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The Possibility of Energy Consumption Misclassification by Sector in Canada

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Executive Summary

Fuel marketers are thought to have become a more prevalent part of energy markets, particularly in Alberta and Ontario, in the last 5-10 years. These fuel marketers purchase fuel (particularly heavy fuel oil (HFO) and light fuel oil (LFO)) from refiners then resell it to small manufacturing and other operations that are outside the commercial/institutional sector. Since the energy purchases made by fuel marketers are recorded as consumption in the commercial sector, but (some of) their product is sold for final consumption in other sectors, energy consumption of the commercial sector as recorded in Statistics Canada's *Report on Energy Supply and Demand* (RESD) may be an over-estimate of what is actually consumed by that sector. This could have important implications for the empirical analysis that is conducted using the recorded data for each sector, and hence for policy recommendations that may be derived from this analysis.

The purpose of this report is to determine the extent to which recorded energy consumption in the commercial sector in RESD may be an over-estimate of what is actually consumed by that sector. We were unable to find any literature on this subject, and contacts with industry personnel, while helpful in some cases, did not help determine the extent of the problem. In response to this, we attempted to determine whether there is any evidence in the recorded data from RESD that there has been a shift in consumption between sectors that could be due to fuel marketers. Our analysis of the consumption data for kerosene, LFO, and HFO in each sector in Alberta, Ontario, and Manitoba, the latter province being used to provide a benchmark, found only weak evidence to suggest that HFO consumption might be being recorded in a sector other than that in which it is finally consumed. Estimates obtained from a linear regression model that allowed the commercial consumption share to increase for different lengths of time, generally confirmed the data analysis. There is no evidence of an increase in the commercial share of any fuel in Alberta, but for Ontario there is strong evidence that the commercial share of HFO increased over the last 8 years. However, this seems like too long a period for it to be attributable to the role of fuel marketers. There is also some weaker evidence that the commercial share of kerosene consumption in Ontario increased over the last 5 years, but further analysis of whether this reflects a misclassification of consumption is an issue that would clearly require access to much more detailed data, which do not appear to be publicly available.

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1. Introduction

Sector by sector analysis and modelling of energy demand usage is important for understanding differences in behaviour in each sector, including each sector's responses to variables such as prices and taxes and the level of economic activity, as well as for input into framing appropriate policy, such as, for example, concerning greenhouse gas emissions. In Canada, there are four main non-transportation sectors, namely residential, commercial, industrial, and agriculture, although the agricultural sector is not always separately identified. Analysis and modelling of energy use in these sectors requires energy consumption data, and in Canada the principal source for this information is the *Report on Energy Supply and Demand* (RESD), which is released annually by Statistics Canada. Much of the relevant data are also available electronically in CANSIM, Statistics Canada's electronic database. Clearly, for analytical purposes, it is necessary that the information for each sector be as accurate as possible.

The definitions of these sectors may seem obvious from their names, but in practice there are a number of complications. For example, high-rise apartment buildings for many years were considered as part of the commercial sector. Similarly, as mentioned above, for many years residential and agricultural energy consumption were often only provided in aggregate form. A more recent phenomenon, which has implications for the accuracy of energy consumption data for each sector, concerns fuel marketers or resellers. Due to deregulation in the electricity markets in some provinces (Alberta and Ontario) and increased competition in petroleum products and gas markets, fuel marketers (which are considered part of the commercial/institutional sector) have become a more prevalent part of energy markets in the last 5-10 years. These fuel marketers purchase fuel (particularly heavy fuel oil and light fuel oil) from refiners then resell it to small manufacturing and other operations that are outside the commercial/institutional sector. Since the energy purchases made by these fuel marketers are recorded as consumption in the commercial sector, but they sell at least some of their product for final consumption in other sectors, this would suggest that recorded energy consumption in the commercial sector in RESD may be an over-estimate of what is actually consumed by that sector, while correspondingly, recorded energy consumption in other sectors where the fuel marketers ultimately sell their product will be under-estimated. To the extent that this occurs, it

could have important implications for the empirical analysis that is conducted using the recorded data for each sector, and hence for policy recommendations that may be derived from this analysis.

The objective of the project which is summarized in this report is to determine the extent to which this phenomenon is occurring. Our initial plan was to summarize what has been written on this topic and to survey fuel marketers in Alberta to determine the extent to which energy consumption recorded in the commercial sector is actually being consumed in other sectors. However, as detailed in the next section, our efforts in this regard proved to be largely unsuccessful. Consequently, we approached this issue from another direction, and attempted to determine whether there is any evidence in the recorded data from RESD (and CANSIM) that there has been a shift in consumption between sectors that could be due to fuel marketers. The bulk of this report details our analysis of this issue.

In the following section we explain what we did and did not determine from a literature review and contact with industry personnel. In Section 3 we analyze consumption data for three fuels in each sector in Alberta and Ontario – as well as in Manitoba to provide a benchmark – in order to determine if there is anything in the data that suggests that energy consumption is being recorded in a sector other than that in which it is finally consumed. Section 4 contains the results of some econometric modelling and testing designed to further test this contention, while Section 5 concludes.

2. Information on Fuel Marketers and on Energy Consumption being recorded in the Incorrect Sector.

A search of the academic literature found no references to the problem of energy consumption being recorded in one sector but actually being consumed in another. A search of internet sources proved to be no more successful. This does not seem to be an issue that has received wide attention in written work.

Next we attempted to determine the names of fuel marketers in Alberta. There are no listings under this category or any other categories that would seem related in any phone directories, so

we approached industry sources. In most cases our efforts were rebuffed or ignored. However, we did have a very informative discussion with the Canadian Petroleum Products Institute (CPPI), Western Division, located in Calgary. After explaining what we were trying to determine, the first question we were asked is exactly what defines the commercial sector? Their view was that most firms would not know (because it is of no concern to them) what sector they were operating in, or in what sector they ultimately made their sales. They also did not think that we were going to be able to get a list of clients so that we could determine the sector to which those clients belonged, and even if we did manage to do so, there was little chance that we could get volume or even percentage sales information for each client, which would be necessary to determine the amount of consumption that is being allocated to the incorrect sector.

In their view, there were three major fuel marketers in Alberta – Husky (which does no refining but supplies fuel to service stations and commercial operations, as well as to gas bars associated with Big Box stores, like Canadian Tire and Safeway, among others), United Farmers of Alberta (which provides fuel mainly to co-ops and possibly accounts for 10% of all fuel that is used), and Parkland Fuels which supplies gasoline to gas bars (including convenience store gasoline outlets) under the *FasGas* label. In all cases it seemed that these fuel marketing firms were mainly supplying gasoline to gasoline bars, including those located at co-ops in rural locations. If this is the case, then even knowing how much fuel these marketers provide to their destinations would not help, since we would still not know in which sector the fuel was ultimately consumed. Co-ops can sell to farmers or residential or commercial customers, and of course retail gasoline stations can sell fuel to customers in any of the sectors.

The CPPI also suggested that a more fruitful avenue for our investigation might be to approach the provincial taxation department, and to use information on who has paid the taxes on the fuels to determine the ultimate purchaser. Apparently, tax regulations in Alberta involve taxation at the point of sale, but there are possibly some types of exemptions involved when there is just a transfer from a provincial terminal to a reseller. We did not pursue this line of inquiry given that there is no way to obtain the type of information we would need from a government department in Alberta, under current FOIPP regulations, and even if we did, we could still not resolve the

problem of which sector the ultimate purchaser belonged to, especially for sales through retail outlets.

As a consequence of these problems, we decided to approach the problem differently, and try to determine if there was any *prima facie* evidence in the RESD data that would suggest that energy consumption is being recorded in a sector other than that in which it is finally consumed.

3. Data Analysis

Our empirical analysis examines utilization of three refined petroleum products in Alberta and Ontario. The products for which commercial use is believed to be over-estimated are heavy fuel oil (HFO), light fuel oil (LFO), and kerosene. Heavy fuel oil is a low-grade fuel primarily used in medium to large industrial plants, marine applications and power stations in combustion equipment such as boilers, furnaces and diesel engines. Heavy fuel oil is the least expensive of the refined oil fuels and can only be used by facilities that have preheating capabilities.¹ Light fuel oil is a convenient heating fuel used to heat homes and buildings, process food, and as a fuel in industry, agriculture and ships. It also makes an ideal reserve and emergency fuel for industrial plants and power stations using other forms of energy.² Kerosene is thin oil distilled from petroleum or shale oil, used as a fuel for heating and cooking, in lamps, and as a denaturant for alcohol.³

In this section, quantities consumed of heavy fuel oil, light fuel oil, and kerosene, are examined for different sectors. The data set containing fuel consumption in commercial, institutional, and residential sectors is obtained from Statistics Canada's CANSIM electronic database, Table Number 1280002. These are the same data provided in RESD. We extracted these data series for Alberta and Ontario, where fuel marketers are suspected to have played a role in energy consumption possibly being recorded in the incorrect sector. For comparison purposes we also extracted data for Manitoba, where it is assumed that no such problem arises. Since energy

¹ http://www.nrtee-trnee.ca/eng/programs/Current_Programs/EFR-Energy/Case_Studies/EFR_Case-Studies-HeavyFuel_2_E.htm

² <http://www.nesteoil.com/default.asp?path=1,41,535,547,560>

³ <http://www.yourdictionary.com/ahd/k/k0041800.html>

consumption by the commercial and industrial sectors is presumably related to a measure of economic activity, we also obtained data from CANSIM (Table 3840002) for real provincial Gross Domestic Product (GDP) for Ontario, Alberta, and Manitoba. For residential consumption, rather than real GDP we use provincial population (CANSIM Table 510005) as a variable that might reflect changing demand pressures. Graphical representations of the data, for the period 1978 to 2004, both in terms of consumption of each fuel type, as well as shares of consumption for each fuel type that are attributable to each sector, are provided in Figures 1-18 in the Appendix.

3.1 Alberta

As can be seen in Figure 1, despite rising real GDP and population, consumption of kerosene has fallen almost continually over the entire the sample period (1978 to 2004) except for a recent upsurge in the industrial sector. Since 1999, the share of the commercial sector in kerosene consumption has declined (Figure 2), while the share of the residential sector has fallen since 1996. These declines have been offset by an increase in the share of the industrial sector.

LFO shows a similar pattern to kerosene. Consumption by all sectors has generally decreased over the sample period (Figure 3), although industrial consumption increased from 1992 to 1997. In terms of the LFO consumption shares of each sector (Figure 4), these have fallen for the residential sector since 1994, while for the commercial sector they increase slightly from 1996 to 2001 before falling again. As with kerosene, these declines have been offset by an increased share for the industrial sector – this share has generally been increasing since 1994.

Consumption of HFO (Figure 5) shows a different pattern. Industrial consumption began falling after 1988, while commercial consumption began increasing in 1994, and increased sharply from 1997 to 1999, after which time it fell again. However, it has undergone another large increase from 2003 to 2004. In terms of HFO consumption shares for each sector (Figure 6), the industrial share has fallen since 1989, with a steep fall in 1994-95, while the commercial share began increasing in 1990, increased sharply from 1994 to 1995 and has remained high (close to 80% or higher) since that time.

Overall, Figures 1 to 6 provide little evidence to support the suggestion that consumption in the commercial sector has been overstated in the last 5 or so years, except perhaps weakly for HFO. However, even for HFO, the share of the commercial sector began increasing in 1989, which would appear to predate the appearance (at least in a significant way) of fuel marketers.

3.2 Ontario

As Figure 7 shows, in Ontario, kerosene consumption has been decreasing steadily over the entire sample period in all three sectors despite growth in real GDP and population. The residential share of kerosene consumption has decreased steadily during this time, except for a one year anomaly in 1999 (Figure 8). The industrial share has decreased since 1990, while the commercial share has increased steadily since 1991.

In terms of LFO consumption (Figure 9), this has been dominated by the residential sector but has been generally falling in this sector and in the industrial sector throughout the 1978 to 2004 period. Consumption in the commercial sector has been increasing since 1999, but remains relatively low. LFO consumption shares for each sector (Figure 10) show that the commercial sector's share has been increasing steadily since 1986, although the rate of increase of this share increased between 2003 and 2004.

HFO consumption, which is dominated by the industrial sector, has been falling in this sector throughout the period except between 1985 and 1989 (Figure 11). Commercial consumption has increased since 1999, but remains relatively low. In terms of consumption shares for each sector (Figure 12), the industrial share has been decreasing, and the commercial share increasing, since 1999, although this situation reversed in the last year of the sample period, from 2003 to 2004.

As was the case with Alberta, Figures 7 to 12 provide little evidence for Ontario to support the suggestion that consumption in the commercial sector has been overstated in the last 5 or so years, except possibly for HFO. The commercial sector share has been increasing in kerosene and LFO, but this begins around 1986. However, for HFO, the share of the commercial sector began increasing in 1999, which would appear to coincide with an increased role for fuel marketers.

3.3 Manitoba

As noted earlier, Manitoba is included in our analysis as a benchmark because it is expected that there should be no role in this province for fuel marketers to have affected the commercial consumption figures.

As with the other two provinces, kerosene consumption in Manitoba is largest for the residential sector but has generally been falling throughout the 1978 to 2004 period (Figure 13). In terms of the kerosene consumption shares for each sector (Figure 14), until 1999 the residential share was at 80% or higher, but it has fallen since that time. This has been offset by an increase initially in the commercial share, although that has since fallen back to its previous level, and then in the industrial share which in 2003 and 2004 is above 80%.

LFO consumption in Manitoba (Figure 15) behaves similarly to kerosene consumption. The LFO consumption shares for each sector (Figure 16) show that the commercial share has been increasing since 1998, mainly at the expense of the share for the residential sector, although the industrial sector share decreased sharply in 2003.

Consumption of HFO (Figure 17) has been generally falling in the industrial sector since 1990. However, the share of this sector in HFO consumption has remained essentially at 1.0.

For Manitoba overall, the commercial sector share of LFO consumption has increased since 1998, while its share of kerosene consumption increased between 1999 and 2001, although this share has since decreased.

3.4 Summary

For the two provinces where it is suspected that the increased presence of fuel marketers in the last five or so years has resulted in overstatement of consumption by the commercial sector – Alberta and Ontario – there is relatively little empirical support for this contention, except perhaps for HFO consumption where the commercial sector's share has increased in recent years. However, in Alberta this share increase began in 1989 which would appear to be too early to

attribute to fuel marketers. In Ontario, this increase began in 1999. Also in Ontario, the commercial shares of kerosene consumption and LFO consumption have increased, but these increases began in 1986. Interestingly, in Manitoba, where it is not expected that fuel marketers played any such role in artificially increasing consumption that is recorded in the commercial sector, the commercial share of LFO consumption also has increased since 1998.

4. Testing whether Commercial Consumption Shares have Increased

Since the data analysis in Section 3 finds only weak support for the contention that the increased presence of fuel marketers in the last five or so years has resulted in overstatement of consumption by the commercial sector in Alberta and Ontario, and only for HFO, in this section we subject the data to some additional tests using econometric modelling tools. Specifically, we estimate a simple regression model designed to explain the share of consumption of each fuel attributable to the commercial sector in each province – Alberta, Ontario, and also Manitoba – and test whether there is evidence that this share has significantly and permanently increased in any of these provinces during the last five to ten years.

The model that we estimate has the following general form:⁴

$$s_{it} = \beta_1 + \beta_2 DV_t + \beta_3 g_t + \beta_4 (g_t)^2 + \beta_5 s_{it-1} + e_{it}$$

where s_{it} is the commercial sector's share of consumption of fuel type i in year t ,

g_t is the growth rate of real GDP,

s_{it-1} is the commercial sector's share of consumption of fuel type i in the previous year,

DV_t is a dummy variable that takes the value 1 in certain years (as specified below), and zero otherwise,

e_{it} is a random error term

$\beta_1, \beta_2, \beta_3, \beta_4$, and β_5 are parameters to be estimated,

and the subscript i refers to either Alberta, Ontario, or Manitoba, while the subscript t refers to the year (1978 to 2004).

⁴ As well as the growth rate of real GDP, we also tried including the growth rate of population in the model, but this did not contribute significantly and was omitted.

By including the lagged share term, the model allows for the possibility that adjustment of consumption shares to any change is likely not to be instantaneous. Inclusion of the growth rate of real GDP allows the shares to adjust in response to changes in levels of economic activity – inclusion of the squared term allows these responses to be nonlinear.

Our interest in the parameters of this model focuses on β_2 , the coefficient on the dummy variable, DV_t . We consider 8 different definitions of DV_t . These vary by the length of time prior to the end of the sample that the commercial consumption shares are allowed to have changed. Thus, DV1 takes the value 1 only in 2004, DV2 takes the value 1 in 2003 and 2004, DV3 takes the value 1 in 2002, 2003, and 2004, etc. We alternately include DV1, DV2, up to DV8 in the model, where DV8 will take the value 1 in all years from 1997 to 2004, inclusive.

The equation is estimated by Ordinary Least Squares using data from 1982 to 2004 (23 annual observations) due to limitations on the available real GDP data series. There is generally no evidence of autocorrelation or misspecification in the results, although there are some difficulties with the estimation for Manitoba, particularly for HFO. Table 1 contains the t-statistics for a test of the hypothesis that the coefficient on the dummy variable (one of DV1 to DV8) is significantly different from zero. The critical value for this statistic (18 degrees of freedom) at a 1% level of significance is 2.878, at a 5% level is 2.101, and at a 10% level is 1.734.

The results in Table 1 generally confirm our findings from the previous section. For Alberta, there is no evidence that the share of consumption of the commercial sector significantly (at a 5% level or higher) increased over any part of the last 8 years, either in kerosene, LFO, or even in HFO. Indeed, there is weak evidence that the commercial sector's share of kerosene consumption *decreased* over the last four or five years (DV4, DV5), and that its share of LFO also *decreased* over the last two or three years (DV2, DV3). For Ontario, the evidence is mixed. In terms of kerosene, apart from 2004 by itself (DV1), there is also evidence of an increase in the commercial share of consumption over the last 5 years (DV5), and weaker evidence for a similar increase over the last 6 or 7 years (DV6, DV7). For LFO in Ontario, there is only weak evidence of an increase in commercial consumption over the last 5 years (DV5). However, for HFO in this province, there is very convincing evidence that the commercial share of consumption

increased over the last 4, 5, 6, 7, or 8 years. The fact that this is significant over the last 8 years suggests that this may be too long a time for the increase to be attributable to the role of fuel marketers in causing consumption to be incorrectly classified as occurring in the commercial sector. Finally, for Manitoba, there is relatively weak evidence that the share of commercial consumption of LFO has increased over the last 1, 2, or 3 years (DV1, DV2, and DV3).

Table 1: Tests of Significance of DV Terms

Fuel	DV1	DV2	DV3	DV4	DV5	DV6	DV7	DV8
Alberta								
Kero.	-1.34	-1.67	-1.70	-1.97†	-2.12*	-1.22	-0.11	0.43
LFO	-1.18	-2.28*	-2.16*	-0.51	-0.48	-0.85	-0.38	-0.43
HFO	0.46	1.46	1.12	0.89	1.08	0.92	1.42	1.77†
Ontario								
Kero.	3.22**	1.54	1.54	1.74†	3.27**	2.74*	2.15*	1.18
LFO	3.82**	1.88†	1.46	1.50	2.18*	1.80†	1.61	1.67
HFO	-1.25	0.13	1.22	4.59**	7.53**	3.97**	4.27**	3.65**
Manitoba								
Kero.	-0.30	-0.86	-1.15	1.70	1.94†	1.18	0.73	0.65
LFO	2.08*	2.40*	2.11*	1.76†	1.56	1.53	1.06	0.19
HFO	-0.07	-0.11	-0.15	-0.16	-0.32	-0.33	-0.49	-0.64

Note: Numbers in the table are t-statistics for a test of the hypothesis that the coefficient on the Dummy variable (DV1 through DV8) is equal to zero

**, *, and †, indicate significance at the 1%, 5%, and 10% levels, respectively.

5. Conclusion

The purpose of this report is to determine the extent to which recorded energy consumption in the commercial sector in RESD may be an over-estimate of what is actually consumed by that sector, a phenomenon that may be occurring because of energy purchases made by fuel marketers, which are recorded as consumption in the commercial sector even though they sell some of their product for final consumption in other sectors. We were unable to find any literature on this subject, and contacts with industry personnel, while helpful in some cases, did not help determine the extent of the problem. In response to this, we approached this issue from another direction by attempting to determine whether there is any evidence in the recorded data from RESD (and CANSIM) that there has been a shift in consumption between sectors that could be due to fuel marketers. The bulk of this report details our analysis of this issue.

Our analysis of consumption data for kerosene, LFO, and HFO in each sector in Alberta, Ontario, and Manitoba – the latter province being used to provide a benchmark – found only weak evidence to suggest that energy consumption might be being recorded in a sector other than that in which it is finally consumed. In both Alberta and Ontario, the commercial sector’s share of HFO has increased in recent years, although in Alberta this increase began in 1989 which would appear to predate an extensive role for fuel marketers. Also in Ontario, the commercial shares of kerosene consumption and LFO consumption have increased in recent years, although these increases began as far ago as 1986. Interestingly, in Manitoba, where fuel marketers are not viewed as having played any such role in artificially increasing the energy consumption that is recorded for the commercial sector, the commercial share of LFO consumption also has increased since 1998.

To conduct a more formal evaluation of whether the commercial share of energy consumption of the different fuels has increased in recent years, we estimated a linear regression model that allowed this share to increase for different lengths of time, extending up to 8 years before the end of the sample in 2004. The results of this econometric estimation and testing generally confirm our data analysis. No evidence of an increase in the commercial share of any fuel was found for Alberta, but for Ontario there is strong evidence that the commercial share of HFO increased over the last 8 years. However, this seems like too long a period for it to be attributable to the role of fuel marketers, and thus possibly representing a misclassification. There is also some evidence that the commercial share of kerosene consumption in Ontario increased over the last 5 years, but this evidence must be interpreted cautiously since a similar increase in the commercial sector’s share of consumption of LFO was found for Manitoba over the last three years even though fuel marketers apparently did not play an important role in that province. This helps to emphasize that even finding that the commercial share of the consumption of a particular fuel has recently increased is not sufficient to be able to conclude that recorded energy consumption in the commercial sector in RESD might be an over-estimate of what is actually consumed by that sector. Further analysis of this issue would clearly require access to much more detailed data, which do not appear to be publicly available.

APPENDIX: FIGURES

Figure 1: Annual Kerosene Consumption – Alberta

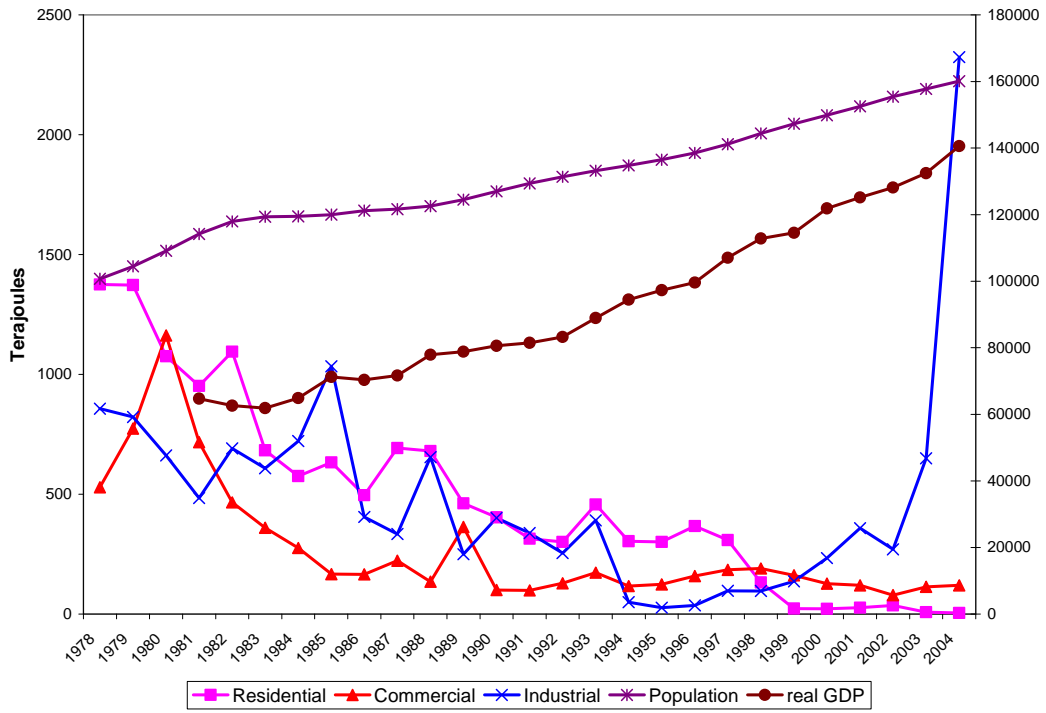


Figure 2: Kerosene Consumption Shares – Alberta

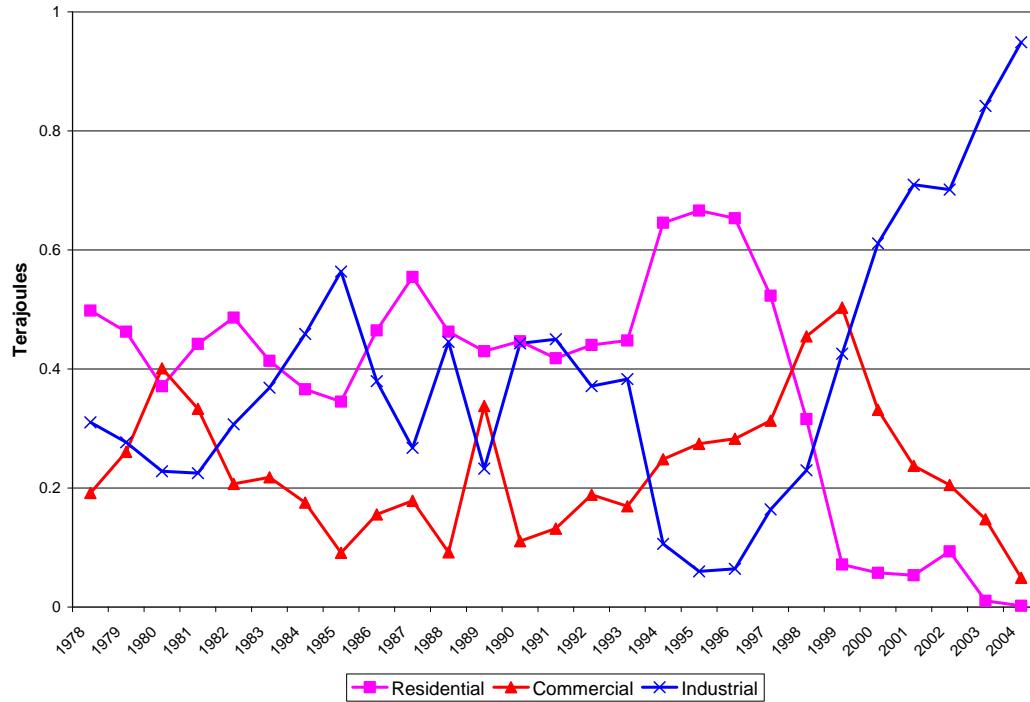


Figure 3: Annual Light Fuel Oil (LFO) Consumption – Alberta

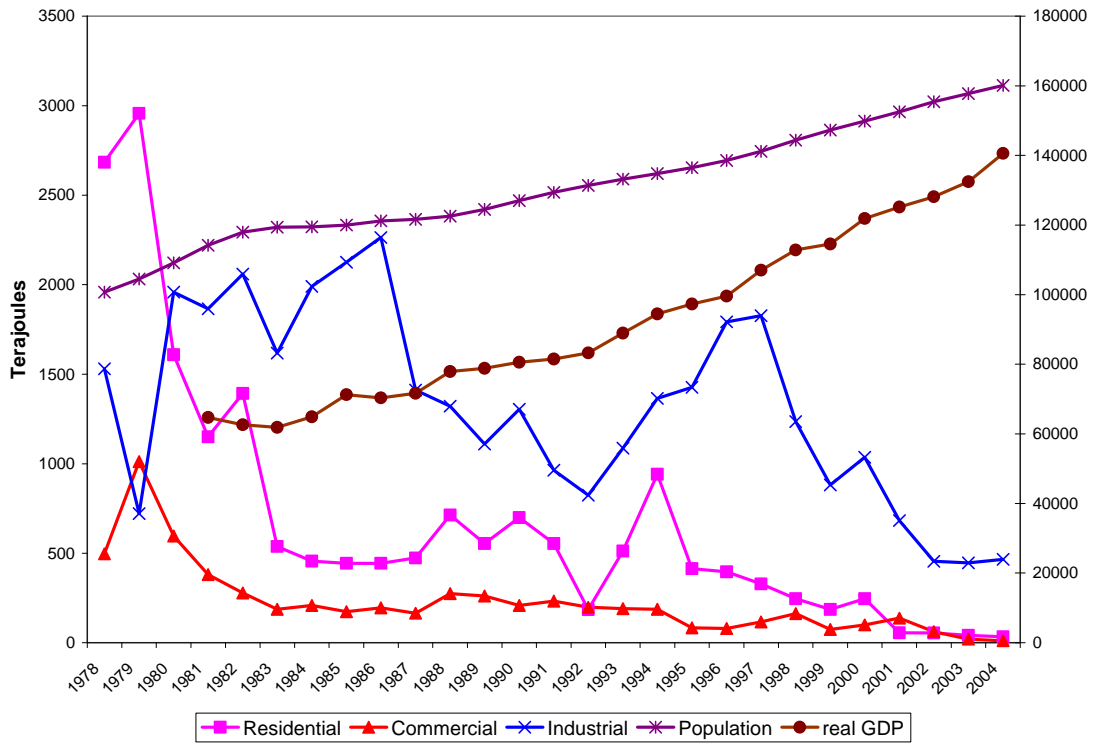


Figure 4: Light Fuel Oil Consumption Shares – Alberta

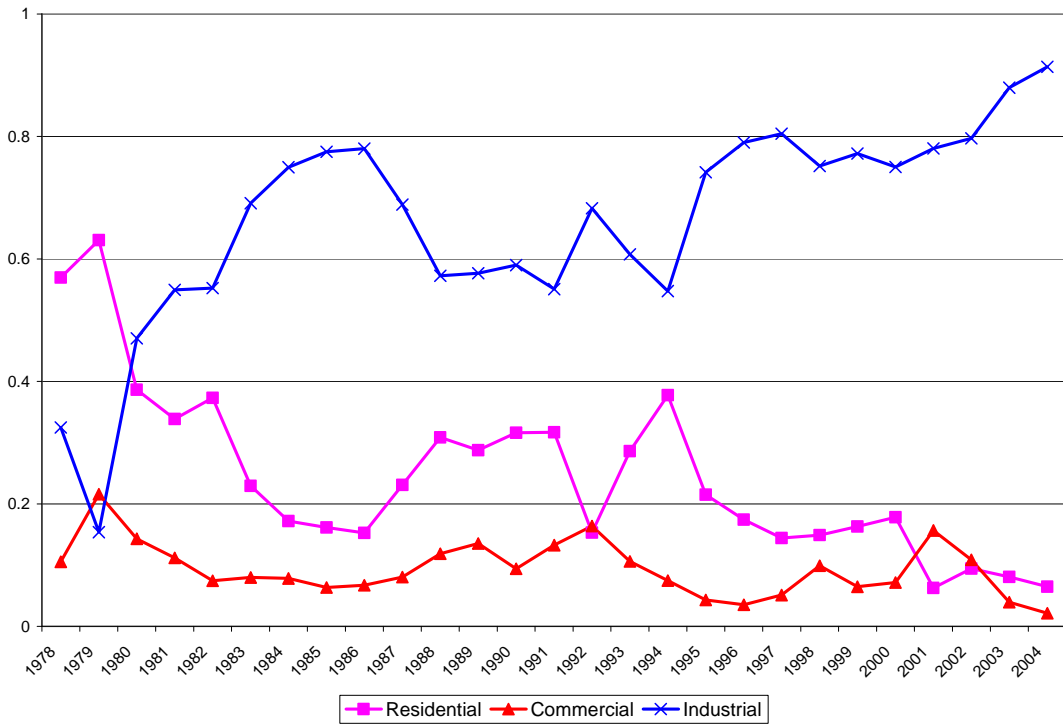


Figure 5: Annual Heavy Fuel Oil (HFO) Consumption – Alberta

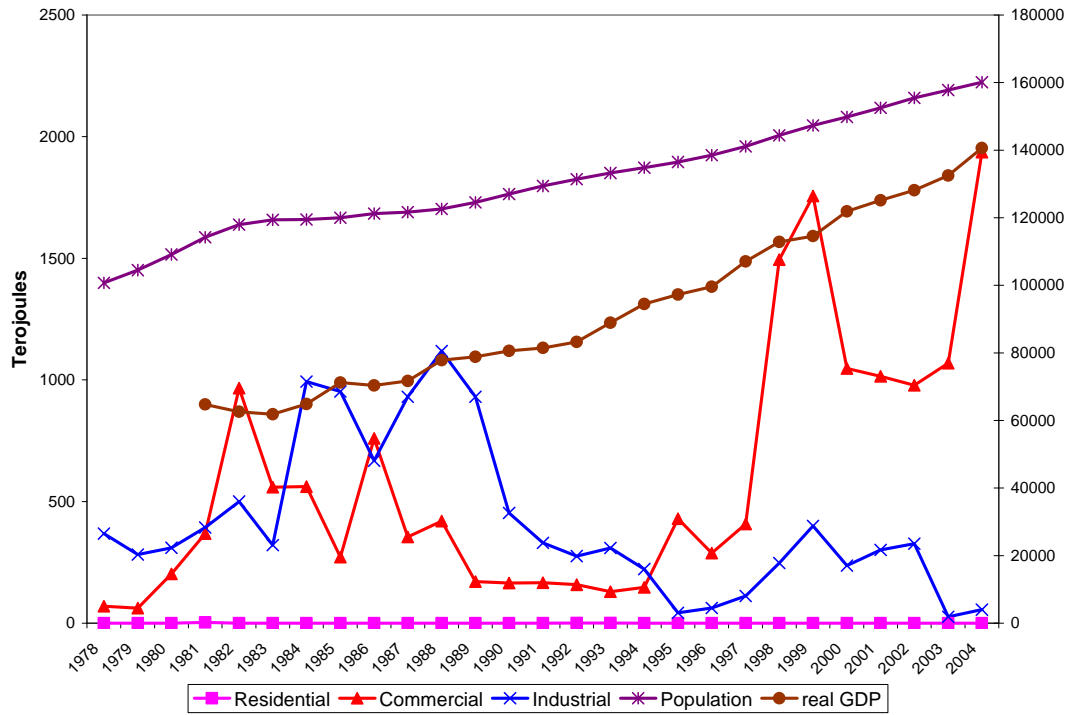


Figure 6: Heavy Fuel Oil Consumption Shares – Alberta

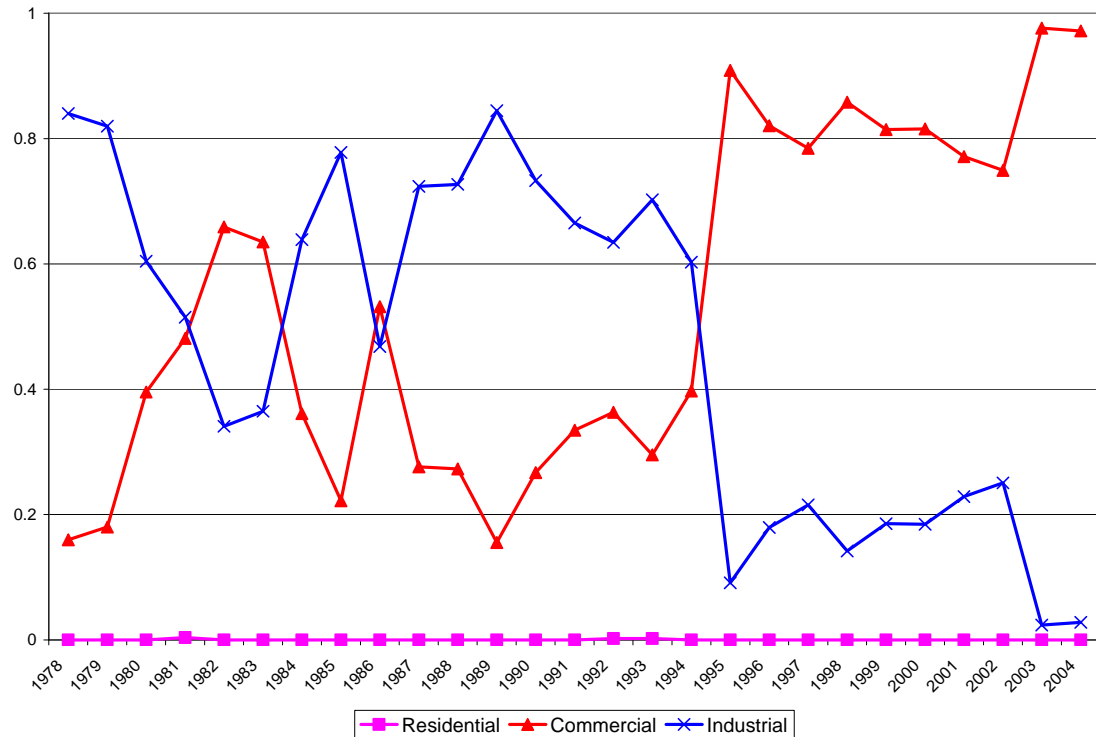


Figure 7: Annual Kerosene Consumption – Ontario

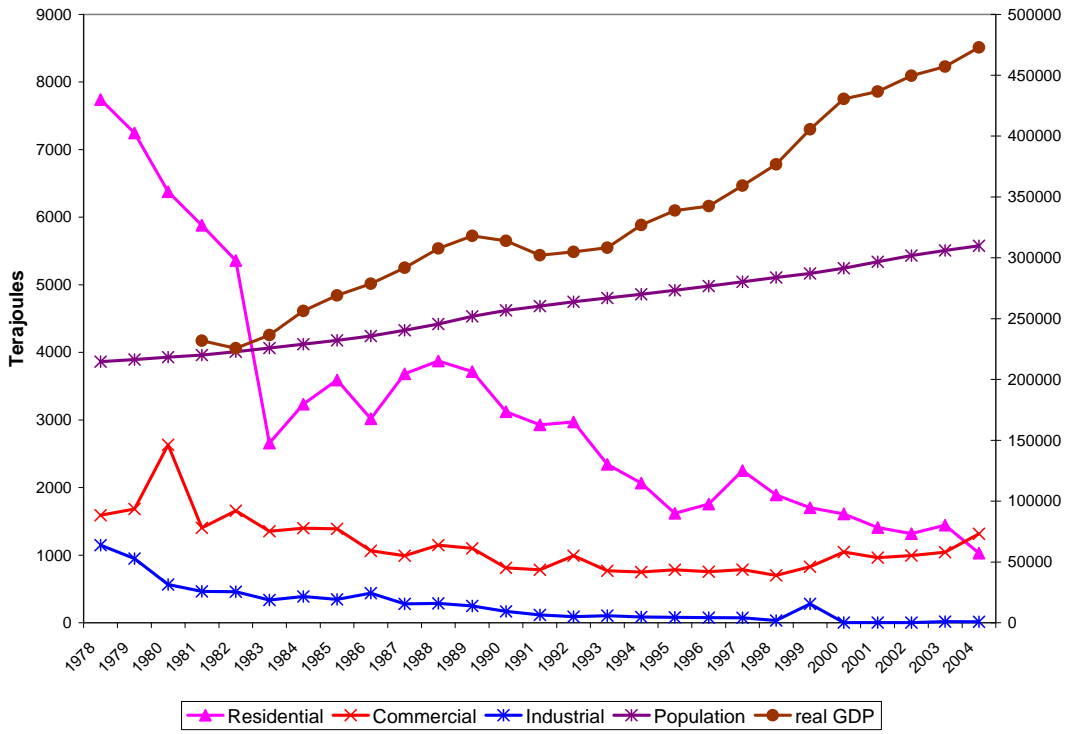


Figure 8: Kerosene Consumption Shares – Ontario

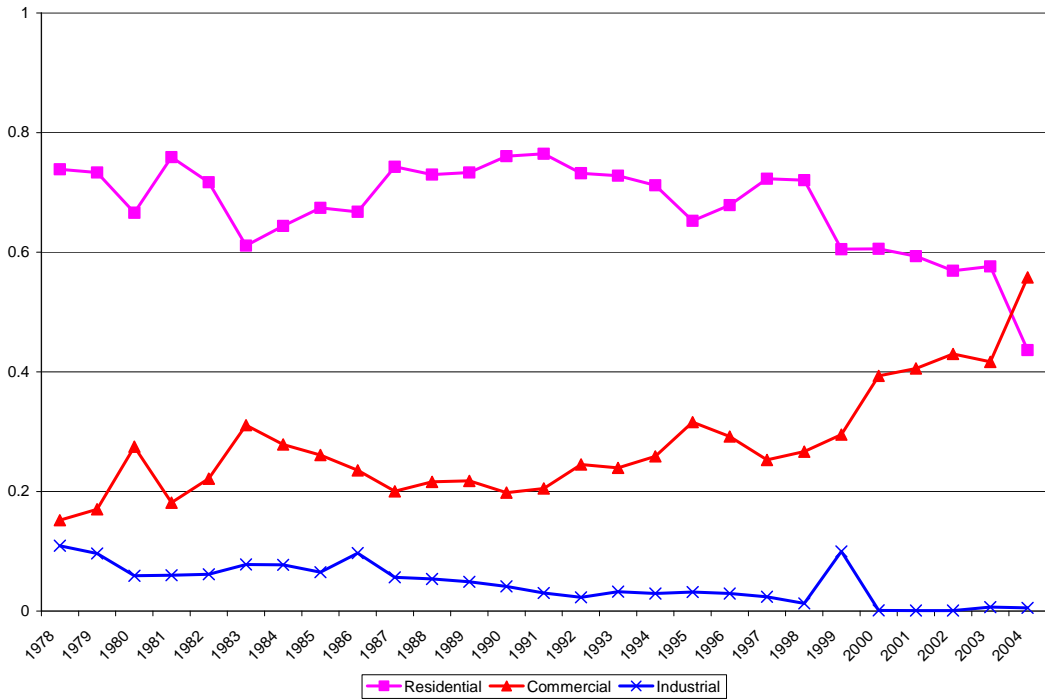


Figure 9: Annual Light Fuel Oil (LFO) Consumption – Ontario

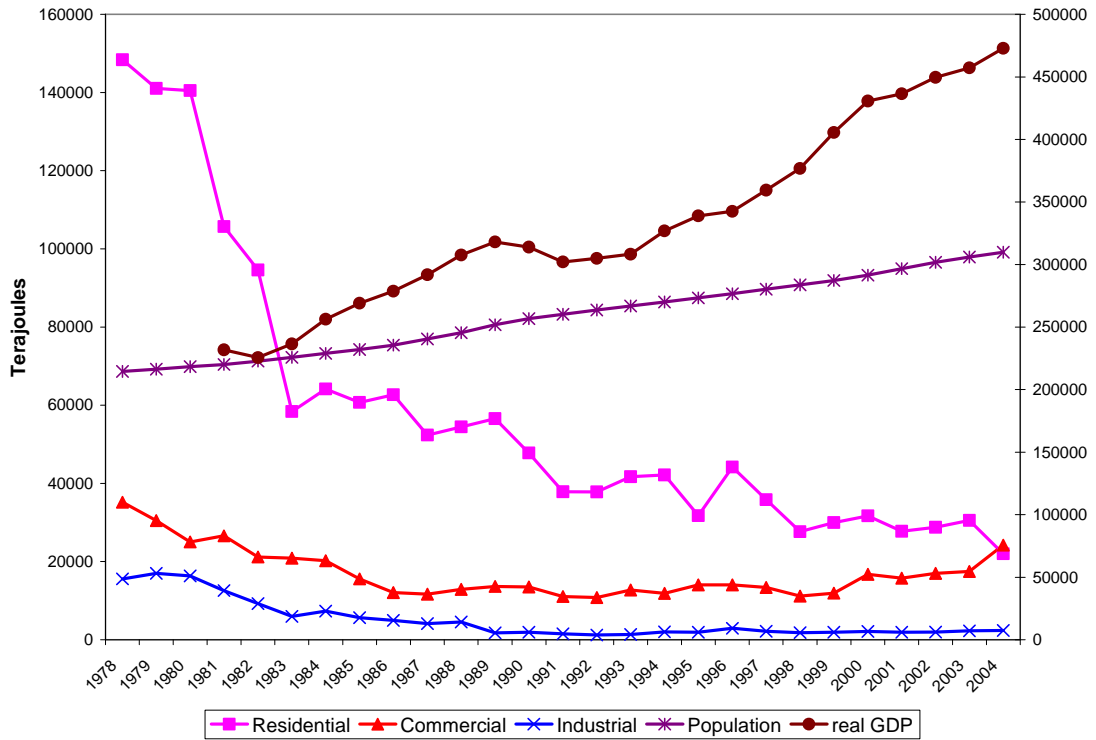


Figure 10: Light Fuel Oil Consumption Shares – Ontario

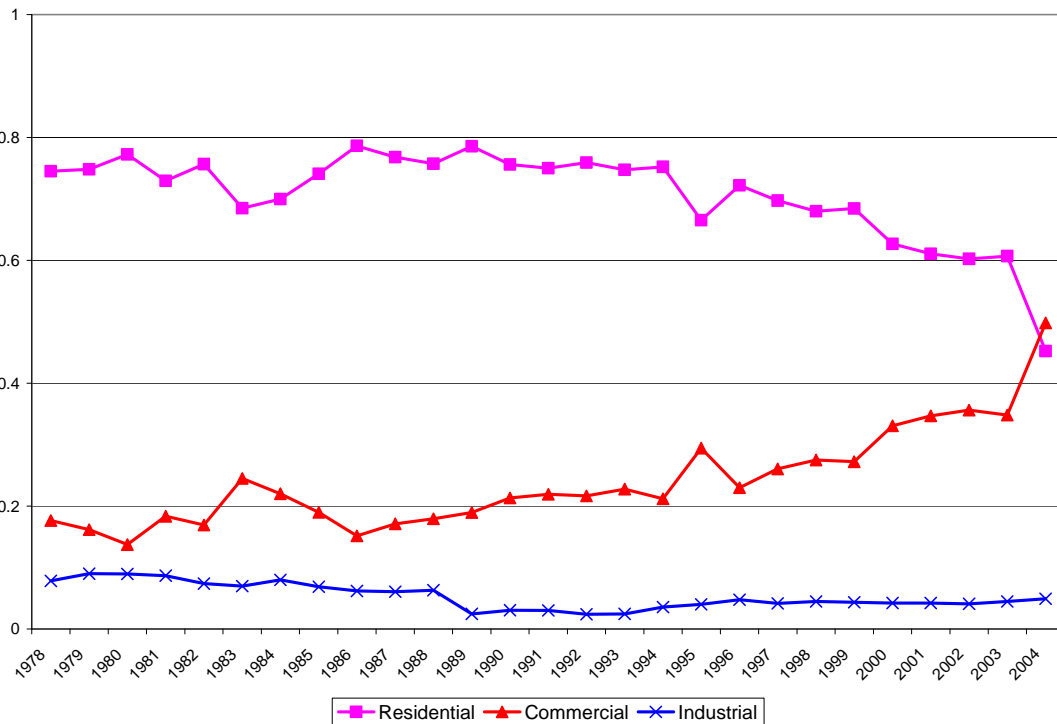


Figure 11: Annual Heavy Fuel Oil (HFO) Consumption – Ontario

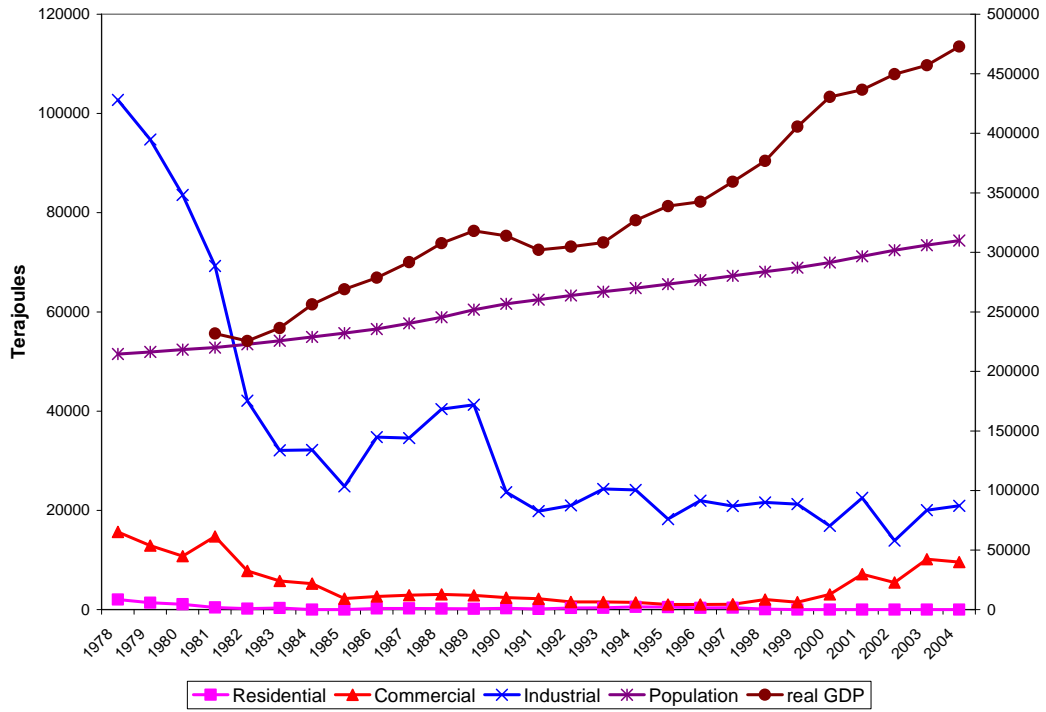


Figure 12: Heavy Fuel Oil Consumption Shares – Ontario

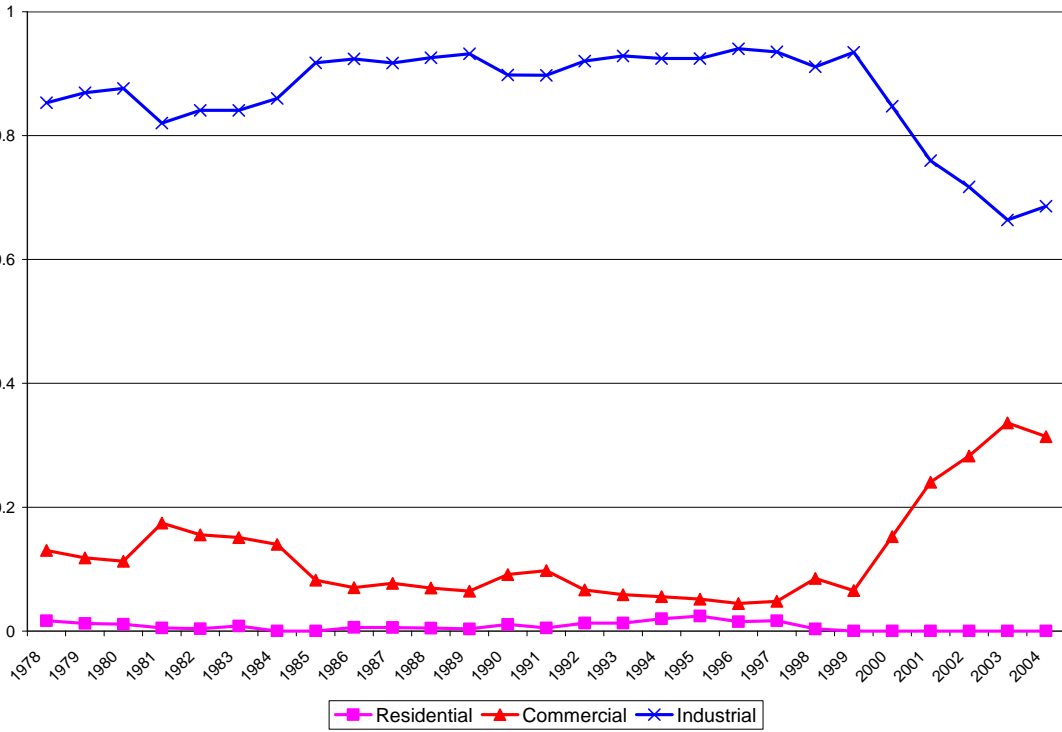


Figure 13: Annual Kerosene Consumption – Manitoba

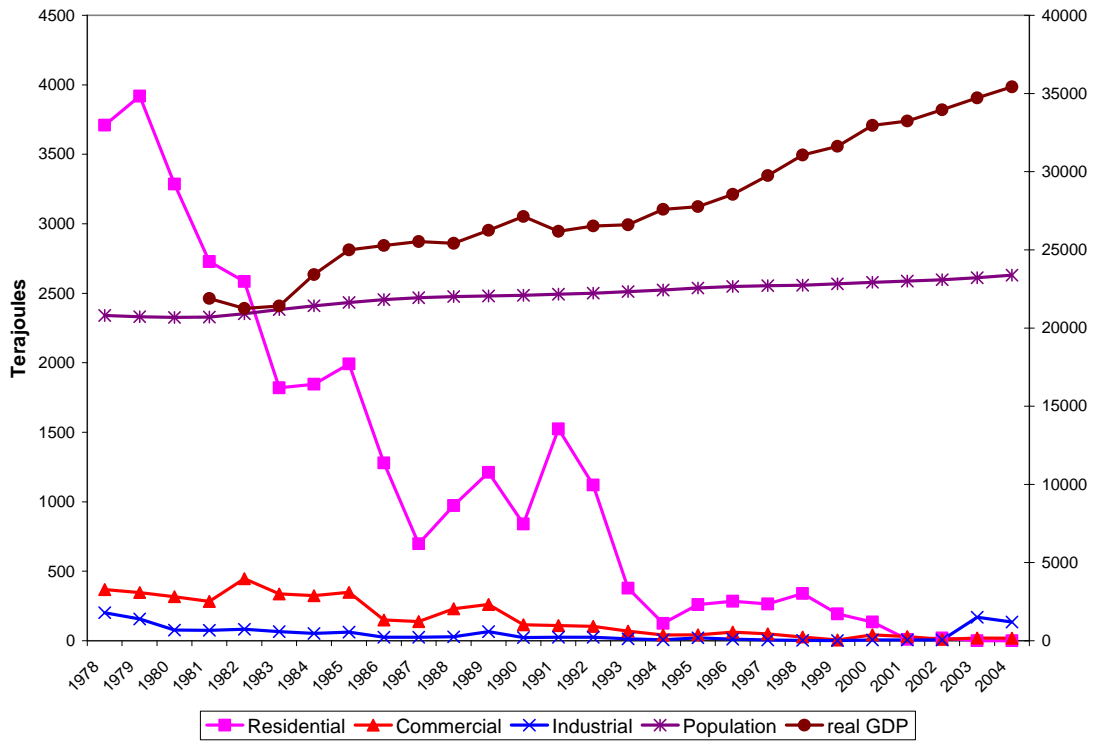


Figure 14: Kerosene Consumption Shares – Manitoba

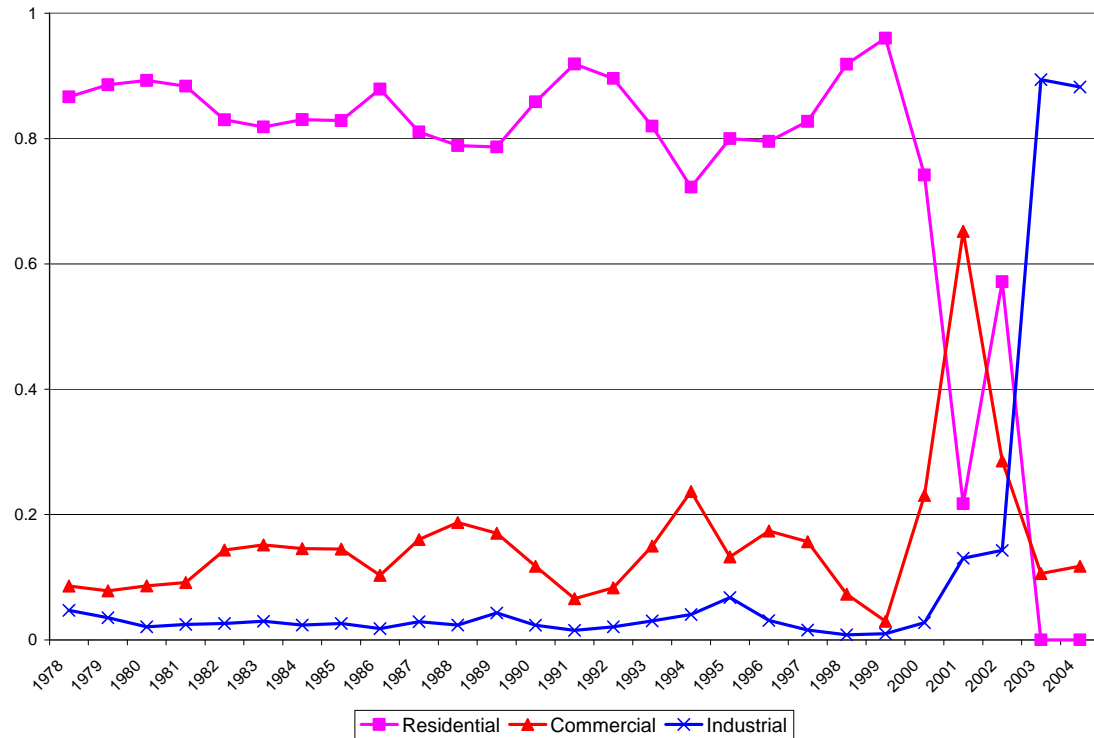


Figure 15: Annual Light Fuel Oil (LFO) Consumption – Manitoba

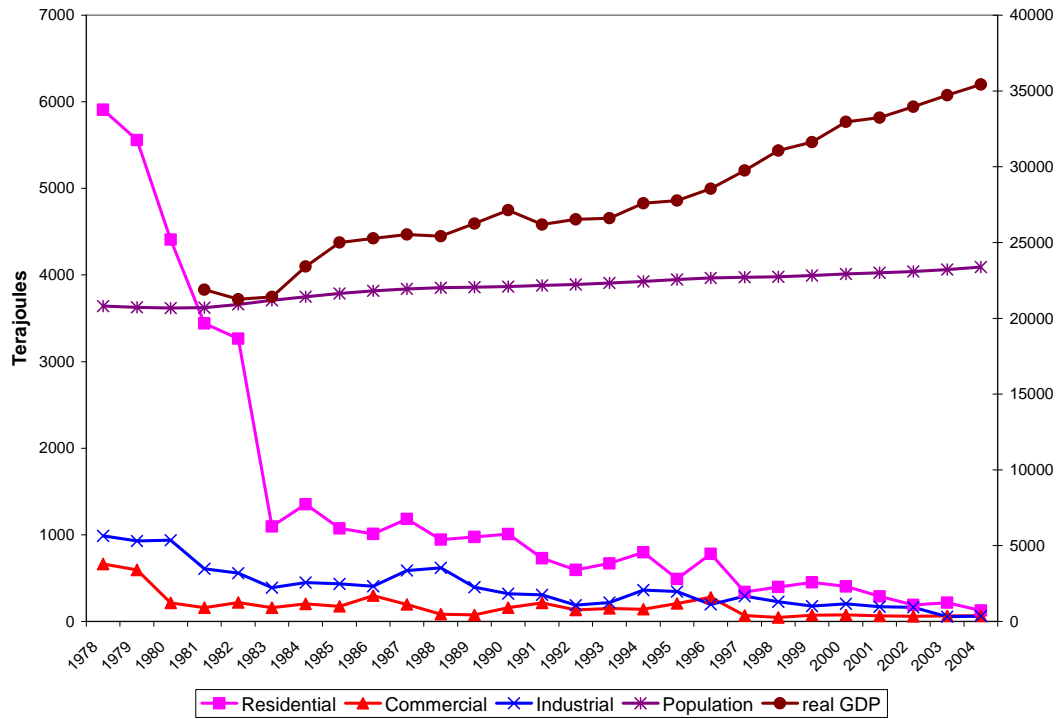


Figure 16: Light Fuel Oil Consumption Shares – Manitoba

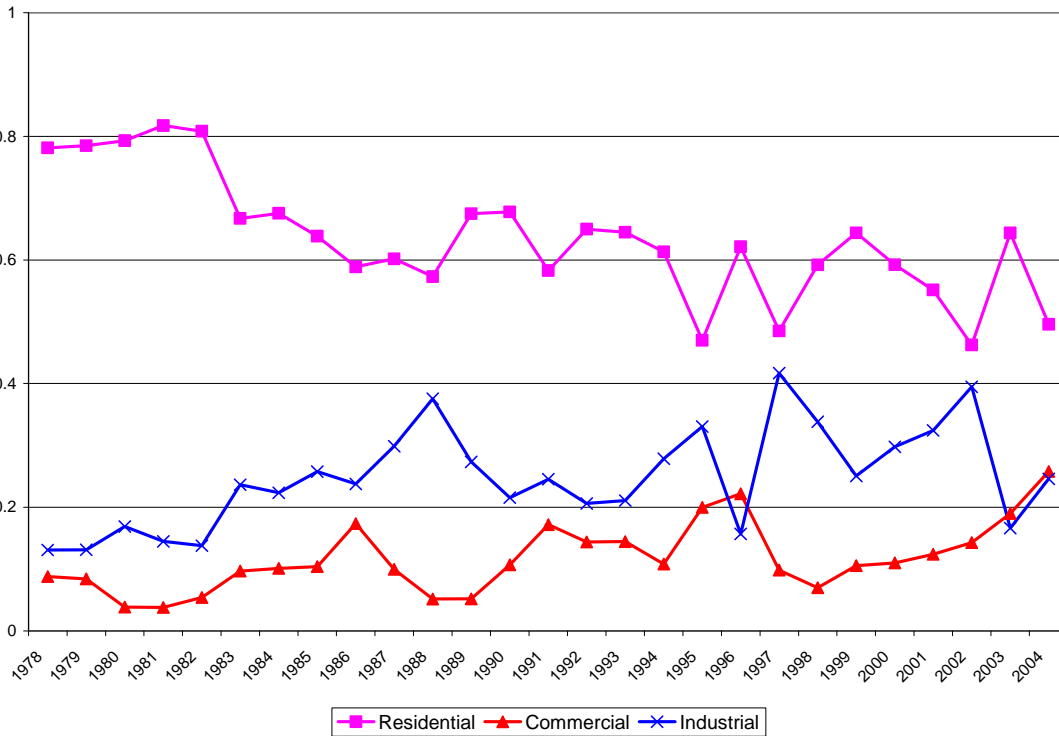


Figure 17: Annual Heavy Fuel Oil (HFO) Consumption – Manitoba

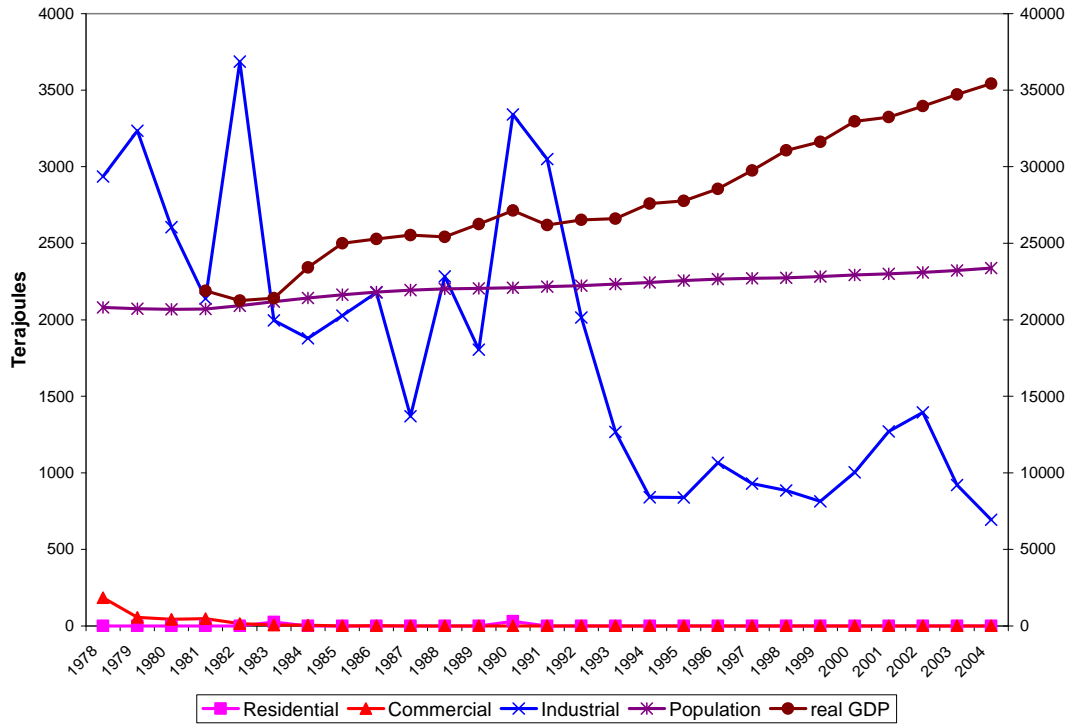
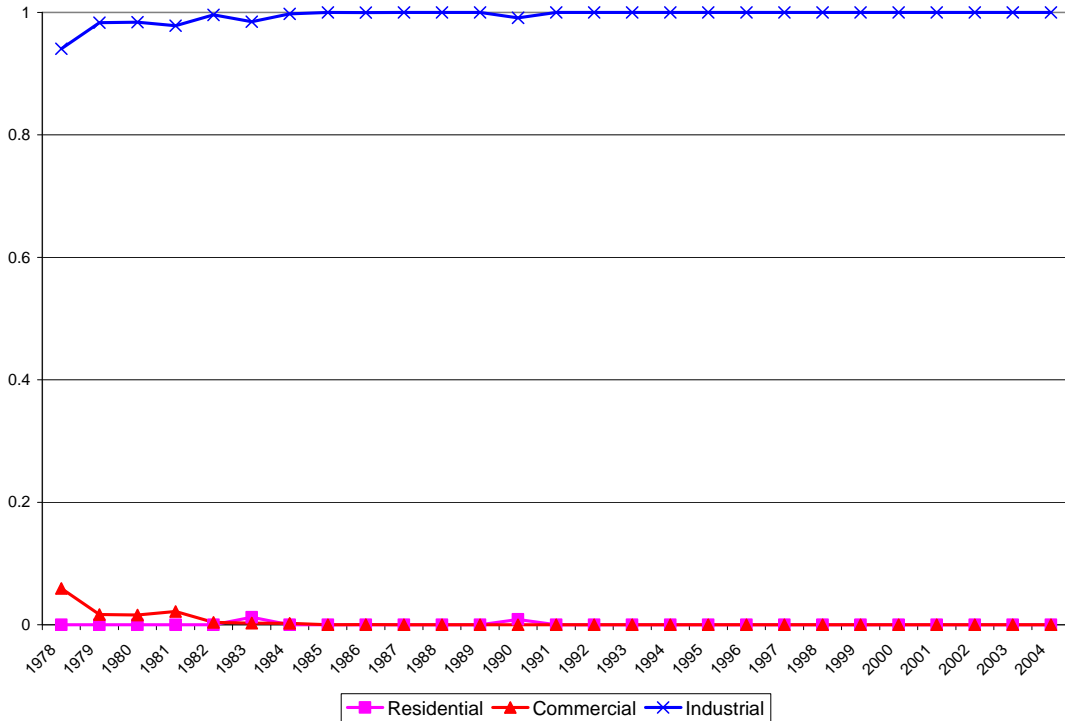


Figure 18: Heavy Fuel Oil Consumption Shares – Manitoba



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