects in 2010, while two companies were unable to break out fuel gas efficiency projects from larger project expenditures. **Table 2** summarizes reported information on fuel gas reduction projects for 2010 and 2011, as provided by operators.

Table 4. Fuel gas reduction projects for 2010 and 2011

Operator-provided project details	Number of companies	Investment cost reported ($ millions)	Mean	Median
2010 investment cost	11	29.0	2.4	0.7
2011 investment cost	11	67.0*	6.1	1.5

*Note: One project in consolidations and one project in compressors together account for $37 million of the $67 million.

Figure 18 shows responses from the 17 individual companies regarding fuel gas project investments in 2010 and 2011. One company reported spending $12 million in 2010 on several projects that received funding through a corporate-wide initiative.

The mean 2010 capital expenditure for the 11 companies reporting investment was $2.4 million, while the median of the data was $0.7 million.

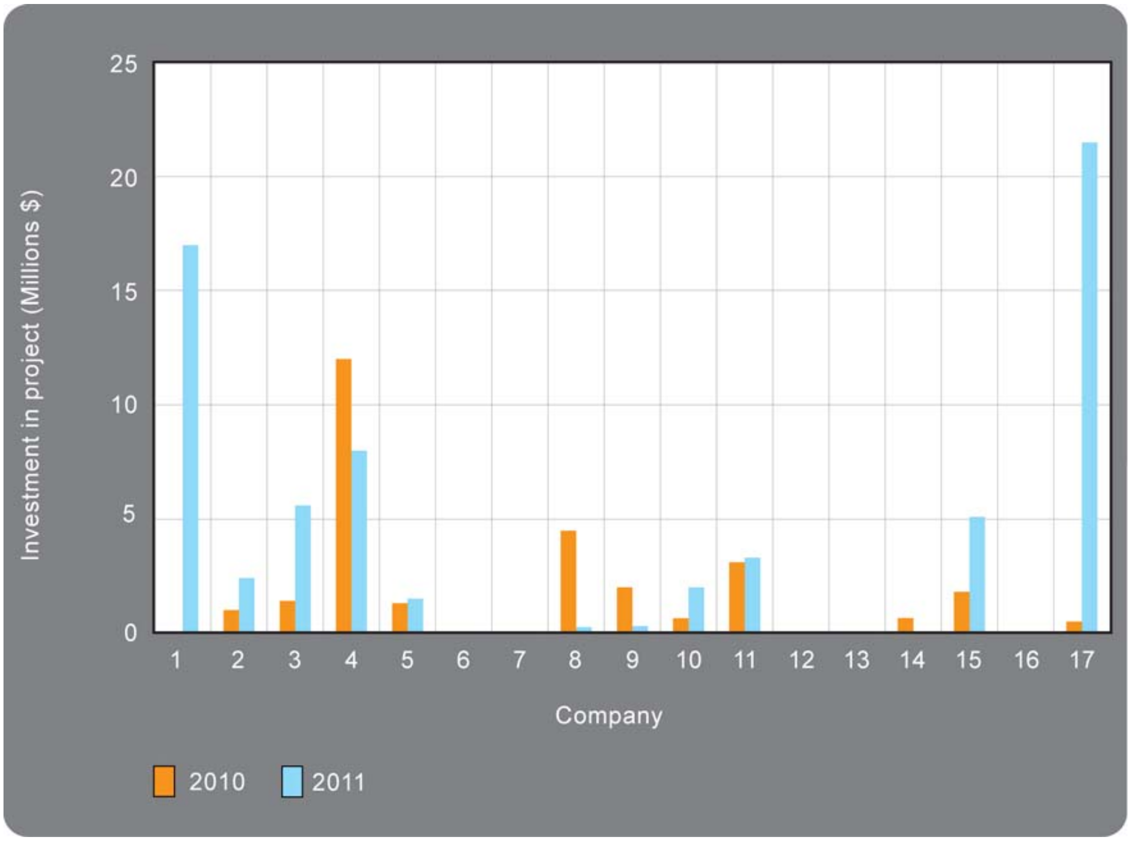


Figure 18. Fuel gas efficiency project investment by company, 2010

Of the companies that provided information on fuel gas reduction projects, 11 were able to quantify capital investment for fuel gas investment projects planned for 2011. **Figure 18** shows the responses from the 11 companies that reported planned investments totalling $67.0 million.

Two companies (and essentially two projects) accounted for about $37 million of the planned spending in 2011. One of these projects includes compression with waste heat recovery and the second project is a facility consolidation. While the projects generated fuel gas savings, the primary driver of each project was not fuel gas savings.

The nine other companies reporting planned investment in 2011 tended to involve smaller projects. The average investment came in at $6.1 million, and the median investment was $1.5 million.

Six companies responded that they had no fuel gas savings projects planned for 2011.

Fuel gas savings in 2010 were reported by 12 companies. **Table 5** shows the total savings and the mean and medium for all 12 responses. **Figure 19** shows the fuel gas savings reported for the 17 companies.

Table 5. Estimated project fuel gas savings, 2010

	Number of companies		Fuel gas savings		
			Total	Mean	Median
Company savings	12	$10^3 m^3/d$	459.0	38.0	11.8
		mcfd	16 290	1358	420

The 2010 projects were estimated to have saved 459.0 $10^3 m^3/d$ (16 290 mcfd) of fuel gas. As shown in **Figure 19**, two of the twelve companies that reported fuel gas savings saved over 3000 mcfd each. The largest fuel gas saving was reported by the same company that reported the most capital spent in 2010; the capital was spent on several projects. The second largest fuel saving was reported by a company involved in facility optimization and plant shutdowns.

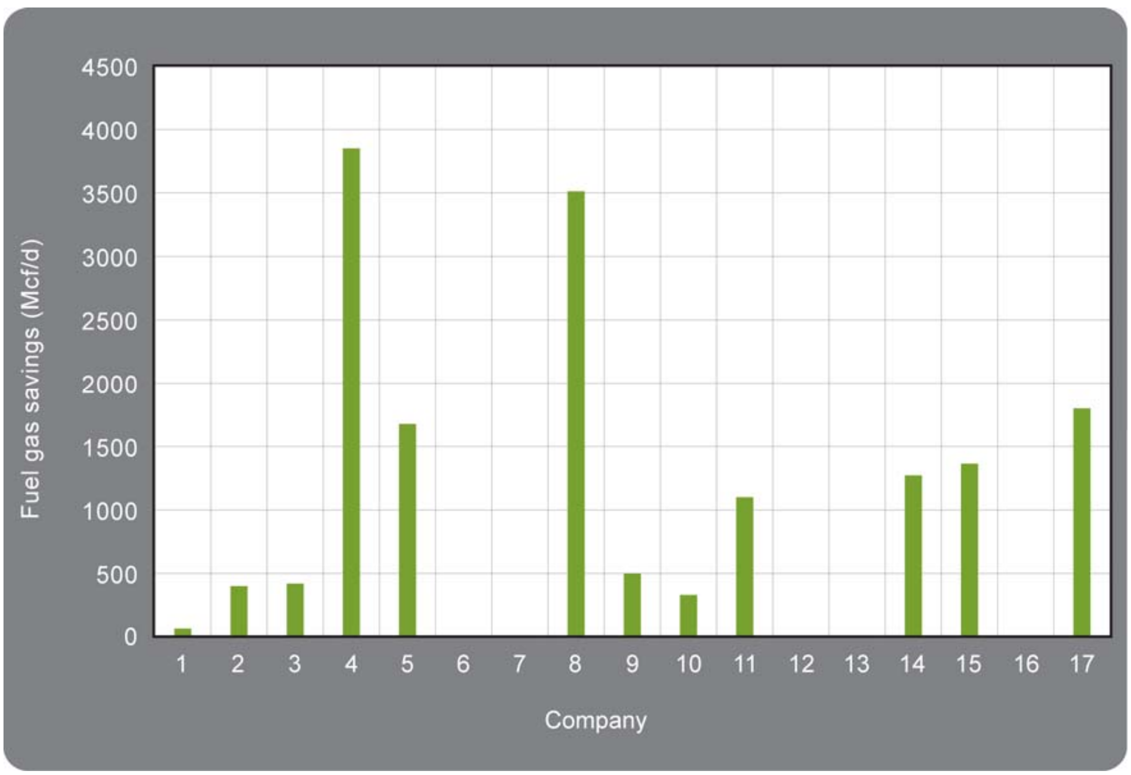


Figure 19. Fuel gas saved by company, 2010

Figure 20 illustrates the energy efficiency performance of companies based on capital spent per mcfd saved in 2010. The total dollars spent in 2010 for each company was divided by the total reported fuel gas saved for companies that reported both. The lower the capital spent per mcfd saved, the more economic the project. To put this into perspective, at $4/mcf gas, the gas value is equal to an investment of $1500 over one year.

As shown in **Figure 20**, there is considerable variability in this ratio. Companies have noted that fuel efficiency costs may be difficult to separate from larger project costs, and some smaller fuel gas savings may not require significant capital outlays.

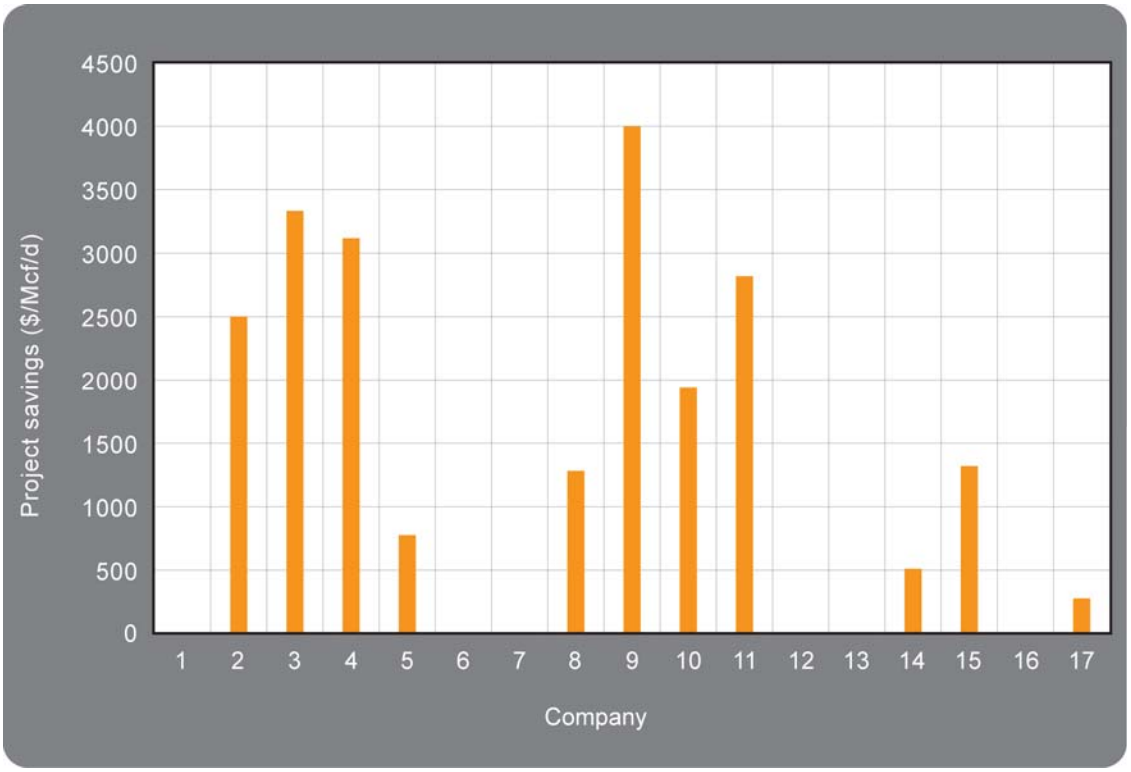


Figure 20. Fuel gas project investment per mcfd saved by company, 2010

In 2010, a total investment of $29.0 million and fuel gas savings of 16 290 mcfd from 11 of the largest producers provided a PE of $1780/mcfd. In metric units this is equal to a fuel gas savings of 459.0 10^3 m^3/d and a PE of $63 200/$10^3$ m^3/d.

2.4 Fuel Gas Use Trends

Table 6 summarizes factors that companies identified as increasing overall fuel gas use.

The major reason noted by companies for the trend in increased fuel gas use in the last three years was their increasing requirements for compression. Other factors that were reported included the building and/or expansion of facilities, acquisition of properties, and higher production volumes for select companies.

Table 6. Factors associated with increased fuel gas use

	Number of responses
1) Increasing compression requirements	5
2) New facilities or property acquisitions	5
3) Higher production	4

Table 7 summarizes factors reported to be associated with decreasing fuel gas use. Lower overall production, property or facility sales, facility shutdowns, and/or plant optimization were factors reported to contribute to decreasing fuel gas use. Three companies reported that energy efficiency programs contribute to decreased fuel gas use, and one company reported that plant optimization resulted in lower fuel gas consumption.

Table 7. Factors associated with decreased fuel gas use

	Number of responses
1) Lower production or throughput	6
2) Property or facility sales	5
3) Facility shutdowns	3
4) Energy efficiency	3
5) Plant optimization	1

Factors contributing to increased fuel gas use per unit of production are outlined in **Table 8**. Twelve companies reported increased fuel gas use per unit of production while five reported that fuel gas use per unit of production had decreased.

Table 8. Factors associated with increasing fuel gas use per unit

	Number of responses
1) Lower production or throughput	6
2) Increasing compression requirements	5
3) Higher production	4

The key factor reported to influence fuel gas use and fuel gas use per unit of production is lower production/throughput.

A number of other factors were reported to affect fuel gas use per unit of production.

In a separate case, a midstream company reported that the acquisition of new plants was a factor contributing to the increase in their fuel use, but that this factor also contributed to a decrease in their fuel gas use per unit of production. Another midstream company reported that its fuel gas use and fuel gas use per unit of production decreased as a result of the shut down of a facility and the rerouting of the gas production to another facility.

In a separate case, a producer reported a reduction in fuel use per unit of production when they optimized compression. Another producer cited reduced fuel gas use by turning off flare stacks when possible. One producer stated that divestments of high-fuel-gas-use projects lowered the average fuel gas per unit of production for the company.

Provincially, the most significant factor contributing to the increasing fuel gas use per unit of production is the decline in reservoir pressure accompanying the decline in gas production. This is typical of a maturing resource basin. The use of compression in the field to move low-pressure gas through gathering systems results in higher fuel gas consumption and higher fuel gas consumption per unit of production. In addition, lower volumes of gas production result in lower throughput and use of existing facilities.

2.5 Motivators to Reduce Fuel Gas Consumption

Our survey asked the top 20 companies what their top three motivators were to reduce fuel consumption or become more efficient. **Figure 21** shows the top motivators cited by the 17 operators that responded to the survey.

About 55 per cent of the motivators reported were business drivers, and about 45 per cent were related to government policy.

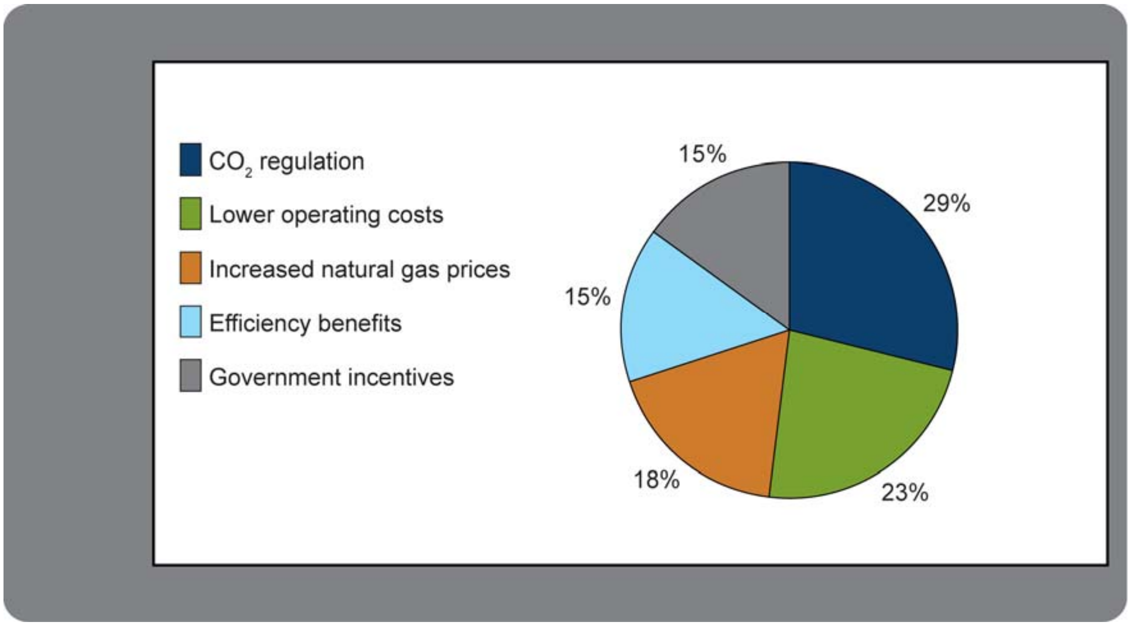


Figure 21. Top motivators to reduce fuel consumption

2.6 Company Fuel Gas Efficiency Project Successes

Figure 22 shows company project successes in 2010 reported by project type. The projects undertaken by the largest number of companies were fired heaters and leak detection and repair. In the 2008 survey, fuel gas venting (pneumatic instrumentation) was reported as being the most common.

There was a range of responses to the question asking for information on fuel gas project successes. One company indicated that it had no successful fuel gas projects to report after evaluating hundreds of potential projects, and another company reported successes in 14 different project areas.

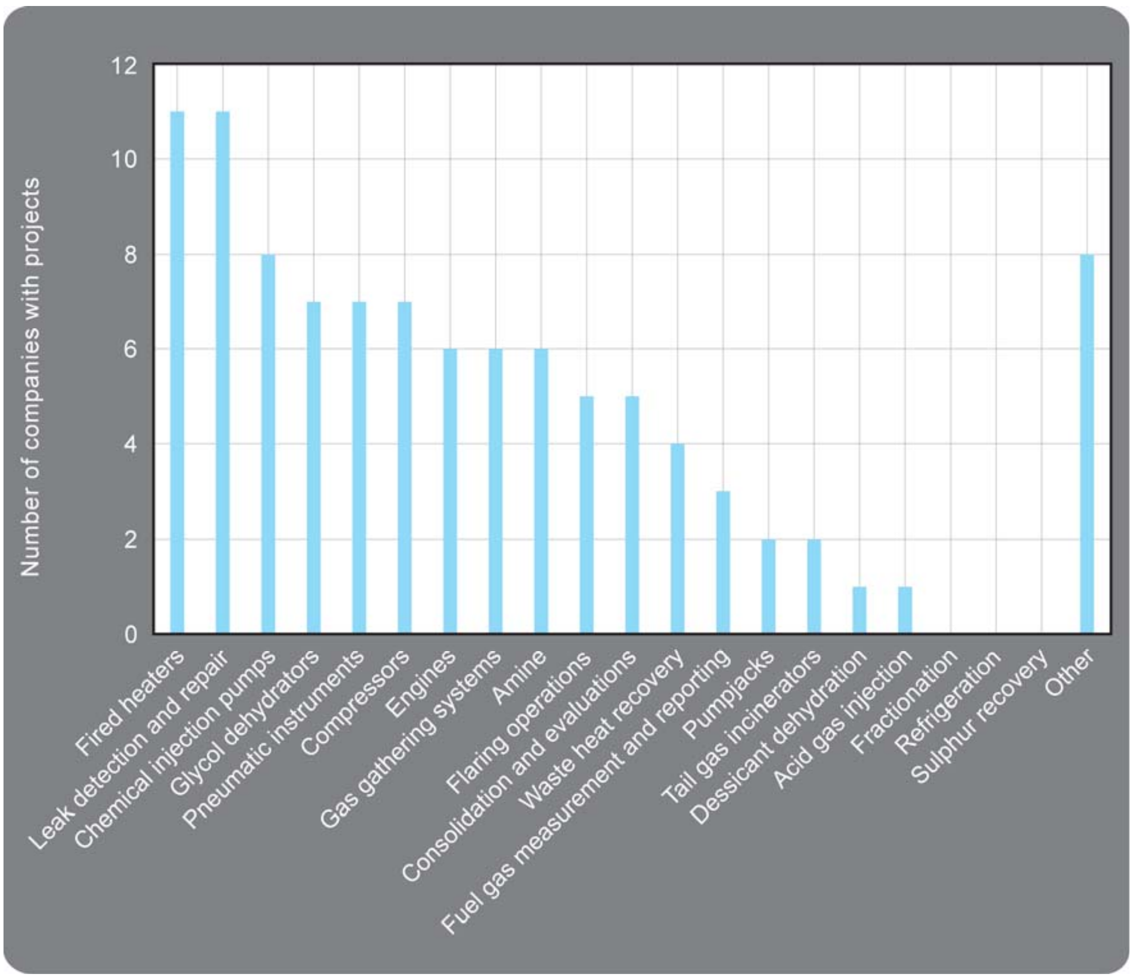


Figure 22. Companies reporting successful projects by type, 2010

The 11 projects listed under fired heaters include replacing glycol burners with more efficient units, installing thermally optimized production tanks, shutting in line heaters, preventative maintenance, and burner upgrades. Most companies reported that leak detection and repair projects are part of fugitive emission management programs.

Other successful projects reported include using vent gas from instruments, packing vents or casing gas as fuel, downsizing submersible pump motors, and general piping and process changes.

Figure 23 shows a breakdown of the capital investment reported by type of project, for about 24 per cent of the total number of projects that resulted in fuel gas savings. One company reported a project that involved installing an area-wide gas gathering system at a cost of $45 million dollars and a fuel gas savings of 137.2 10^3 m^3/d (4870 mcfd). This project was not included in the analysis as it is in an oil sands area. Gas-fired electric co-generation projects and a fuel gas measurement and reporting system were also excluded. The primary driver of each project was not fuel gas savings.

As shown in **Figure 23**, the top areas for capital investment in 2010 were fired heaters, engines, and waste heat recovery. Waste heat recovery projects include the recovery of heat energy from engine or turbine exhaust. In the previous survey, top areas included compression and engines, fuel gas venting, and fired heaters.

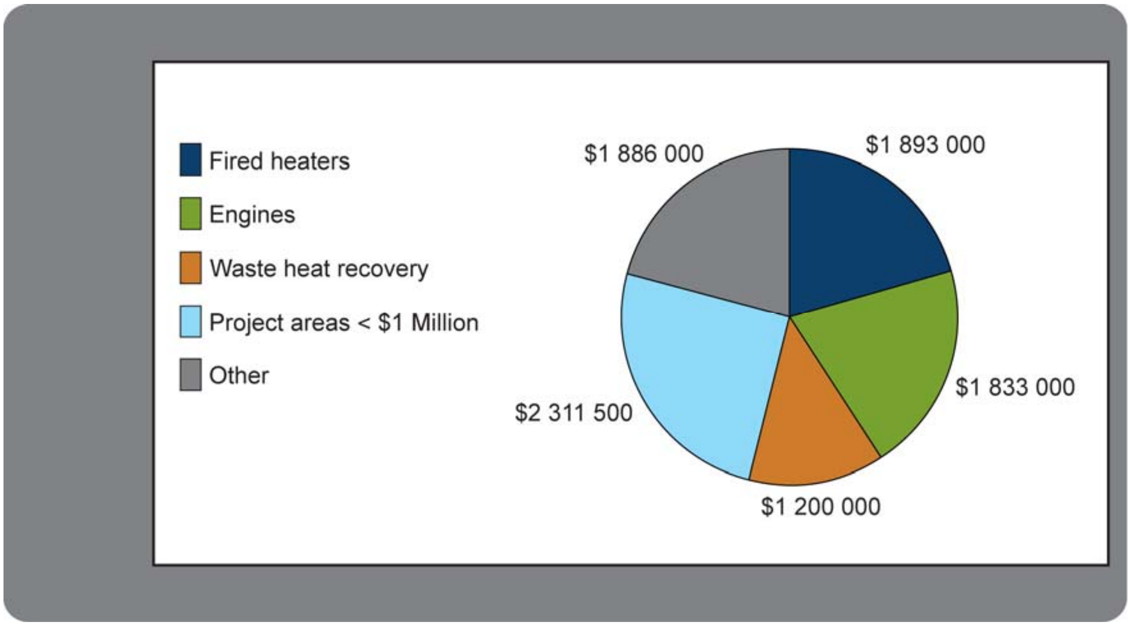


Figure 23. Fuel gas capital investment in project area, 2010

Figure 24 shows the fuel gas savings reported for 27 per cent of the projects. Most fuel gas savings were in the area of consolidation and evaluations, followed by engines and fired heaters. Consolidation and evaluation projects include gas plants, dehydrators, compressor shut-downs, and replacements due to declining reservoir pressures.

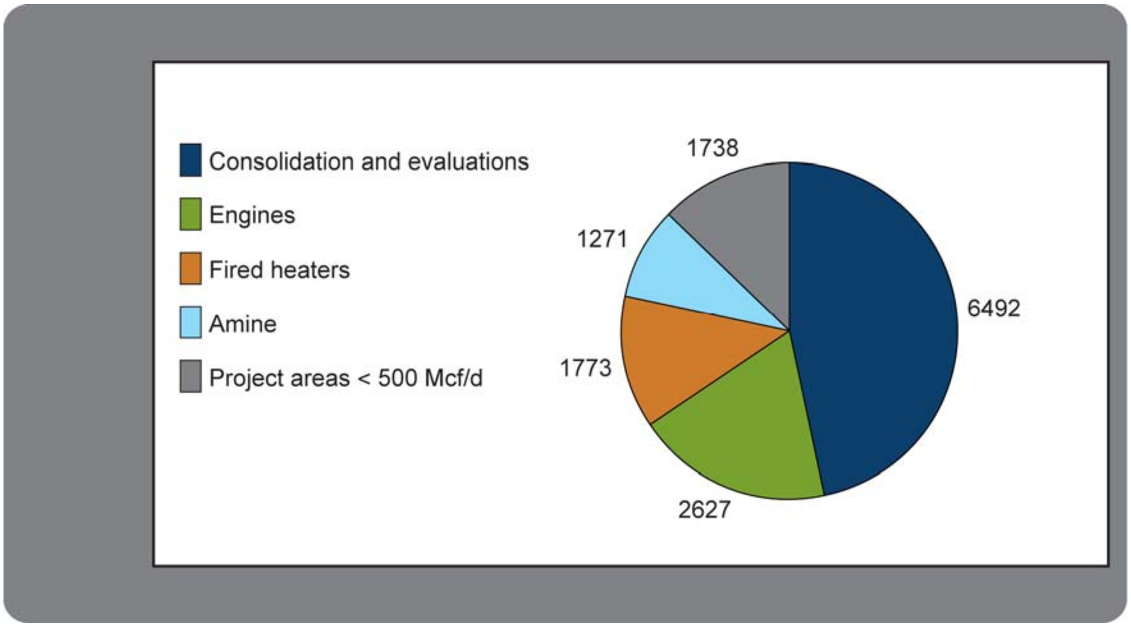


Figure 24. Fuel gas savings reported by project area, 2010

A more detailed breakdown of the projects reported is provided in **Table 9**.

Table 9. Projects reporting fuel gas savings, 2010

Project type	Capital investment ($)	Number of companies reporting	Fuel gas saved		Number of companies reporting
			10^3 m^3d	mcfd[a]	
Fired heaters	1 893 000	3	49.7	1 773	5
Engines	1 833 000	3	73.6	2 627	3
Fuel gas measurement and reporting	1 500 000	1			0
Waste heat recovery	1 200 000	1	12.8	456	3
Amine	650 000	1	35.6	1 271	1
Leak detection and repair	600 000	1			0
Consolidation and evaluations	500 000	1	83.4	2 980	2
Chemical injection pumps	248 000	3	5.0	179	4
Compressors	202 000	3	6.1	217	2
Gas gathering systems	100 000	1			0
Glycol dehydrators	11 500	1			0
Pump jacks	-	0			0
Pneumatic instruments	-	0	1.4	50	1
Flaring operations	-	0	12.0	430	1
Desiccant dehydration	-	0			0
Fractionation	-	0			0
Refrigeration	-	0			0
Sulphur recovery	-	0			0
Tail gas incinerators	-	0			0
Acid gas injection	-	0			0
Total	10 623 500	24	290.9	10 390	26

[a] **Fuel gas savings in mcfd have been rounded as not all data were reported in the same detail.**

Figure 25 provides information on the average cost of saving fuel, by project area, for only those projects identified by operators with capital investment and fuel gas saved (i.e., a subset of **Table 9**). Given the limited number of companies supplying both sets of data (the bars represent between one and three company responses), the relationship shown in **Figure 25** should be treated as an indicator only. Categories that are shown to have the lowest cost per fuel gas saved include consolidation and evaluations, amine, compressors, engines, and fired heaters. These projects may provide the best value if the opportunity is available.

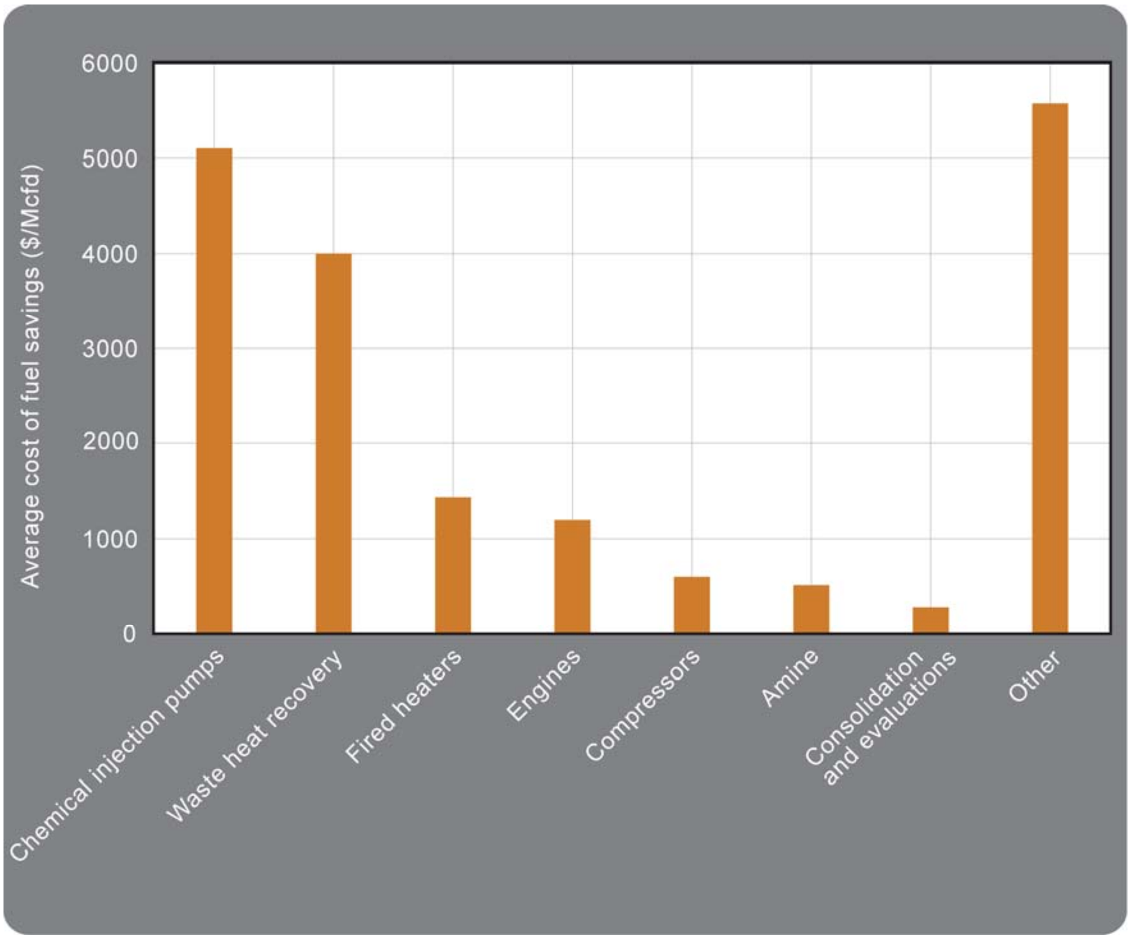


Figure 25. Average cost of fuel savings by project type, 2010

2.7 Lessons Learned

We asked companies to comment on what worked well for projects that are deemed successful.

Midstream operators reported that fuel gas savings projects can be realized if they work with producers to develop the funding.

The following suggestions were reported to help with project success:

- Engage field/operations staff early in the process during project selection and implementation.
- Consider more than just fuel savings in evaluating project candidates.
  - reliability improvement

- safety enhancement
- emissions reduction
- production optimization

- Obtain management and organizational commitment.
- Coordinate modifications with shutdowns.
- Improve internal tracking systems.
- Aggregate smaller projects.
- Monitor compressor performance.
- Secure dedicated capital.
- Drive the program with support from the top.
- Have midstream operators engage producers to develop funding.
- Build energy efficiency into new projects.

One company went as far as to say that most projects were successful when implemented, and most companies suggested that economics are a challenge. One company suggested that none of the projects it evaluated were successful.

Where improvements can be made

The following suggestions were reported as ways to improve project performance:

- Test new technology on a small scale (pilot) before widespread implementation.
- Make it easier to obtain GHG credits for small projects.
- Install measurement equipment to get accurate savings estimates.
- Write operating agreements to give energy incentives to mid-stream operations.
- Improve the process methodology for evaluation of opportunities to ensure successful projects.
- Improve cost estimates when there is large variability in field equipment.
- Improve communication among internal stakeholders.
- Ensure that energy efficiency programs are not lost in company reorganizations.

What requires further technical development

Not a lot of input was received in this area. Much of the input was related to sharing information on what has been successful. The following comments were among the feedback:

- PTAC is ideal for helping to deploy new technologies.
- Share lessons learned.

- Create a database of energy efficiency project case histories.
- Improve data tracking to measure fuel gas usage reductions for individual projects.
- Apply fuel savings technology to old engines/burners.
- Consider how to determine successful projects—by size and benefit.
- Improve reliability of solar chemical injection pumps.
- Simplify burner upgrades for line heaters by eliminating the need to upgrade the supply network.

There may be value in capturing more detailed information about what projects have been evaluated by companies and sharing that information with others. It may be useful to know which companies are having what success with what projects.

What are the challenges to implementation

Reported implementation challenges include the following:

- Fuel efficiency projects compete on the same basis as any other project;
- No dedicated funds for energy efficiency projects with a lower rate of return;
- Predicting the costs correctly for different facilities with different ages and different equipment;
- Low gas prices;
- Less opportunity for companies with mature energy efficiency programs;
- The cost of developing CO_2 offset programs and cost of GHG verification;
- Lost production when implementing projects;
- Staff resourcing;
- Engaging field and engineering staff for timely execution;
- Absence of a corporate fuel efficiency strategy; and
- Training for field staff in project implementation.

One company, which had recently reduced its staff for this initiative substantially, summarized its challenges by stating:

> The key factors to executing a successful energy efficiency program are management support, adequate budget, resourcing and the long-term viability of the producing assets. Ensuring that all of these key factors are in place is challenging. Given the context of persistently low natural gas prices, declining production and asset divestitures, it is difficult to maintain a high priority on fuel gas efficiency projects within our Alberta conventional business.

2.8 Future Fuel Gas Efficiency Projects

Figure 26 shows the number of companies reporting future work by project area and by the category of the fuel efficiency project. Engines and waste heat recovery were the most common types of projects reported.

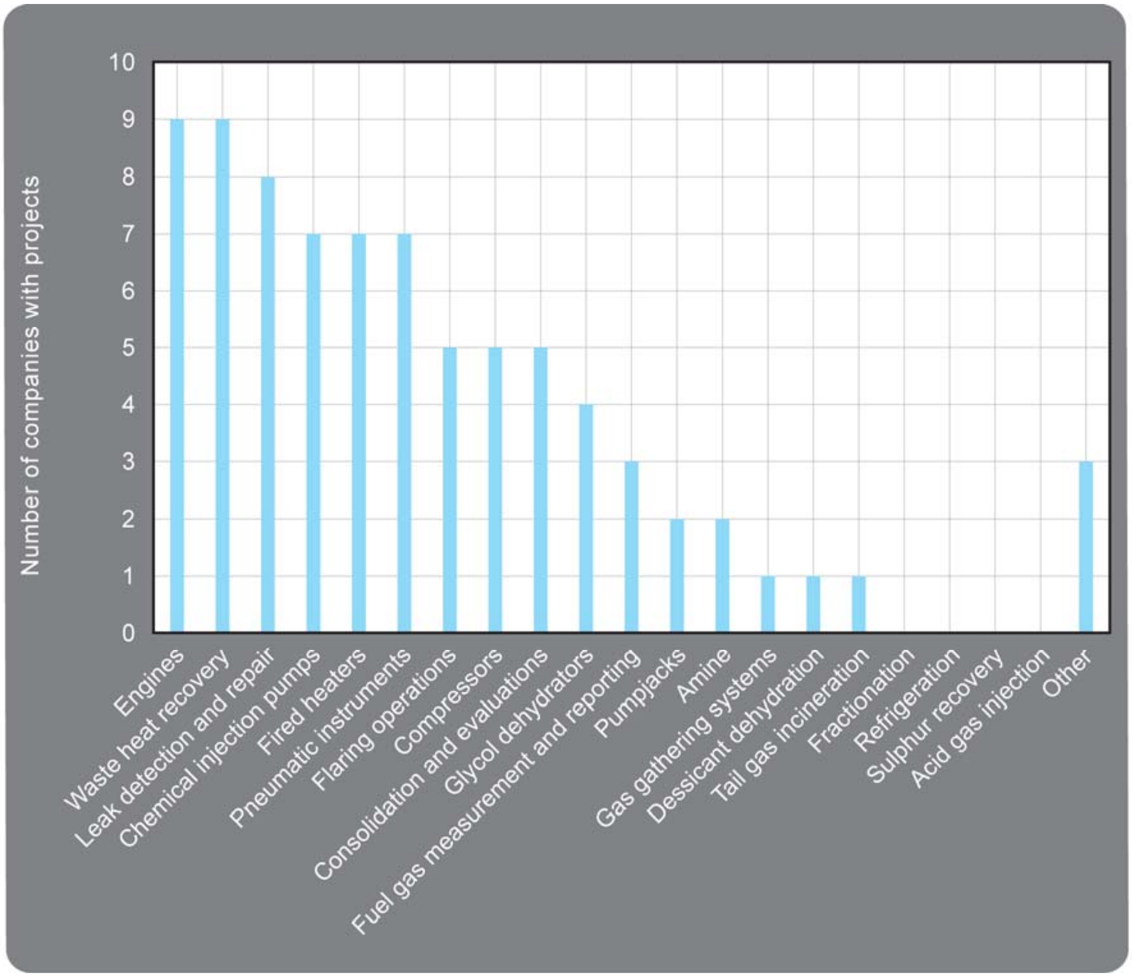


Figure 26. Companies indicating future fuel gas efficiency projects for 2011

Figure 27 provides a breakdown of the investment dollars by type of project. One consolidation project and one compressor project together represent most of the investment dollars. These two projects amount to $37 million.

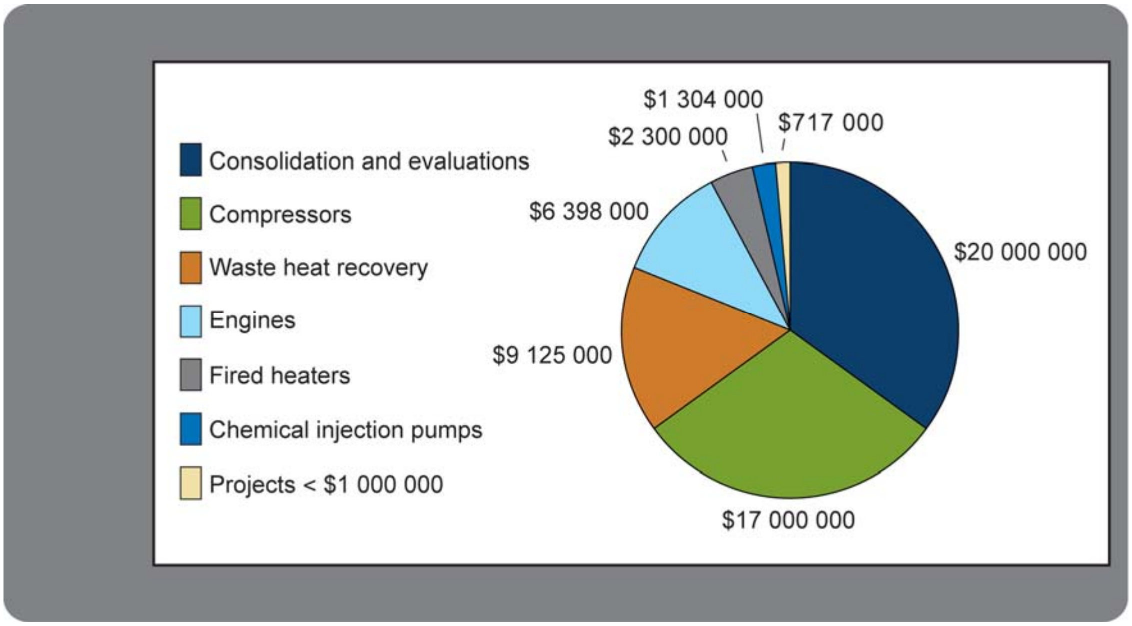


Figure 27. Capital investment in future projects, 2011

Companies submitted fuel gas savings that represent a total fuel gas saving of about 195 10^3 m^3/d (7000 mcfd). As shown in **Figure 28,** for 2011, the largest fuel gas savings are in consolidation and evaluations (note this was data submitted for one project by one company) followed by waste heat recovery.

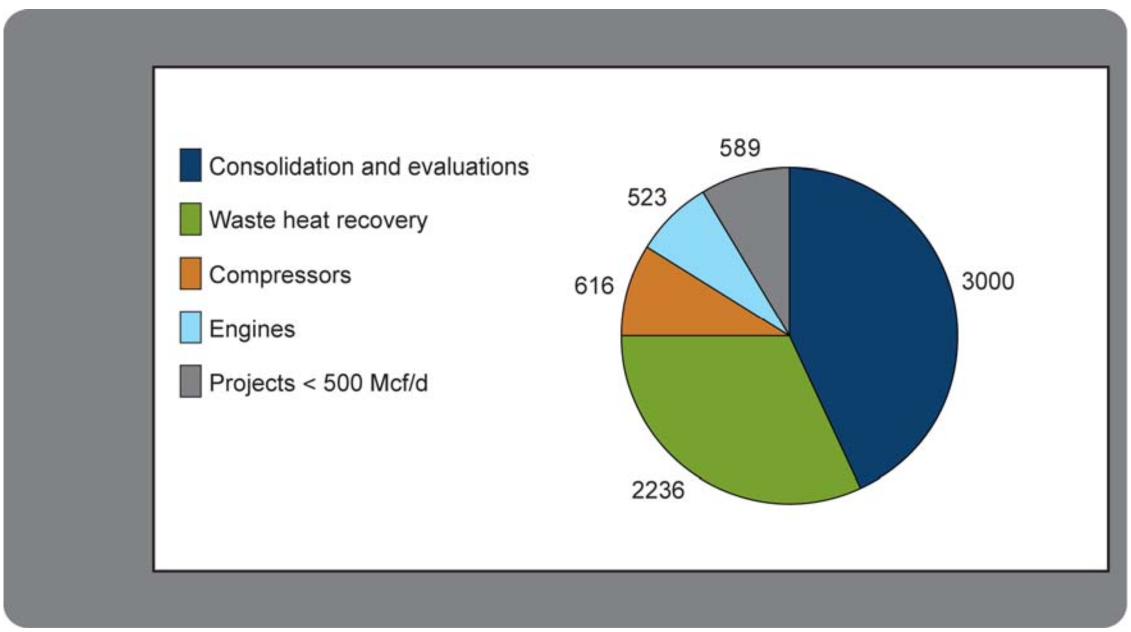


Figure 28. Project fuel gas savings, 2011

A more detailed breakdown of the future projects is in **Table 10.**

Table 10. Future projects with fuel gas savings

Project type	Capital investment ($)	Number of companies reporting	Fuel gas saved (10^3 m^3/d)	Fuel gas saved (mcfd)	Number of companies reporting
Consolidation and evaluations	20 000 000	1	84.5	3000	1
Compressors	17 000 000	1	17.2	616	1
Waste heat recovery	9 125 000	3	62.5	2236	4
Engines	6 398 000	4	14.6	523	4
Fired heaters	2 300 000	3	8.1	288	2
Chemical injection pumps	1 304 000	1	5.2	185	2
Fuel gas measurement and reporting	500 000	1		0	0
Pneumatic instruments	111 000	2	0.9	31	2
Other	106 000	2	2.4	85	2
Gas gathering systems	-	0		0	0
Pump jacks	-	0		0	0
Glycol dehydrators	-	0		0	0
Desiccant dehydration	-	0		0	0
Fractionation	-	0		0	0
Refrigeration	-	0		0	0
Amine	-	0		0	0
Sulphur recovery	-	0		0	0
Tail gas incinerators	-	0		0	0
Acid gas injection	-	0		0	0
Leak detection and repair	-	0		0	0
Total	56 844 000	18	195.0	6964	18

2.9 Company Programs to Encourage Fuel Gas Efficiency

Table 11 lists company programs or processes that were reported as contributing to fuel gas efficiency projects.

Most companies reported that they have tracking systems in place to monitor monthly fuel gas, flared gas, vent gas, and emissions numbers.

Many companies reported that they encourage field staff to submit ideas for improving operations and efficiencies. Of the responses, 11 out of 17 (or 65 per cent) indicated that they had a dedicated fuel gas efficiency resource/team within the company, compared with 9 out of 15 (or 60 per cent) reporting this in the previous survey.

Companies reported incentive fuel gas programs that included an employee energy efficiency rebate program, a greenhouse gas working group, partnership with government on technology development, and company award programs.

Table 11. Components of company fuel gas efficiency programs

	Number of responses
Development of monthly fuel, flare, vent gas, and emission tracking systems	14
Encouraging field staff to submit environmental, safety, and efficiency ideas for improving operations	12
Dedicated fuel gas efficiency resource/team	11
Formal fuel gas efficiency programs as part of corporate initiatives	10
Internal staff training	7
Funding for clean energy technologies	7
Internal newsletter publications that recognize and share fuel gas efficiency lessons learned and successes	7
Corporate sustainable development commitments	6
Energy intensity fuel gas reduction scorecard/benchmark	5
Energy efficiency budget numbers provided to operational areas for planning purposes	4
Corporate climate change action plan	4
Other	8

2.10 Best Management Practices Awareness and Use

The survey also asked companies about their knowledge, usefulness, and application of each of the fuel gas efficiency BMPs.

Table 12 summarizes the responses to questions about whether companies were aware of the BMP, had evaluated the BMP, had found the BMP useful, and were using the BMP as a resource. All 17 companies that responded to the survey answered these questions for each of the 17 BMPs.

Only one company (which is not a CAPP member) reported being unaware of the BMPs. Some of the BMPs did not apply to the midstream companies that were surveyed.

Table 12. Best management practices

		Company aware	Company evaluated	Company found useful	Company used as resource
1)	Efficient use of fuel gas in gas gathering systems	16	3	4	6
2)	Efficient use of fuel gas in pump jacks	15	4	5	6
3)	Efficient use of fuel gas in pneumatic instruments	16	4	8	9
4)	Efficient use of fuel gas in flaring operations	16	2	4	6
5)	Efficient use of fuel gas in chemical injection pumps	15	4	5	7
6)	Efficient use of fuel gas in fired heaters	15	2	6	6
7)	Efficient use of fuel gas in engines	16	5	7	9
8)	Efficient use of fuel gas in compressors	16	3	6	8
9)	Efficient use of fuel gas in glycol dehydrators	15	4	8	8
10)	Efficient use of fuel gas in desiccant dehydration	15	2	4	5
11)	Fuel gas measurement and reporting	15	3	5	5
12)	Efficient use of fuel gas in fractionation	15	2	3	4
13)	Efficient use of fuel gas in refrigeration	15	3	4	6

		Company aware	Company evaluated	Company found useful	Company used as resource
14)	Efficient use of fuel in amine plants	15	3	5	7
15)	Efficient use of fuel gas in sulphur recovery units	16	3	4	5
16)	Efficient use of fuel gas in tail gas incinerators	16	2	3	4
17)	Efficient use of fuel gas in acid gas injection	15	2	4	3

The percentage of companies that reported knowledge and use of the BMPs is shown graphically in **Figure 29**.

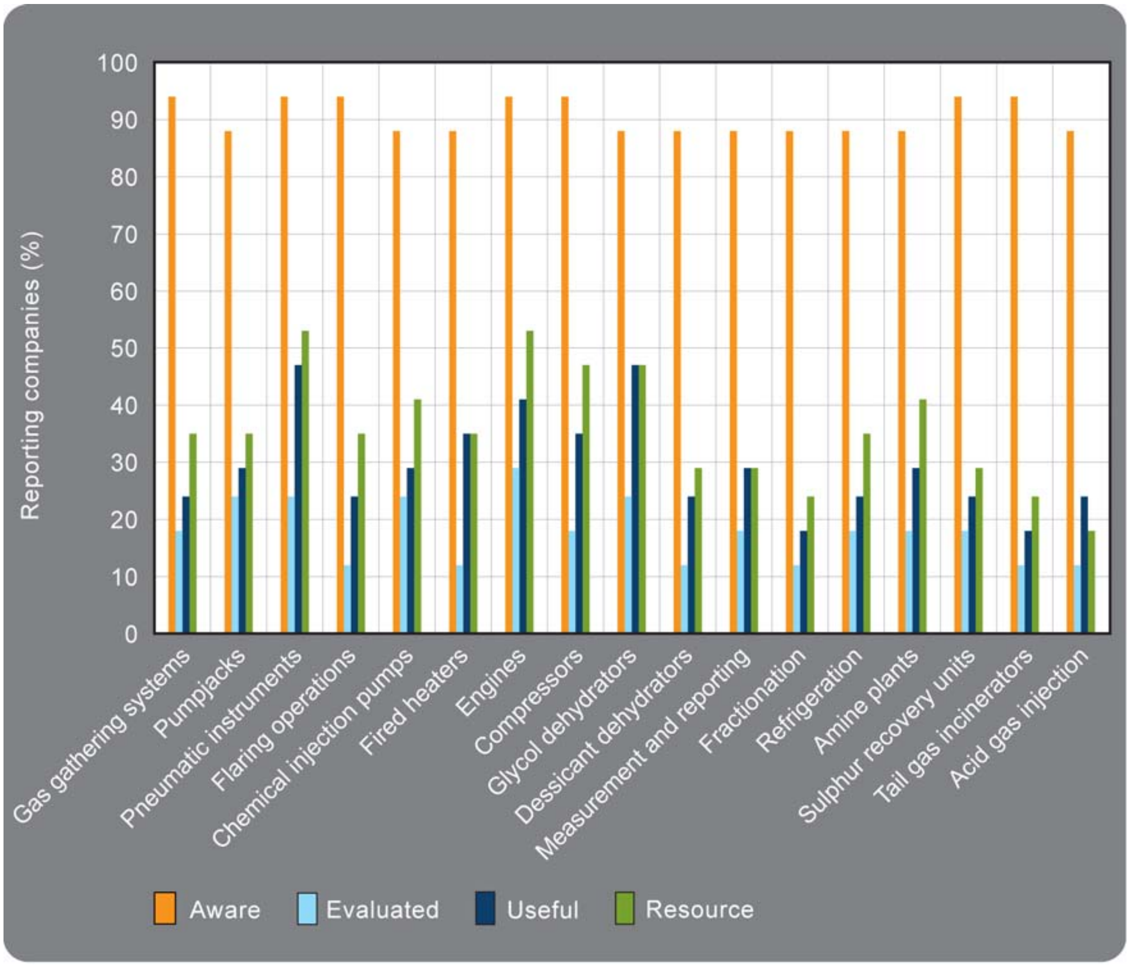


Figure 29. Summary of BMP knowledge and use

In the survey, we asked companies to comments on each of the BMPs. About one third of the companies chose to provide comments. Several companies repeated similar comments on each of the BMPs.

The following are some general comments on the BMPs:

- For many of the BMPs, more specific recommendations that will lead to increased fuel efficiency are needed.

- One company suggested that it have in-house operations, facility, and design staff and expertise, and a global knowledge-sharing network. As a result, energy efficiency projects and activities are undertaken by internal staff or through industry networks, and the BMPs are less useful for them.

- One company said that every year it targets the biggest fuel gas efficiency opportunity for each field district and uses the relevant BMP modules as a resource for achieving targets that are set.

2.11 What Areas Should New BMPs be Developed for?

Six companies provided suggestions for new BMPs or had suggestions for improving the use of the current BMPs. The following were suggestions for topics for future BMPs:

- tracking and estimating energy efficiency projects and energy use at the corporate level;

- a technical and economic evaluation that screens the various technologies and provides guidance on which have been implemented and on quantification of costs and benefits;

- waste heat recovery;

- methods for reducing vent gas (using fugitives for engine fuel, vapour recovery units, and tank venting/heating);

- identifying and quantifying GHG emissions and associated carbon credits; and

- electricity efficiency and usage.

One company suggested that an industry-led technical team could be considered to develop the BMPs further by including new developments in technology and industry knowledge.

There were suggestions that use of the current BMPs could be improved with some type of opportunity to share best ideas and examples—perhaps through a successful project database so that ideas could be shared and developed more rapidly.

2.12 CAPP's Work on Benchmarking Compression

Overview

The CAPP Fuel Gas Efficiency Benchmark ERCB/Industry committee was formed in 2008 and its membership consists of various industry members with a mandate to serve as a forum to share knowledge surrounding fuel gas efficiency initiatives. The committee believed that there was value in developing a benchmarking tool to help industry better evaluate fuel gas efficiency performance in compression systems. The objective was to create a high level tool with a benchmarking standard that takes process conditions into consideration, which would be useful in identifying areas where fuel gas efficiency could be improved. Members from the CAPP Fuel Gas Benchmarking Committee developed this tool and will be sharing results with individual companies that submitted compressor information as part of the ERCB survey.

Adiabatic Horsepower Approach

Historically, companies have used fuel intensity (fuel use as a percentage of throughput) as an efficiency measure. However, fuel intensity changes based on horsepower utilization and therefore, comparison of compression fuel gas efficiency on a fuel intensity basis alone has limitations. Determining the adiabatic horsepower and the corresponding expected fuel intensity is one such means of assessing this efficiency.

Adiabatic horsepower is defined as the amount of power required to compress gas while excluding energy lost to temperature increases or mechanical losses of the compression equipment. A comparison of this value to the actual fuel intensity provides the fuel intensity index. The fuel efficiency index can provide a high level means of identifying areas of inefficiency with respect to fuel gas usage.

Fuel Gas Efficiency Assessment Tool

The purpose of the tool is to serve as a high-level means for industry to evaluate compressor inventory using a theoretical adiabatic baseline. The tool allows the operator to identify areas where fuel gas efficiency may be an issue and where efficiency optimization efforts should be focused. It is not a direct assessment of fuel gas efficiency. A full evaluation of fuel gas efficiency would require an in-depth analysis of each compressor.

Industry data was requested (pressure, flow, throughput, fuel consumption, horsepower rating, etc.) to assist with understanding the range of fuel efficiency index values and to evaluate the theoretical fuel intensity tool.

A CAPP publication, entitled *Fuel Gas Efficiency: Adiabatic Horsepower Approach to Compressor Fuel Efficiency*, has been published. This document outlines the summary of results, the theory behind the adiabatic horsepower approach, and the methodology for using the tool. A template is part of this document and can be used by an operator to input its compressor data and rate its fuel gas intensity using the adiabatic horsepower approach.

Companies that have submitted compressor data to the ERCB as Part 2 of the fuel gas survey will be provided a copy of this template populated with its data. It should be noted that the templates provided to each company that submitted data will only include that company’s data. The full cross-industry data set will not be provided in raw data format. Only the average values will be supplied.

3 Conclusions

Fuel gas use in the upstream oil and gas industry is considerable (approximately 27 million m^3/d, or just under 1 bcfd) and represents a significant opportunity for companies in terms of both improvement in efficiencies and savings. Fuel gas is required by the oil and gas industry for gathering, processing, and transportation, and it currently represents about 7 per cent of total raw gas production.

In the last eight years (2003-2010), fuel gas use per unit of production has continued to increase. This trend is expected to continue as the basin matures and gas production declines. The decline in gas production contributes to lower facility utilization rates and operating pressures. This contributes to higher energy costs to move gas to markets. As gas production declines, we expect opportunities for consolidations and evaluations to increase.

Natural gas prices have declined considerably from the 2008 Alberta Reference Price level of $7.47/GJ. In 2010, the price averaged approximately $3.57/GJ, and we are currently seeing even lower prices. These low prices are detrimental to fuel gas efficiency project economics.

While fuel gas intensity (fuel gas use/unit production) can be a useful measure, it is not a measure of fuel gas efficiency. Although the increased compression horsepower requirement of lower pressure gathering systems results in increased fuel intensity, it does not imply system inefficiency. Increased power for compression is required for efficient and complete production of the resource.

The ERCB surveyed the largest 20 fuel gas consumers (17 companies responded) and asked them to share their successes and challenges in reducing fuel gas use. In 2010, 11 of the top 20 companies estimated capital spending in excess of $29 million in this area, and 12 companies reported fuel gas savings of about 460 10^3 m^3/d (16 mmcfd). In 2011, companies estimated that funding of these types of projects would double due largely to one plant consolidation and one compressor project, which are projects that are driven by more than fuel gas savings. Without these two projects, future funding in 2011 is similar to 2010.

For the most part, companies evaluate fuel gas efficiency projects on the same basis as other capital investments. The leading motivators reported by companies to reduce fuel gas consumption were CO_2 regulations, lower operating costs, and increased natural gas prices.

Companies reported the largest fuel gas savings in 2010 in the areas of consolidation and evaluations, engines, and fired heaters. In 2011, companies estimated the largest savings to be in the areas of consolidation and evaluations, waste heat recovery, and compressors. For some companies, the most economic projects may have already been implemented, but changing operating conditions will provide new opportunities for future savings.

All but one company surveyed were aware of the fuel gas BMPs. All of the BMPs were being used as a resource by at least some of the companies. In general, about a third of the companies were using individual BMPs as a resource. The BMPs with the most use were ones focused on engines, pneumatics, compressors, and glycol dehydrators. Companies suggested new BMPs in the areas of tracking and estimating energy use for projects, economic screening tools, waste heat recovery, and vented fuel gas reductions.

Companies reported several factors that helped with the success of fuel gas projects, including engaging the field staff early in the process and during implementation; considering more than just fuel gas savings; improving reliability; enhancing safety; reducing emissions; optimizing production; and getting management and organization commitment. Also reported was the concept of building energy efficiency into new projects.

Appendix A Terms of Reference of Fuel Gas Efficiency Committee (November 2006)

BACKGROUND

A significant amount of fuel gas is used by the Alberta upstream oil and gas industry; in 2004, approximately 11.2 billion cubic metres of gas was used as fuel at batteries, gas gathering systems, and gas plants. Straddle plants and injection facilities use an additional 3 billion cubic metres of gas.

Site-specific studies indicate the potential to reduce fuel gas use in the upstream oil and gas industry. An initiative designed to optimize and reduce fuel gas consumption would likely have broad economic benefits. Industry participation in shaping government direction on this issue benefits all parties and provides an opportunity for industry leadership on a global scale.

MISSION STATEMENT OF FUEL GAS EFFICIENCY COMMITTEE (the Committee)

To set direction and provide leadership to improve the upstream industry's petroleum energy efficiency per unit of production through the reduction of fuel gas use in oil and gas production, pipeline, and gas processing facilities regulated by the EUB.

PURPOSE AND AUTHORITY

The purpose of the Committee is to:

- identify strategies,
- suggest development of appropriate policies and requirements,
- develop tools for industry, and
- share findings with industry and government to facilitate fuel gas efficiencies in upstream oil and gas processing.

The Committee will make consensus based recommendations to the provincial regulators.

SCOPE

The scope of the Committee work will include:

- development of industry Best Management Practices including, but not limited to; tools to maximize efficient use of fuel, efficiency targets and/or benchmarks, and; case studies of success stories.
- gathering of industry information to better understand where and how much fuel gas is being used and examining whether current fuel gas information collected is sufficient.
- sharing of fuel gas efficiency findings and information with government and industry to help promote change.
- recommending policy or regulation changes, as required.

OUT OF SCOPE

The scope of the committee's work will not include review of fuel gas efficiency opportunities at:

- oilsand facilities
- injection facilities
- and other facilities which, for the most part, purchase their fuel gas.

RESPONSIBILITIES

Responsibilities of the Chair

The Chair, from Alberta Energy, will:

- present the expectations of government
- help ensure the Committee remains on topic with their discussions.
- poll agreement when necessary.
- participate in meetings as a Committee member.

Responsibilities of the Vice-Chair

The Vice-Chair, from Industry, will:

- take on the role and responsibilities of the Chair when the Chair himself is unable to attend Committee or other meetings.
- ensure the Chair is updated and advised of any actions or decisions, as necessary.

Responsibilities of Committee Members

The Committee Member's responsibilities include:

- being informed about issues relating to fuel gas efficiencies.
- sharing this information through attendance at Committee meetings and participation in other related activities as required.
- actively participating in and attending Committee meetings while listening to and respecting the opinions of their co-Committee members.
- reading the minutes and reviewing other materials provided.
- representing the interests and concerns of their organizations.
- establishing sub-groups, as required, to address specific needs or requirements of the Committee.
- sharing the Committee's information, outcomes and findings on fuel gas efficiencies with their own organizations and the public, as and when appropriate.

Responsibilities of the Secretary

The Secretary, from Alberta Energy, will

- coordinate and book meetings for the Committee.
- take notes during meetings, prepare minutes and agendas ensuring these and any other supporting documentation are distributed to Committee members in a timely manner.
- participate in meetings as a Committee member.

CONFIDENTIALITY

All documents prepared for the Committee are solely for the use of the Committee. Documents will be publicly released after the Committee's approval is given, unless otherwise specified.

All documents will be subject to access and privacy provisions of the *Freedom of Information & Protection of Privacy Act.*

STRUCTURE AND REPORTING OF THE COMMITTEE

Representation from the provincial government will include Committee members from the Department of Energy and the Alberta Energy & Utilities Board, totally approximately nine members.

The balance of the Committee will be composed of non-government stakeholders, totaling approximately nine members.

TIMEFRAME

The Committee will complete work on the Best Management Practices in the 2007/08 fiscal period at which point they will revisit expected timelines and deliverables.

The Committee will complete all other work by the end of the 2007/08 fiscal period.

DISCUSSION PROCESS

Open and supportive participation is essential to the success of the Committee and its objectives. Committee members will be asked to actively participate in discussions, sharing ideas while also respecting the position of other co-workers. Committee members will work towards consensus where possible. If consensus cannot be reached these items will be captured and explained in meeting minutes.

MEETINGS

Meetings will be scheduled as required, usually once per month.

Appendix B Fuel Gas Use By Upstream Activity

B1 Gas Processing Plants

B1.1 Gas Processing Plant Fuel Gas Use

Figure 30 shows the monthly and annual fuel gas use for gas processing plants compared to monthly and annual gas plant receipts.

Gas plant fuel use held fairly flat from early 2003 until late 2006, and declined thereafter. Monthly gas plant receipts also held fairly flat over this time period and then went on decline. There is a strong correlation between fuel gas use by processing gas plants and gas plant receipts.

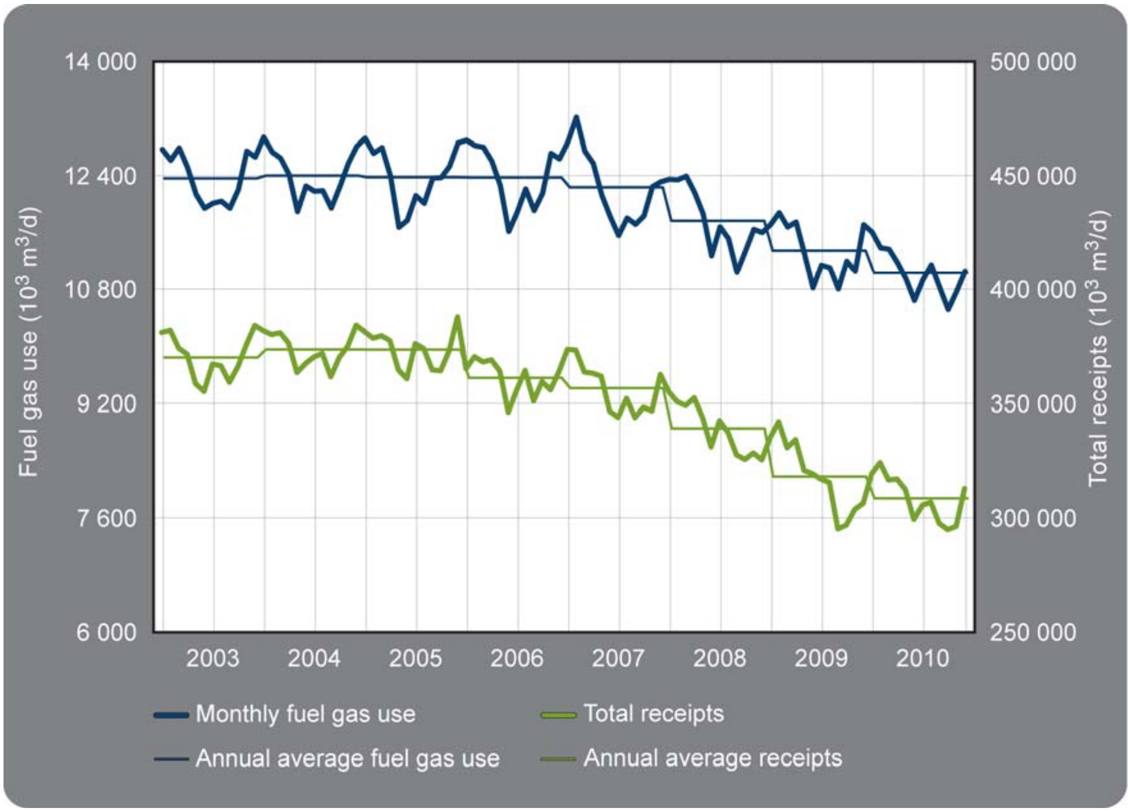


Figure 30. Gas plant fuel gas use and total gas processing plant receipts

B1.2 Gas Processing Plant Fuel Gas Use as Percentage of Plant Receipts

Another way of looking at the data in **Figure 30** is to examine fuel gas use as a percentage of gas plant receipts. **Figure 31** shows the percentage of gas plant fuel gas use to gas plant receipts on a monthly and annual basis.

Fuel gas use to receipts over time period remains at 3.5 per cent over the historical time period, indicating a strong relationship between fuel use at gas plants and gas plant receipts. This suggests that the trend of declining gas plant receipts has not significantly impacted fuel gas consumption per unit of receipts.

The annual average data from 2003 to 2005 was virtually unchanged from year to year. Increases have occurred each year since then illustrating that plants are more fuel efficient when they are processing a higher volume of receipts.

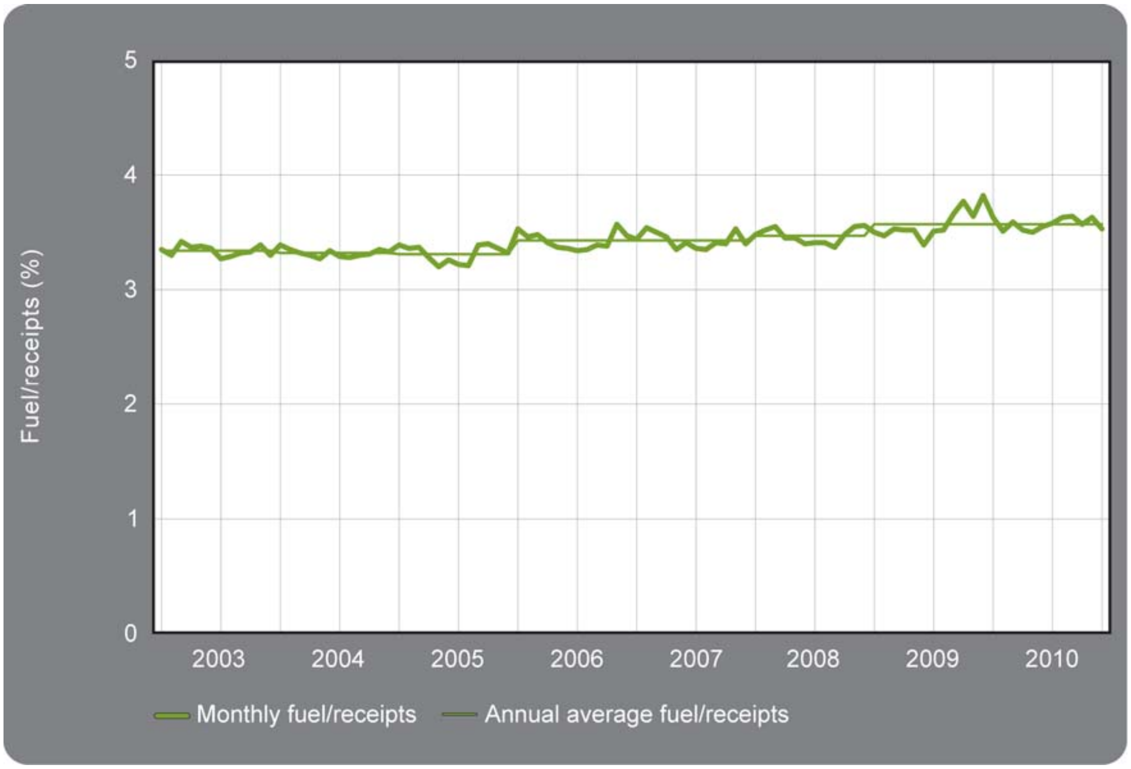


Figure 31. Gas plant fuel gas use as percentage of total receipts

Figure 32 shows 2010 gas plant fuel gas use, gas plant receipts and the ratio of fuel gas use to gas plant receipts, by the on-stream date of plants (aggregated into 10 year time periods). About 54 per cent of the raw gas inlet volume being processed in 2010 was by plants that came on stream prior to 1981.

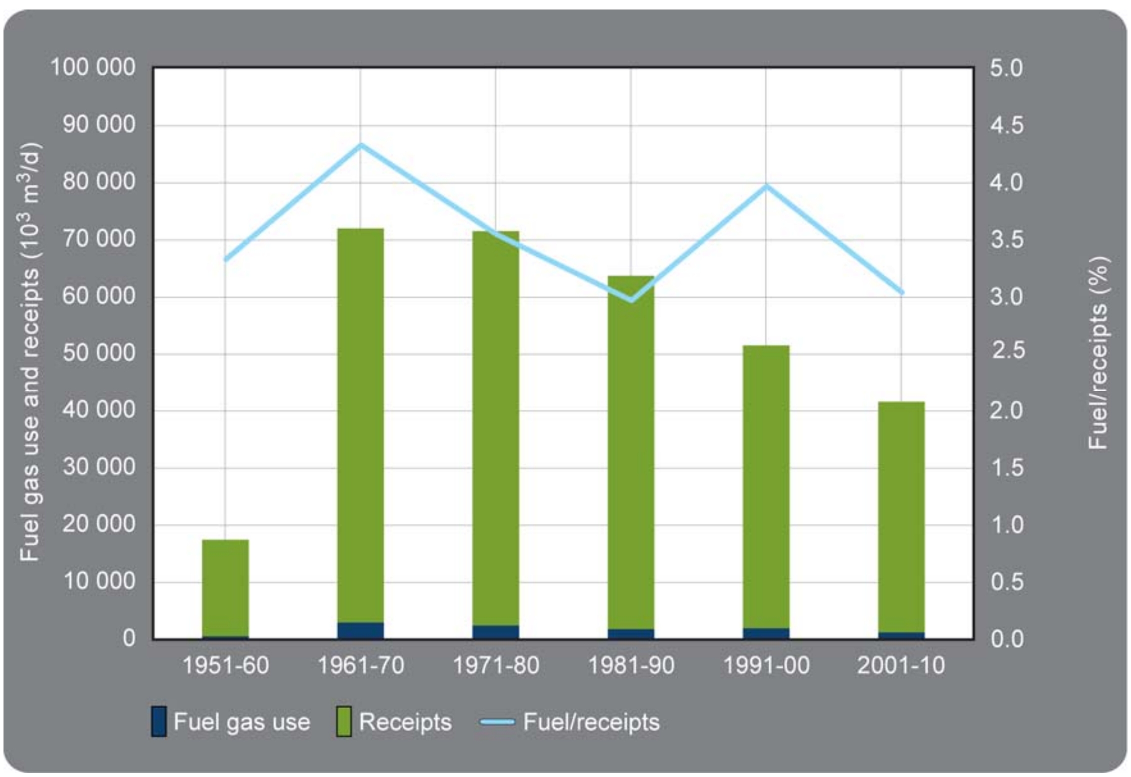


Figure 32. 2010 Gas plant fuel gas use by on-stream year, 2010

B1.3 Gas Plant Utilization Rate

The utilization rate of gas processing pants can impact the fuel gas usage and efficiency. In many cases, gas plants have been sized for maximum production; as throughput declines, the efficiency of the plant generally decreases.

As the data in **Figure 33** illustrates, the gas plant utilization rate was 13 per cent lower in 2010 than in 1998. In 2010, the gas plant utilization rate was roughly 33 per cent compared to 46 per cent in 1998.

Given the declining gas plant utilization rate, there is value in examining opportunities for plant rationalizations and consolidations and using tools such as *JP-05: A Recommended Practice for the Derivation of Processing Fees* to help share processing facilities. With government encouragement, industry developed the *JP-05* tool to improve the process of negotiation of processing fees by providing guidelines on a number of factors affecting processing fees, recognizing a range of potential considerations and outcomes. Industry representatives on the taskforce that developed the report included membership from CAPP, GPAC, Petroleum Joint Ventures Association (PJVA), and SEPAC. The report is available on the ERCB website www.ercb.ca.

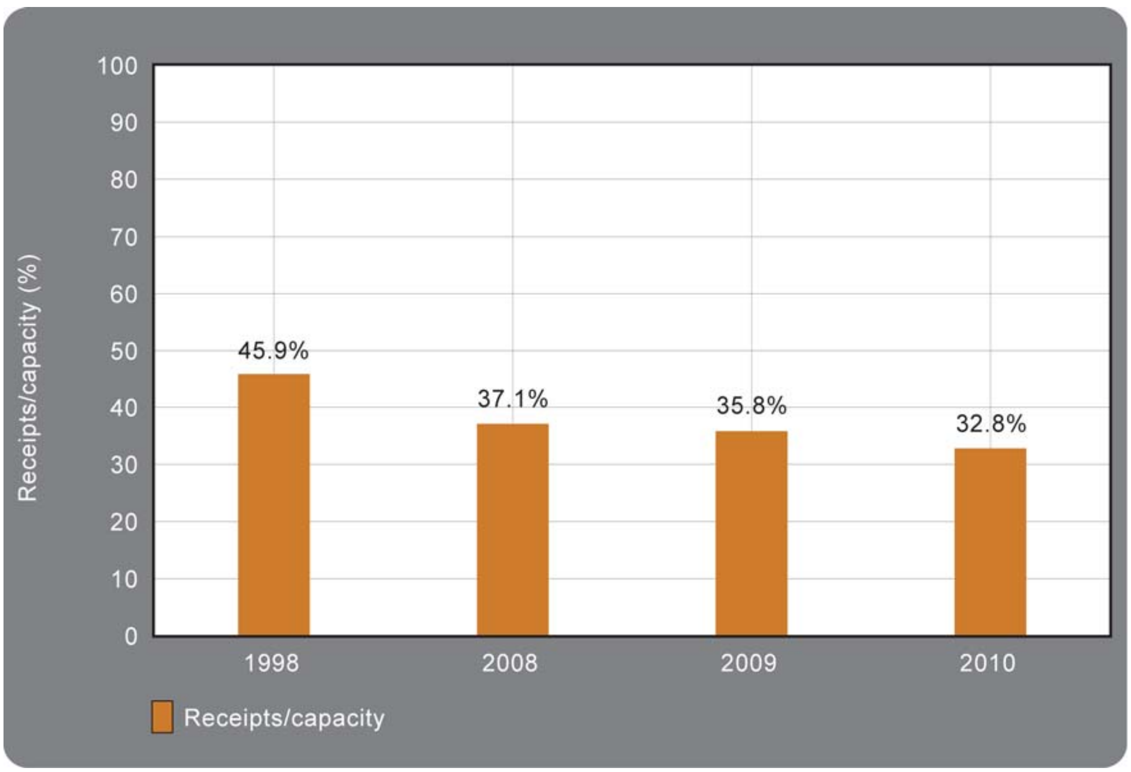


Figure 33. Gas plant utilization rates

B1.4 Fuel Gas Use by Type of Gas Processing Plant

Figure 34 shows a breakdown of fuel use by gas processing plant type. In 2010, sulphur recovery gas plants consumed 41 per cent of total gas plant fuel. Sweet gas plants, acid gas injection (AGI) plants, and acid gas flaring (AGF) plants consumed 36 per cent, 10 per cent and 13 per cent respectively. These percentages are similar for 2008 and 2009 data. Sulphur recovery gas plants use more fuel than sweet gas plants in part because of the heat requirements on the amine system and incinerator.

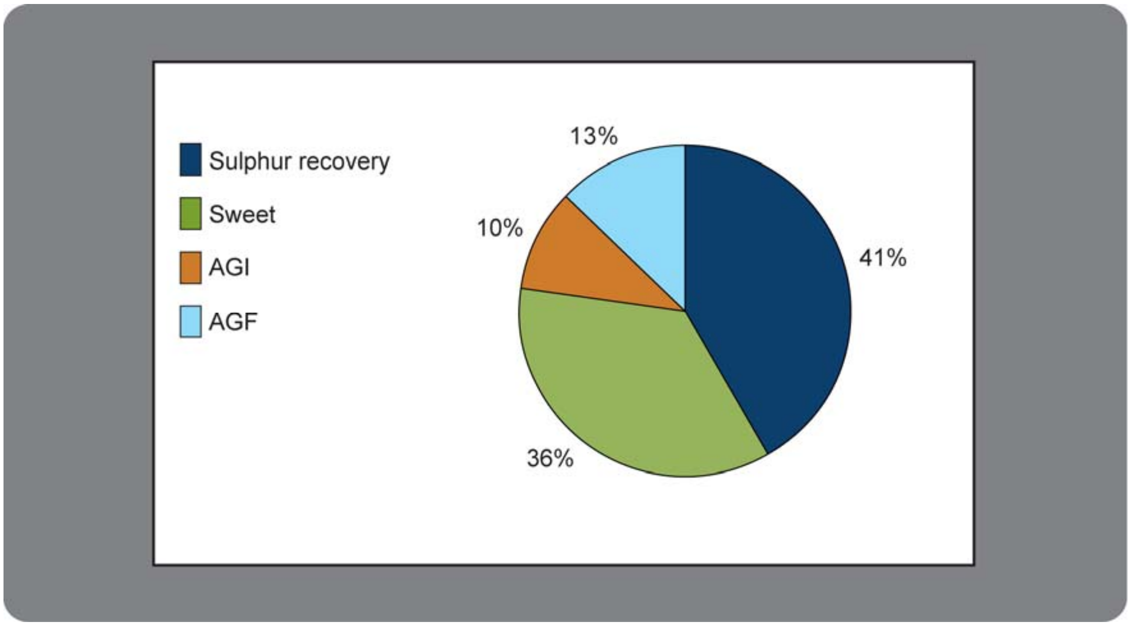


Figure 34. Fuel gas use by type of plant, 2010

B1.5 Fuel Gas Use by Individual Gas Plant

Figure 35 summarizes 2010 data for individual gas plants by fuel gas use /receipts, total annual gas receipts, and cumulative fuel gas use. Each bar on the chart represents a crude measure of fuel efficiency for 2010 (i.e., fuel gas divided by gas plant receipts). Cumulative fuel gas use has then been charted on the right-hand y axis along with the 2010 gas receipts.

The figure shows all operating gas plants (over 600) in 2010, sorted from the largest throughput plant on the left of the chart, to the smallest throughput plant on the right. There is considerable variation in fuel gas usage among plants, and on first look one may question the value of comparing what are clearly different gas plants. The variability can be explained by a number of reasons, including the option for plants to use electric vs. gas compression, the operating conditions of high inlet pressure vs. low inlet pressure, and sweet vs. sour equipment at the plant.

That being said, there still can be value in looking at provincial data in this manner and examining the individual gas plant fuel use. A trend that can be seen is the tendency for larger plants to operate more efficiently (less fuel per receipt) than smaller plants.

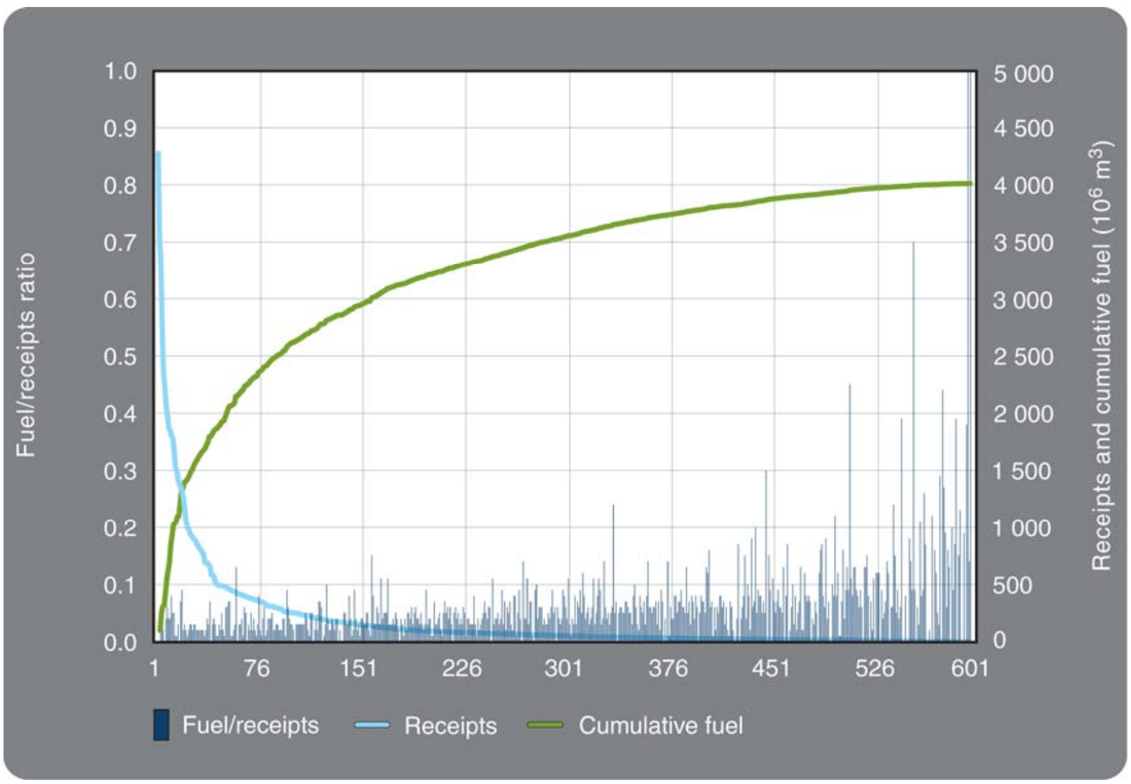


Figure 35. Fuel gas use by individual gas plant, 2010

B1.6 Sulphur Recovery Plant Fuel Gas Use/Receipts

Figure 36 shows the ratio of fuel gas use to gas plant receipts for sulphur recovery plants in 2010.

The 39 operating sulphur recovery plants account for 6 per cent of the total number of gas plants in the province, but they consume about 42 per cent of the total fuel used at gas plants.

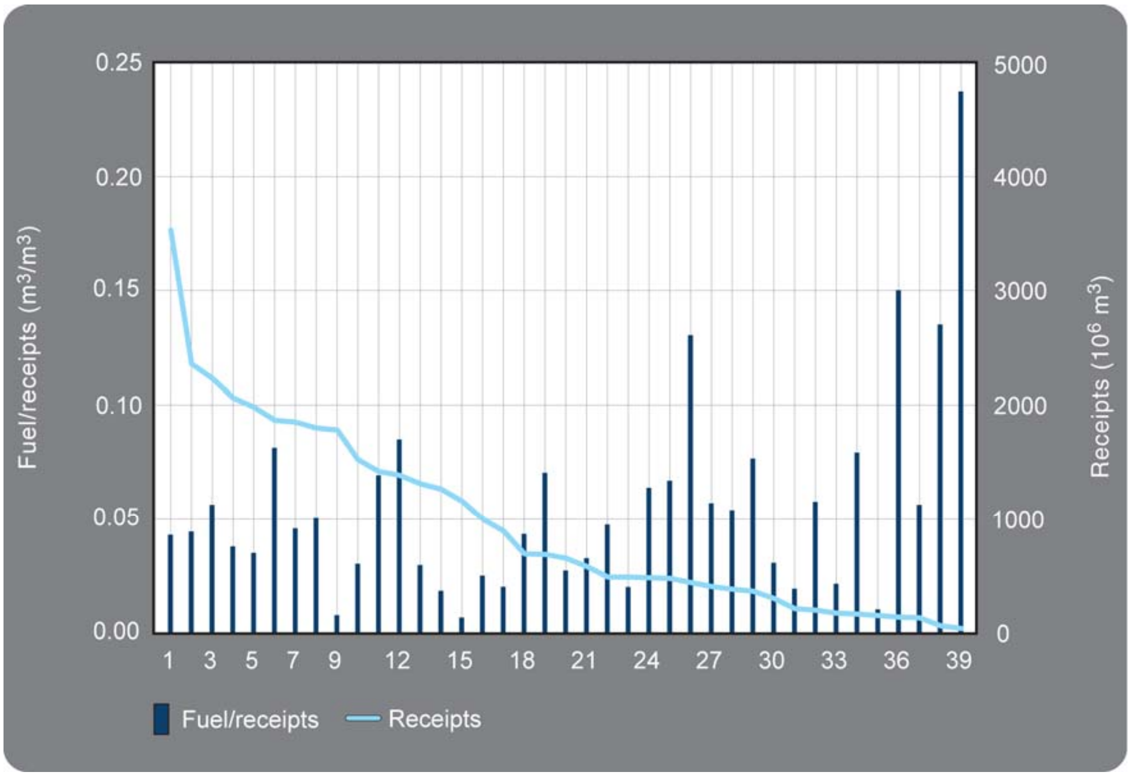


Figure 36. Sulphur recovery plant fuel gas use/receipts, 2010

Operators of sulphur recovery plants in Alberta with high fuel use are actively working to reduce fuel gas usage. Improvements in plant design, waste heat recovery, plant consolidation, and improved processes to reach agreement on projects with third-party producers. This analysis supports the value of examining individual operations and comparing them to similar-sized facilities.

B2 Gas Gathering Systems

B2.1 Gas Gathering System Fuel Gas Use

Figure 37 compares fuel gas use for gas gathering systems to raw gas production. Fuel gas use in gas gathering systems has generally tracked raw gas production. However, the rate of raw gas production decline that began in 2007 has been more severe than the decline in fuel use year over year. This is likely due to equipment continuing to operate at lower throughput volumes.

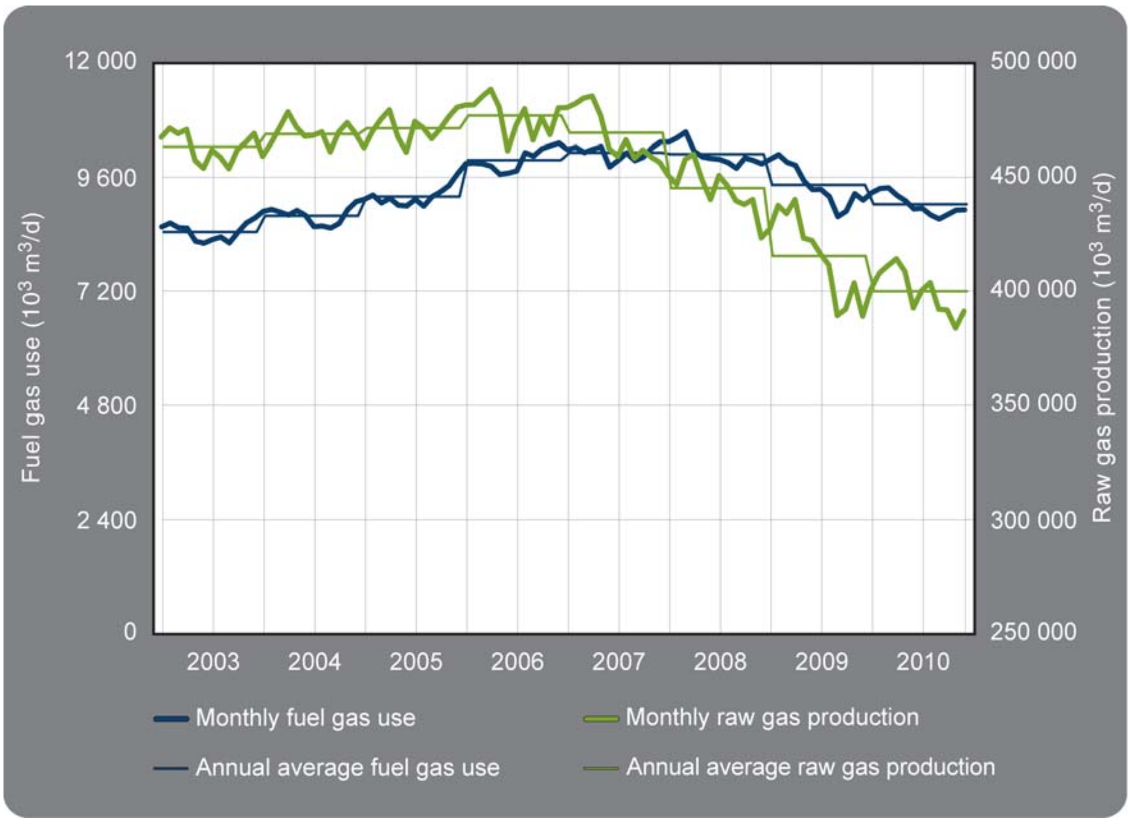


Figure 37. Gas gathering system fuel gas use and raw gas production

B2.2 Gas Gathering System Fuel Gas Use as a Percentage of Production

The percentage of gas gathering system fuel gas use to raw gas production is shown in **Figure 38**, plotted on a monthly and annual average basis. The percentage has increased from an average of 1.8 per cent in 2003 to 2.3 per cent in 2009; remaining stable in 2010. This is likely due to equipment continuing to operate at lower throughput volumes.

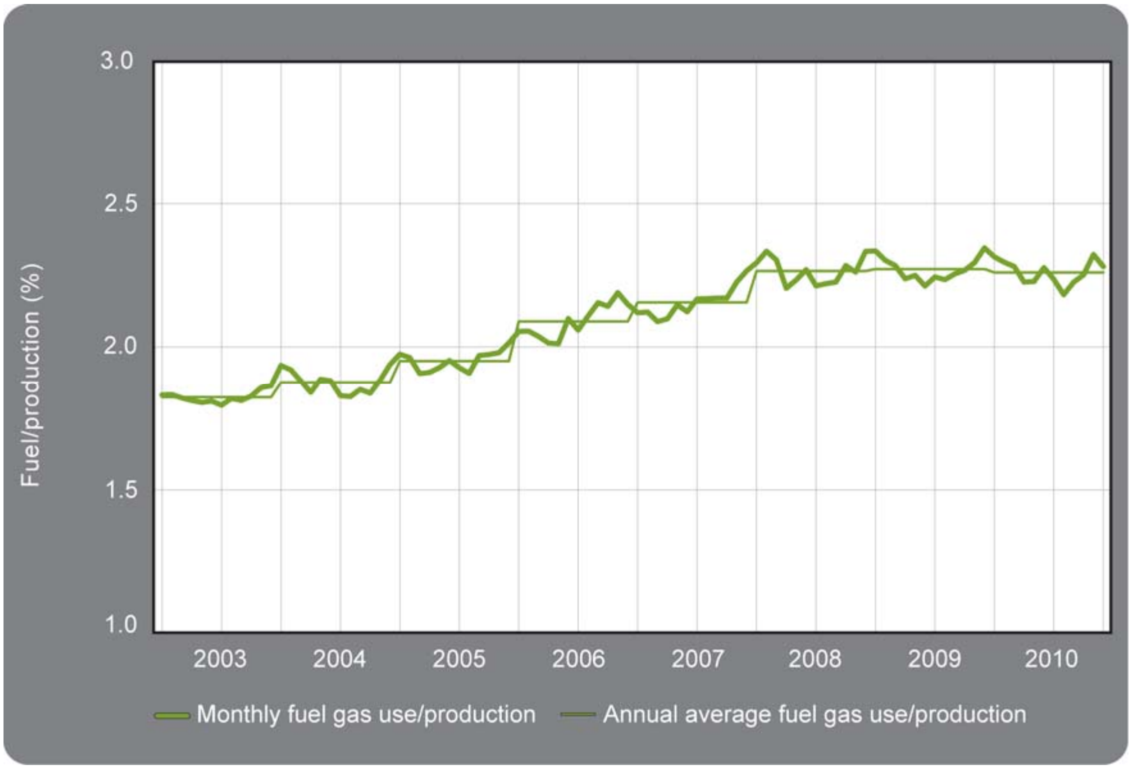


Figure 38. Gas gathering system fuel gas use as a percentage of production

B3 Fuel Use at Batteries

B3.1 Gas Battery Fuel Gas Use

In **Figure 39** illustrates gas battery fuel gas use and raw gas production. Fuel gas use year over year has been declining marginally since 2008, following the lead of raw gas production. There appears to be a delayed response, as raw gas production at batteries began its decline in 2006.

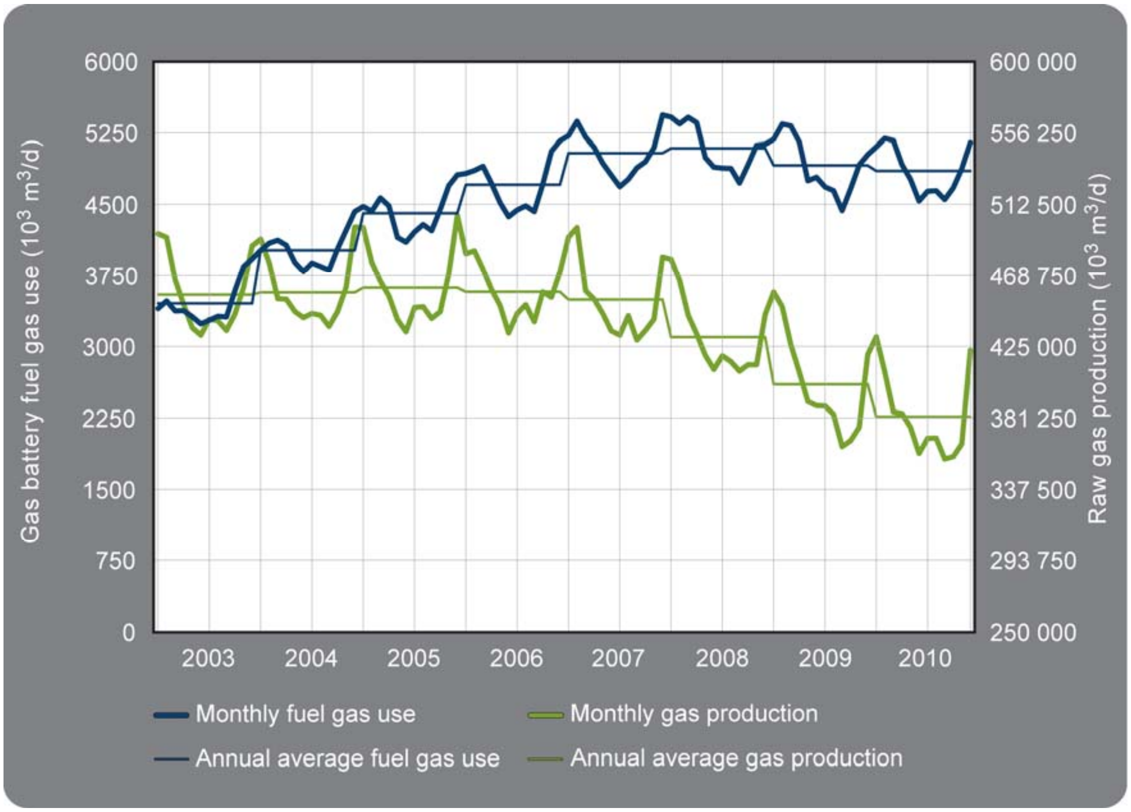


Figure 39. Gas battery fuel use and raw gas production

B3.2 Gas Battery Fuel Gas Use as a Percentage of Production

Figure 40 shows gas battery fuel gas use as a percentage of raw gas production at batteries. In 2003, gas battery fuel gas use represented 0.76 per cent of raw gas production. By 2010, gas battery fuel gas use increased to 1.27 per cent of raw gas production. Although this is a significant percentage increase over the period, it still represents a very small portion of the fuel consumed in the upstream oil and gas industry.

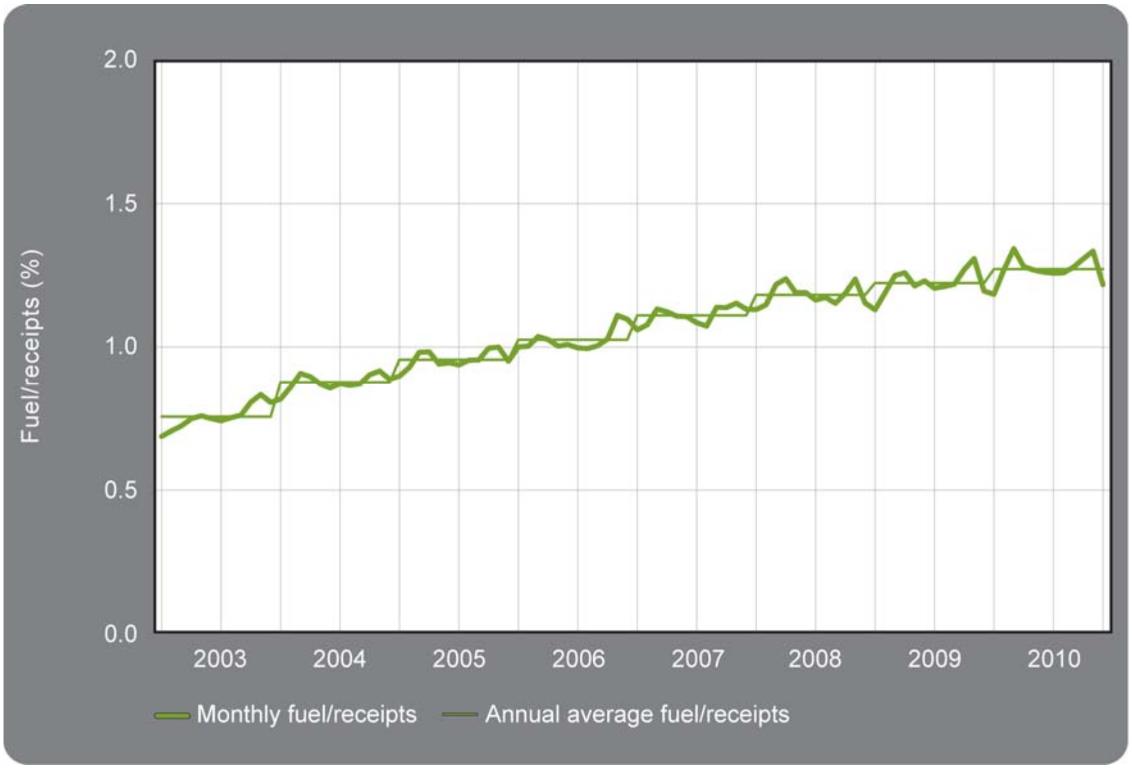


Figure 40. Gas battery fuel gas use as a percentage of raw gas production

B3.3 Oil Battery Fuel Gas Use

In **Figure 41**, oil battery fuel gas use is contrasted with conventional crude oil production. Total oil battery fuel gas use has held relatively flat over the historical period in contrast to declining oil production.

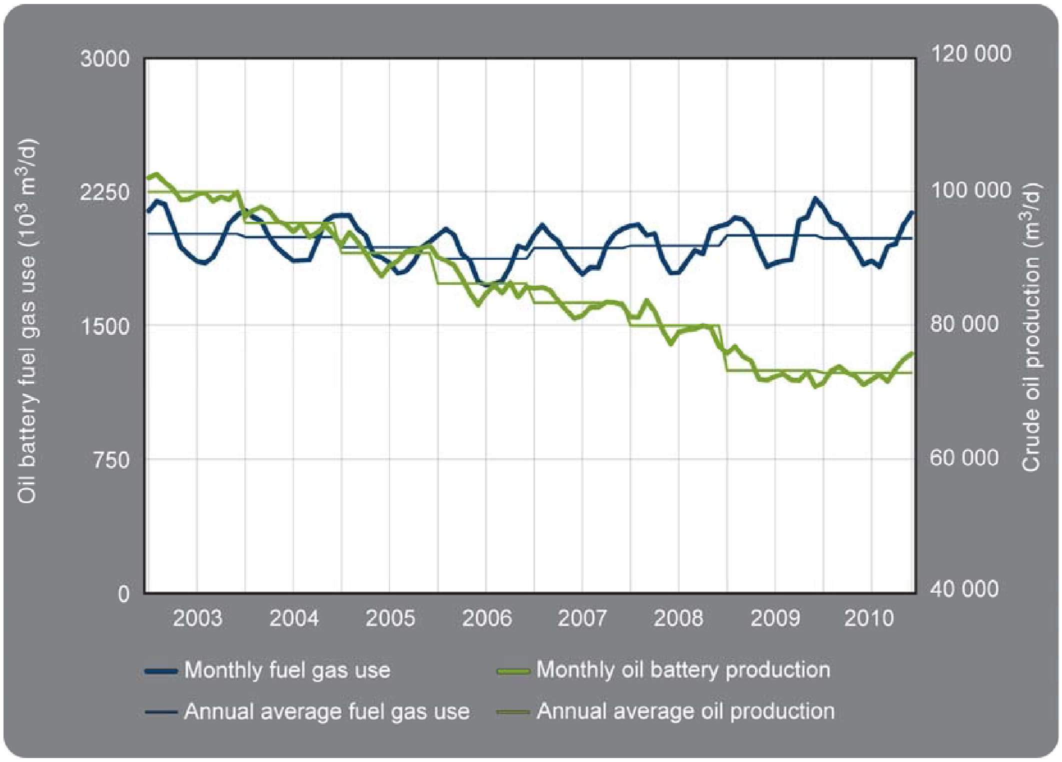


Figure 41. Oil battery fuel gas use and oil production

B3.4 Ratio of Oil Battery Fuel Gas Use to Oil Production

The ratio of oil battery fuel gas use per unit of oil production is shown in **Figure 42**. There has been a steady increase in the ratio over time; however, fuel gas at oil batteries remains the smallest segment of fuel use in the upstream gas and conventional oil industry.

Data using total combined oil and water volumes indicate the trend in fuel use has been relatively constant over this time period in a similar pattern to oil battery fuel gas use. That being said, most of the fluid handling at the batteries is likely by electric pump, and the largest fuel use is as treater fuel. Given this, the relationship between oil production and fuel gas use is likely a better indicator of fuel efficiency.

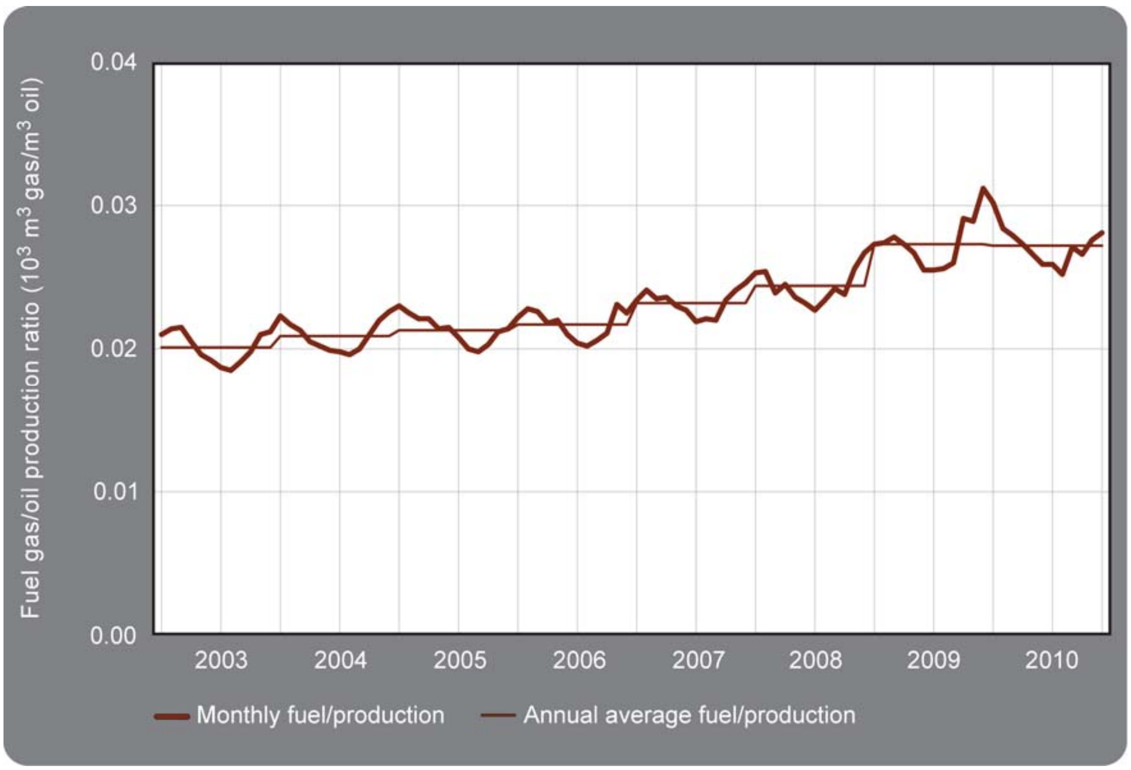


Figure 42. Ratio of oil battery fuel gas use to oil production

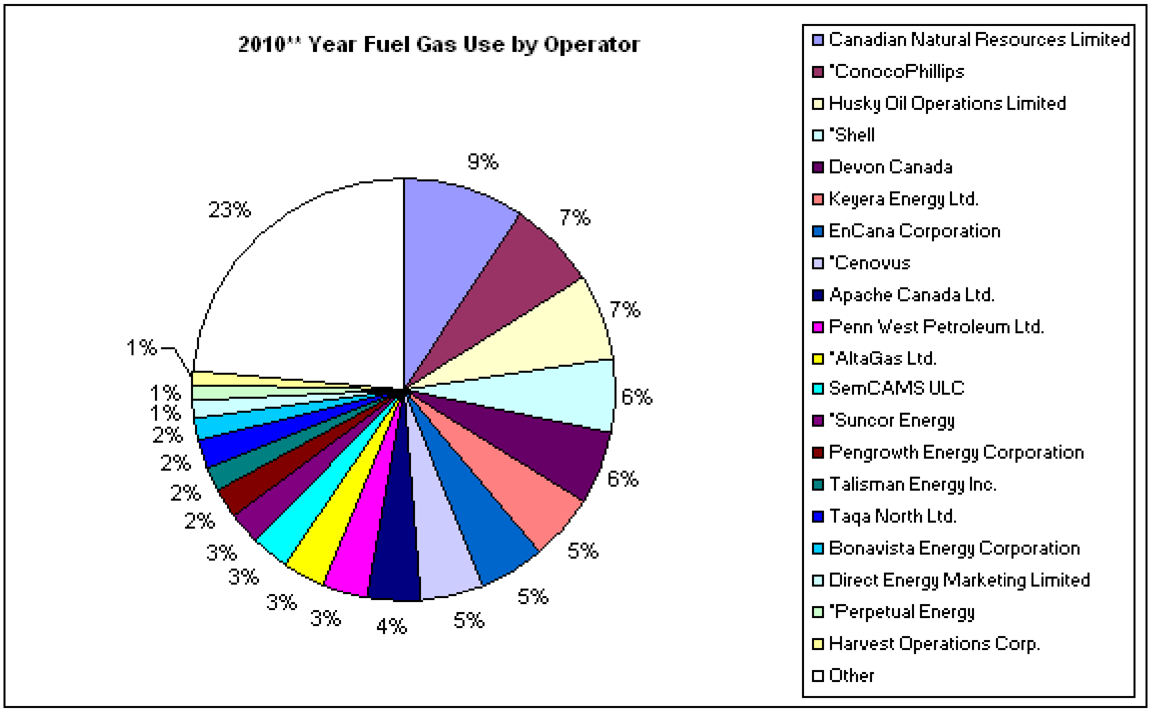
Appendix C ERCB Survey of Top 20 Fuel Gas Consumers in Alberta

Background

The Energy Resources Conservation Board (ERCB) will be surveying the top operators responsible for 77% of the fuel gas consumed in the upstream oil and gas industry in Alberta. The top 20 companies will be asked to share how they were making decisions on fuel gas efficiency projects. Some of the criteria are the project successes and challenges they were having with respect to improving gas efficiency and reducing fuel gas usage.

The intent of this survey is for the ERCB to collect and share this information with industry and other interested parties.

NOTE: Respondents can go back to previous pages in the survey and update existing responses until the survey is finished. Only one respondent per operator.



* Reflects multiple licensee with the same parent name.
** Calendar Year

Information is Mandatory

Contact Information

Company Name:

Company Contact:

E-Mail Address:

Phone Number:

Question #1: Fuel Gas Use Estimation

Please Approximate Your 2010 Fuel Gas Use By Category (%):

(Use your gross operating fuel gas for the facility)

Compressors and Engines, Turbines, Generators:

Boilers, Heaters, Furnaces:

Fuel to Flare and Incinerator:

Fuel Venting (Purge, Glycol Dehydrators, Pneumatic Equipment, etc.):

Other (specify):

Please Comment on the Information Provided and Explain any Events that Have Caused a Major Change in Fuel Consumption Increase/Decrease from 2009 - 2010

Question #2: Decision Criteria

Please Provide Decision Criteria Information for 2010 Fuel Efficiency Projects:

Decision Criteria for Fuel Efficiency Projects: ROR (%) - Before Taxes

Payback Period (Yrs):

$/mcfd Saved (Assumes No Credit for CO2 Saved):

Do You Consider Greenhouse Gas (GHG) Emission Reductions? (Yes/No)

Do You Include the Cost of Carbon in Your Economics? (Yes/No)

Please Provide Comments on Your Decision Criteria:

Question #3: Fuel Gas Reduction Projects

For your company's Alberta operations, provide the volume of fuel gas saved and plans for investment in fuel gas reduction projects for 2011. Note that the volume of fuel gas saved could include "zero-cost" projects that improved fuel efficiency (e.g. improved operating practices) or could include projects that were not fuel gas specific, but which increased fuel efficiency (e.g. as facility consolidation).

Please Provide Information on Fuel Gas Reduction Projects:

Total Fuel Gas Project Investment 2010 (Millions $)

Total Fuel Gas Project Investment Planned for 2011 (Millions $)

Mcfd Saved in 2010 (Assume No Credit for CO_2 Saved):

Please Provide Any Comments:

Question #4: Fuel Gas Use Trends

Describe your company's trend of fuel gas use in its Alberta Operations over the past 3 years (2008-2010). How does the fuel gas consumption trend correlate to the gross production/throughput trend? What are the principal factors that contributed to this trend, including mergers and acquisitions etc.

Fuel Gas Use in the Last 3 Years:

- (●) Increased
- ( ) Decreased

Fuel Gas Use Per Unit of Production in the Last 3 Years:

- ( ) Increased
- ( ) Decreased

Please Provide Comments on Fuel Gas Trends and Why:

Question #5: Motivators to Reduce Fuel Gas Consumption and Promote Efficiencies

Example Motivators are:

- Competition
- Lower Operating Costs
- Efficiency Benefits
- Natural Gas Prices
- Government Incentives
- CO_2 Regulations
- Government Penalties

What is going to Motivate/Encourage You to Reduce Consumption or Become More Efficient?
Please List your Top 3, with Top 1 Being Most Important:

Top 1:	
Top 2:	
Top 3:	

Please Provide Additional Comments for Your Top 3 Motivators:

Question #6: Fuel Gas Efficiency Project Successes in 2010

Comment on the success of fuel gas reduction projects or initiatives that you have observed. What type of projects were implemented? Does additional opportunity exist? Provide any information that would be helpful to other companies considering fuel gas reduction projects or initiatives.

Please Select the Following Projects That Were Successful in 2010 if and Provide the Project Cost ($) and mcfd Saved:

The List of BMPs:	Yes	Project Cost ($)	mcfd Saved	Please Provide Detail
Gas Gathering Systems	✓	xxxx.x	xxxx.x	
Pump jacks				
Pneumatic Instruments				
Flaring Operations				
Chemical Injection Pumps				
Fired Heaters				
Engines				

Compressors				
Glycol Dehydrators				
Desiccant Dehydration				
Fuel Gas Measurement and Reporting				
Fractionation				
Refrigeration				
Amine				
Sulphur Recovery				
Tail Gas Incinerators				
Acid Gas Injection				
Consolidation and Evaluations				
Leak Detection and Repair				
Waste Heat Recovery				
Other (specify):				
Other (specify):				
Other (specify):				

Question #6: Fuel Gas Efficiency Project Successes in 2010

Please Provide Details on Each of Your Project Successes:

Question #7: Lessons Learned

Example Lessons Learned are:

Consider more than fuel gas savings in the economics; Engage the field and other staff; Track your successes; Aggregate small projects; Centralize and dedicate expertise; Coordinate modifications with scheduled shutdown; See environment regulations as an opportunity.

What Worked Well and Why:

What Did Not Work Well and Why:

Question #7: Lessons Learned

What Requires Further Technical Development to be Successful?

What are the Challenges Related to Implementation of Fuel Gas Reduction Projects in your Company?

Question #8: Planned Future Fuel Gas Efficiency Projects for 2011

Comment on specific projects or project types or initiatives planned for 2011. What is planned and what is the expected fuel gas saving?

Please Select the Following Fuel Gas Reduction Projects Planned for the Future:

The List of BMPs:	Yes	Project Cost ($)	Mcfd Saved	Please Provide Detail
Gas Gathering Systems	✓	xxxx.x	xxxx.x	
Pump jacks				
Pneumatic Instruments				
Flaring Operations				
Chemical Injection Pumps				
Fired Heaters				
Engines				
Compressors				
Glycol Dehydrators				

Desiccant Dehydration				
Fuel Gas Measurement and Reporting				
Fractionation				
Refrigeration				
Amine				
Sulphur Recovery				
Tail Gas Incinerators				
Acid Gas Injection				
Consolidation and Evaluations				
Leak Detection and Repair				
Waste Heat Recovery				
Other (specify):				
Other (specify):				
Other (specify):				

Question #8: Planned Future Fuel Gas Efficiency Projects

Please Provide Details on Each of Your Planned Projects:

Question #9: Company Incentive Programs (Budget Processes, Training, etc.)

Comment on any formalized programs or processes that your company uses to encourage fuel gas reduction. This may include items specific to internal reporting, staff training, budget processes, organizational responsiblity or other programs and practices that may be in place.

Please Select the Following Company Programs You Use in 2010 to Encourage Fuel Gas Efficiency:

	Yes	Please Provide Detail
Dedicated Fuel Gas Efficiency Resource/Team	✓	
Formal Fuel Gas Efficiency Program as Part of Corporate Initiatives		
Energy Efficiency Budget Numbers Provided to Operational Areas for Planning Purposes		
Energy Intensity Fuel Gas Reduction Scorecard/Benchmark		
Development of Monthly Fuel, Flare, Vent Gas, and Emission Tracking Systems		
Internal Staff Training		
Encourage Field Staff to Submit Environmental, Safety, and Efficiency Ideas for Improving Operations		
Funding for Clean Energy Technologies		
Internal Newsletter Publications Recognize and Share Fuel Gas Efficiency Lessons Learned and Successes		
Corporate Sustainable Development Commitments		
Corporate Climate Change Action Plan		
Other (specify):		
Other (specify):		
Other (specify):		

Please Provide Any Comments:

Question #10: Best Management Practices

The Best Management Practices (BMPs) bring existing knowledge on fuel gas efficiencies into one place. A number of companies have been using these principles for many years and have been successful in improving their field operations to maximize efficiency.

Of the CAPP Fuel Gas Best Management Practices, which were seen to be the most helpful in terms of your company's fuel gas reduction success?

The List of BMPs:	**Aware?**	**Evaluated?**	**Useful?**	**Used as Resource?**	**Comments**
Module 1: Efficient Use of Fuel Gas in Gas Gathering Systems	✓	✓	✓	✓	
Module 2: Efficient Use of Fuel Gas in Pumpjacks					
Module 3: Efficient Use of Fuel Gas in Pneumatic Instruments					
Module 4: Efficient Use of Fuel Gas in Flaring Operations					
Module 5: Efficient Use of Fuel Gas in Chemical Injection Pumps					
Module 6: Efficient Use of Fuel Gas in Fired Heaters					
Module 7: Efficient Use of Fuel Gas in Engines					
Module 7: Efficient Use of Fuel Gas in Engines					
Module 9: Efficient Use of Fuel Gas in Glycol Dehydrators					
Module 10: Efficient Use of Fuel Gas in Desiccant Dehydration					
Module 11: Fuel Gas Measurement and Reporting					

Module 12: Efficient Use of Fuel Gas in Fractionation					
Module 13: Efficient Use of Fuel Gas in Refrigeration					
Module 14: Efficient Use of Fuel in Amine					
Module 15: Efficient Use of Fuel Gas in Sulphur					
Module 16: Efficient Use of Fuel Gas in Tail Gas Incinerators					
Module 17: Efficient Use of Gas in Acid Gas Injection					

Question #11: What Other Areas Should New BMPs be Developed For?

Please Provide Your Suggestions:
