

**Potential to Reduce Emissions of Sulphur Dioxide  
through Reducing Sulphur Levels  
in Heavy and Light Fuel Oils**

*- Discussion Paper -*

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# Potential to Reduce Emissions of Sulphur Dioxide through Reducing Sulphur Levels in Heavy and Light Fuel Oils

## 1. INTRODUCTION

### 1.1 *Purpose of Paper*

When fuel oils are combusted, the sulphur in them is emitted into the air in the form of sulphur dioxide (SO<sub>2</sub>) and sulphate particles (SO<sub>4</sub>). Fine particulate matter (PM<sub>2.5</sub>), of which sulphate particles are a significant fraction, has a significant effect on the health of Canadians. Emissions of sulphur dioxide are the primary cause of acidic deposition (“Acid Rain”), which has a significant effect on the Canadian environment, particularly in central and eastern Canada.

Information on sulphur levels in all liquid fuels produced or imported for use or sale in Canada is provided annually to Environment Canada by refiners and importers as required by the federal *Fuels Information Regulations, No. 1*. The data are compiled regionally and are presented in annual reports entitled *Sulphur in Liquid Fuels*. In this report, in addition to the regional and national data for the years 1994 to 1999, the sulphur levels of fuel oils of individual refineries and importers are presented<sup>1</sup>.

Table 1.1 shows the distribution of sulphur in liquid fuels used in Canada in the years 1994 to 1999. In 1999, sulphur in HFO accounted for 73% by weight of the sulphur in all liquid fuels in Canada. If the fuel used for refinery consumption is included (almost always HFO), this number rises to 81% of the total sulphur in liquid fuels. The relative fraction has increased since the mid 1990s, primarily due to the reduction of sulphur in the diesel pool. The sulphur content of LFO has stayed constant at between 4 and 5% – this level is comparable with the sulphur concentration in gasoline and somewhat lower than that in diesel.

The purpose of this paper is to provide background information on the sulphur levels in light fuel oil (LFO or residential heating oil) and heavy fuel oil (HFO or industrial fuel oil). The report provides:

- a description of LFO and HFO sulphur levels in Canada;
- a summary of regulatory limits, both in Canada and elsewhere; and
- a description of the emission benefits of decreasing sulphur in the fuels.

### 1.2 *Description of Fuels*

LFO are fuels that are suitable for use in liquid-fuel-burning equipment without preheating, primarily domestic-type burners, although they may be used for some industrial purposes. There are three types:

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<sup>1</sup> Importer data is presented for 1998-99 only

- Type 0 is for use in sleeve-type and wick-type burners and most vapourizing pot-type burner applications,
- Type 1 is for use in atomizing burners in which Type 2 cannot be used satisfactorily as well as certain vapourizing pot-type burners, and
- Type 2 is for use in most atomizing burner applications (i.e., most domestic furnaces and boilers and some medium capacity commercial-industrial boilers).

HFO are essentially industrial fuels that are suitable for use in boiler plants, metallurgical operations, etc. There are three types:

- Type 4 is an industrial type of fuel intended primarily for burner installations not equipped with preheating facilities,
- Type 5 is a residual type of oil for burner installations equipped with preheating facilities requiring an oil with lower viscosity than Type 6, and
- Type 6 is a high-viscosity residual oil for use in burner installations equipped with preheating facilities adequate for handling oil of high viscosity.

A comparison of Environment Canada and Statistics Canada volumetric data on Canadian HFO and LFO production and imports is presented in Table 1.2.

## **2. HEAVY FUEL OIL**

### **2.1 *Sulphur Levels in Canada***

HFO is almost exclusively used in central and eastern Canada. In comparison, very little is used in western Canada. Sources that use HFO, such as power plants, refineries, and industrial boilers, are considered "point" rather than "area" sources.

Table 2.1 gives volumes of HFO produced, exported and imported by region in Canada. In 1999, imports of HFO accounted for over a third (38%) of the national demand. Of HFO produced in Canada in 1999, almost one-quarter (23%) was exported. In 1998 the destination of all exports of HFO was the US.

Table 2.2 provides a summary of the source countries for imports of HFO (the majority coming from non-US sources). The percent of demand that the imports provide is shown in Table 2.3.

Figure 2.1 shows the change in quarterly national and regional volumes of HFO produced and imported over the period 1994 to 1999. This figure shows increases in production and importation of HFO during the winter in the Atlantic region.

Figure 2.2 shows the regional sulphur levels for HFO for the years 1994 to 1999. Ontario has the highest levels but they have decreased by 3% since 1994. Quebec has the lowest levels and they have decreased by 22% while average levels of sulphur in HFO in the Atlantic region has increased by 6% since 1994. The average sulphur level of the small volumes of HFO in the west have decreased by about 29% since 1994.

Figure 2.3 shows the mass of sulphur<sup>2</sup> in HFO in Canada in the years 1994-99. The sulphur mass in HFO nationally and in eastern Canada has been increasing since 1995-1996. Nationally the sulphur mass has varied from a low of 105 kilotonnes in 1995 to a high of 126 kilotonnes in 1999.

Figure 2.4 presents yearly sulphur levels in HFO produced and imported by individual refiners between 1994 and 1999 and by importers between 1998 and 1999.

## **2.2. Regulated Limits for Sulphur in HFO**

### *Canada*

There is no regulated national standard for sulphur in HFO. The voluntary standard for HFO set by the Canadian General Standards Board (CAN/CGSB-3.2-M99) does not specify any limit for sulphur in HFO. Several provinces regulate the sulphur content of HFO; for example, British Columbia, New Brunswick, Quebec and Ontario. The Montreal Urban Community also has a by-law limiting the sulphur content in HFO.

### *International*

The European Union passed a binding directive for LFO and HFO in April 1999. For HFO, the directive requires that starting January 1, 2003 sulphur content not exceed 1.0% wt. There are provisions that allow countries unaffected by acidic deposition (specifically, Spain, Portugal and Greece) to apply for a derogation which would permit them to set a limit of up to 3.0% wt. As well, the EU allows sulphur levels higher than 1% if facilities using that fuel meet SO<sub>2</sub> caps and monitoring requirements. Austria, Denmark, Finland, Germany and the Netherlands already require 1.0% sulphur in HFO, and Belgium, Denmark and Sweden have tax incentives for low-sulphur HFO.

A number of US states, including Maine, Michigan, Delaware, Texas and New York, have requirements for sulphur in HFO. Table 2.4 presents the details. Note that some states regulate sulphur dioxide emissions from boilers rather than the sulphur content of the fuel.

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<sup>2</sup> Sulphur Mass = Fuel Volume x %Sulphur x Density.

All regulated limits for HFO are per-litre (or per-gallon) maximum limits. Unlike Canadian and US limits for sulphur limits in gasoline, there are no limits on annual average levels of sulphur in fuel oils.

### **2.3 *Benefits of Reducing Sulphur in HFO***

Reducing sulphur in HFO would reduce emissions of sulphur dioxide and sulphate particles. Table 2.5 shows the amount by which sulphur oxide emissions (primarily SO<sub>2</sub>) would be reduced for sulphur limits of 2.0%, 1.5%, 1.0% and 0.5% by weight. Setting limits for HFO could reduce national emissions of sulphur oxides by 50 to 215 kilotonnes per year (depending on the limit set). This corresponds to a reduction of between 2 and 8% of the national SO<sub>2</sub> emissions inventory<sup>3</sup>. Almost all of these reductions (95%) would occur in central and eastern Canada - areas sensitive to acidic deposition.

### **2.4 *Price Differentials for Low Sulphur and Regular HFO***

In the US low sulphur HFO is a distinct commercial product. Figure 2.5 shows the historical price difference for sales to end users between low sulphur HFO and regular HFO in the US from 1978 to 1998. The average difference during this period was 7.8 US cents per gallon (or 3.1 Cdn cents per litre). Over the 22 year period, the difference varied from a low of about 4 to over 15 US cents per gallon. Over the last five years the average difference was 7.2 US cents per gallon (2.8 Cdn cents per litre) and the range was 3.0 to 12.6 US cents per gallon. Figure 2.6 shows the monthly price difference between regular and low sulphur HFO during 1998 and 1999.

## **3. LIGHT FUEL OIL**

### **3.1 *Sulphur Levels in Canada***

Similar to HFO, very little LFO is used outside of central and eastern Canada. Sources that use LFO, such as residential furnaces, are widely dispersed and can be thought of as “area” (rather than “point”) sources.

Table 3.1 provides volumes of LFO produced, exported and imported in Canada in 1999. Imports of LFO accounted for approximately 1% of the national demand. Of LFO produced in Canada in 1999, nearly half (45%) was exported.

Table 3.2 provides a summary of source countries for imported LFO and the corresponding percent of demand is shown in Table 3.3. The destinations of Canadian LFO exports are given in Table 3.4. Nearly all exported LFO goes to the US.

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<sup>3</sup> Based on Canada's 1998 inventory

Figure 3.1 shows the change in quarterly national and regional volume of LFO produced and imported over the period 1994 to 1999. This figure shows, not surprisingly, significant increases in production and importation of LFO during the winter.

Figure 3.2 shows the regional sulphur levels for LFO for the years 1994 to 1999. Quebec had the highest average level during this period. Since 1994, the average level of sulphur in LFO in Quebec has increased by 42%. Sulphur levels in LFO are lowest in the West. In the Atlantic region, LFO sulphur levels have decreased by 34% since 1994.

Figure 3.3 shows the total sulphur mass in LFO in Canada. Nationally the sulphur mass has varied from a low of 7.1 kilotonnes in 1995 to a high of 8.7 kilotonnes in 1999. Figure 3.4 presents the LFO sulphur levels for LFO produced and imported by individual refiners between 1994 and 1999 and importers between 1998 and 1999.

In January 1998, the federal *Diesel Fuel Regulations* came into effect. These regulations require that sulphur in diesel for use in on-road vehicles not exceed 500 ppm (0.05% by weight). In implementing these regulations, it appears that some refineries initially elected to divert some of their higher-sulphur streams away from the diesel pool and into the LFO pool. In 1998, a 48% decrease in sulphur levels in the total diesel pool from 1997 levels in central and eastern Canada was accompanied by a 31% increase in the average sulphur level in LFO. However, LFO sulphur levels subsequently decreased in 1999, as shown in Figure 3.5. The total sulphur mass in LFO in central and eastern Canada increased only minimally (about 1%) between 1997 and 1998 because the volumes of LFO decreased during this period. In 1999 total sulphur mass in LFO decreased by 14% in central and eastern Canada (refer to Figure 3.6).

### **3.2 Regulated Limits for Sulphur in LFO**

#### *Canada*

There is no regulated national standard for sulphur in LFO. The voluntary standard for LFO set by the Canadian General Standards Board (CAN/CGSB-3.2-M99) is 0.5% wt., although type 0 is lower (0.3% by weight). Several provinces regulate the sulphur content of LFO; for example, New Brunswick, Ontario and Quebec.

#### *International*

Since 1994, the European Union has required that the sulphur content of LFO be less than 0.2% wt. The European Union passed a binding directive for LFO and HFO in April 1999. For LFO, the directive requires that starting January 1, 2008 sulphur not exceed 0.1% wt. There are provisions that allow countries unaffected by acidic deposition (specifically, Spain, Portugal and Greece) to apply for a derogation which would permit them to maintain the current limit of 0.2% wt. Austria and Finland already require 0.1% sulphur in LFO, and Denmark and Sweden have tax incentives for low-sulphur LFO.

A number of US states have requirements for sulphur in LFO; e.g. Texas, Delaware and other north eastern states. (Note that many states regulate SO<sub>2</sub> emissions from boilers rather than the sulphur content of the fuel.)

All regulated limits for LFO are per-litre (or per-gallon) maximum limits. Unlike sulphur limits for gasoline, there are no limits on annual average levels for fuel oils. Table 3.5 presents the details on the regulated levels for LFO.

### **3.3 Benefits of Reducing Sulphur in LFO**

Reducing sulphur in LFO would reduce emissions of sulphur dioxide and sulphate particles. Table 3.6 shows the reductions in emissions of sulphur oxides which would result for sulphur limits of 2000, 1500, 1000 and 500 ppm. Setting limits for LFO could reduce national emissions of sulphur oxides (primarily SO<sub>2</sub>) by 4 to 12 kilotonnes per year (depending on the limit set). As with HFO, almost all (99%) of the reductions would occur in central and eastern Canada.

### **3.4 Price Differentials for Low Sulphur and Regular LFO**

Environment Canada is not aware of any available price information on the difference between low sulphur and regular LFO.

## **REFERENCES**

Environment Canada, *Sulphur in Liquid Fuels – 1994 to 1999*.

Environment Canada, *1999 Annual Progress Report on the Canada-Wide Acid Rain Strategy for Post-2000*, November 1999.

European Union, 1999. *Council Directive 1999/32/EC of 26 April 1999 relating to a reduction in the sulphur content of certain liquid fuels and amending Directive 93/12/EEC*. Official Journal L121, Document 399L0032, May 11, 1999, pp. 0013-0018.

Statistics Canada, *Refined Petroleum Products (Manufacturing, Construction and Energy Division)*, Report 45-004, Vol. 54, No.12, December 1999.

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**Table 1.1: Distribution of Sulphur in Fuels**

Fuel	Distribution of Sulphur in Fuels (%)*					
	1994	1995	1996	1997	1998	1999
Heavy Fuel Oil	64.5	65.8	60.8	61.1	67.5	73.3
Refinery Consumption**	10.9	11.0	14.7	15.9	13.5	7.7
Light Fuel Oil	5.5	4.5	4.8	4.7	4.7	4.4
Regular Diesel	12.5	10.4	11.1	9.8	4.9	4.5
Low-Sulphur Diesel	0.0	1.1	1.3	1.6	2.4	3.0
Gasoline	4.9	5.4	5.3	5.0	5.1	5.2
Others	1.7	1.8	1.9	1.9	1.8	1.8
Total Diesel	12.5	11.5	12.4	11.4	7.3	7.5
HFO + Ref. Consump.	75.4	76.8	75.5	77.0	81.0	81.0

\* From Environment Canada *Sulphur in Liquid Fuels Reports 1994-1999*

\*\* Almost always heavy fuel oil



**Table 1.2: Volumes of LFO and HFO Produced and Imported in Canada**  
 - Comparison of Statistics Canada and Environment Canada data

<b>Fuel</b>	<b>Year</b>	<b>Statistics Canada (m<sup>3</sup>)</b>	<b>Environment Canada (m<sup>3</sup>)</b>
LFO	1994	5,312,193	5,147,395
	1995	5,903,953	4,050,456
	1996	6,303,971	4,284,822
	1997	5,605,118	4,867,643
	1998	4,715,336	4,432,544
	1999	4,895,393	4,288,089
HFO excluding refinery consumption	1994	6,986,268	6,298,433
	1995	7,539,058	5,672,816
	1996	6,894,087	5,787,813
	1997	7,900,343	6,308,889
	1998	8,519,158	7,677,638
	1999	7,484,554	7,103,971
HFO including refinery consumption	1994	7,847,617	7,305,599
	1995	8,400,407	6,522,157
	1996	7,897,225	7,339,986
	1997	8,939,037	7,995,515
	1998	9,460,214	8,788,554
	1999	8,407,192	7,899,772

**Notes:**

- Sources for Statistics Canada data: Catalogue 45-004
- Source for Environment Canada data: *Sulphur in Liquid Fuels*, 1994-99 Reports
- Environment Canada volumes reflect mostly production at the various refineries, while Statistics Canada considers opening and closing inventories and inter-product transfers

**Table 2.1: Regional Supply of HFO**  
(Source: Statistics Canada Publication 45-004 - 1999)

HFO	Volume (m <sup>3</sup> )				
	Production	Exports	Imports	Sales	Refinery Consumption
Atlantic	2,583,964	1,018,557	2,155,809	3,498,510	372,158
Quebec	1,975,985	261,561	336,700	2,190,659	188,660
Ontario	1,628,268	157,381	29,098	929,191	359,379
Alberta	662,735	34,148	-	54,618	-
Rest	182,452	166,468	290,900	811,576	2,441
<b>CANADA</b>	<b>7,033,404</b>	<b>1,638,115</b>	<b>2,812,507</b>	<b>7,484,554</b>	<b>922,638</b>
<b>Percent breakdown</b>					
Atlantic	37%	62%	77%	47%	40%
Quebec	28%	16%	12%	29%	20%
Ontario	23%	10%	1%	12%	39%
Alberta	9%	2%	0%	1%	0%
Rest	3%	10%	10%	11%	0%
<b>CANADA</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>

**Table 2.2: Sources of Imported HFO**  
(Source: Revenue (Customs) Canada - 1998)

Country	Heavy Fuel Oil								
	Atlantic	Quebec	Ontario	Prairies	B.C.	Yukon	NWT/Nun.	CANADA	Percent
<b>UNITED STATES</b>	<b>483,773</b>	<b>31,089</b>	<b>236,951</b>	<b>7</b>	<b>309,479</b>	<b>-</b>	<b>-</b>	<b>1,061,299</b>	<b>45%</b>
Washington					298,269			298,269	13%
Connecticut	40,590		234,648					275,238	12%
Texas	238,994	31,089		7				270,090	12%
Louisiana	102,160							102,160	4%
New York	96,416							96,416	4%
California					11,209			11,209	0%
Maine	5,613							5,613	0%
Wisconsin			2,093					2,093	0%
Ohio			210					210	0%
Other	0.1							0.1	0%
<b>NON-US</b>	<b>1,034,766</b>	<b>200,144</b>	<b>45,445</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>1,280,355</b>	<b>55%</b>
Venezuela	809,158							809,158	35%
Nigeria		101,495	45,445					146,940	6%
Brazil	39,379	63,849						103,227	4%
Neth. Antilles	41,143	18,000						59,143	3%
Trinidad	49,071							49,071	2%
Columbia	46,747							46,747	2%
Russia	33,898							33,898	1%
Germany		14,801						14,801	1%
Norway	8,719							8,719	0%
Lithuania	6,651							6,651	0%
Netherlands		2,000						2,000	0%
Other								-	0%
<b>TOTAL</b>	<b>1,518,539</b>	<b>231,233</b>	<b>282,395</b>	<b>7</b>	<b>309,479</b>	<b>-</b>	<b>-</b>	<b>2,341,653</b>	<b>100%</b>

Note: only 1998 data available

**Table 2.3: Contribution of Imports: Percent of Demand**  
(Source: Statistics Canada publication 45-004 for 1998 & 1999)

Region	Percent of HFO demand, 1998	Percent of HFO demand, 1999
Atlantic	61	62
Quebec	28	15
Ontario	23	3
Alberta	0	0
Rest	26	36
<b>CANADA</b>	<b>42</b>	<b>38</b>

**Table 2.4: Regulations on Sulphur in HFO**

Jurisdiction	Sulphur Max. (% wt.)	Regulation	Notes
<b>CANADA</b>			
Canada - Federal	-	None	
CGSB (voluntary)	-	CAN/CGSB-3.2-M99	No limits specified
British Columbia	1.1	Sulphur Content of Fuels (67/89)	Applies all fuel oils
New Brunswick	1.5-3.0	Air Quality (83-208 / am. 1995)	Type 4 = 1.5% wt.; Type 5 = 2.0% wt.
Ontario	1.5	Sulphur Content of Fuels (361-90)	Only applies in Metro Toronto
	1.0	Boiler (338-90)	Only applies to boiler fuel; Exempts Ontario Hydro (has SO2 limit)
Quebec	2.0	Règlement sur la qualité de l'atmosphère	
Montreal	1.0-1.5	By-law 90	Eff. 1987
<b>US</b>			
US Federal	-	None	
Connecticut	1.0	Section 22a-174-19	
Delaware	1.0	SO2 Emissions from Fuel Burning Equipment (8)	Only in New Castle County
Idaho	1.75		Applies to all the state
Maryland	1.0-2.0		1.0% wt. in urban areas; 2.0% wt. in rural areas
Massachusetts	0.5-2.2	310 CMR 7.05	Sale or use in excess of following limits prohibited: Metro Boston - 0.5%; Berkshire district - 2.2%; Other parts of state - 1.0 to 2.2%
Michigan	1.0-1.5	Emission Limitations and Prohibitions (R336.1401)	Small boilers 1.5% wt.; Large boilers 1.0% wt.; Eff. 1978
Maine	1.0-2.0	Low Sulphur Fuel (Chapter 106)	Eff. 1991; 1.0% wt. in Portland; 2.0% wt. rest of state
New Hampshire	1.0-2.0	Chap Env - A 401	1% for No. 4 oil; 2% for No. 5 and 6 oils
New York	0.3-1.5	Fuel Composition and Use (ch. III, subpart 225.1)	Dependent on region; 0.3% wt. in NYC
Rhode Island	1.0	Regulation No. 8	
Texas	0.3	Environmental Quality (30 part I, ss. 112.9)	Only in Harris & Jefferson counties; Eff. 1993
Vermont	2.0		All state, unless another limit is stated in a "bubble" rule
<b>EUROPE</b>			
European Union (2003)	1.0	Sulphur Content of Certain Liquid Fuels (1999/32/EC)	Eff. 2003; option for 3% in Spain, Portugal and Greece
Austria	1.0		More severe restrictions (0.2-0.6%) on heating plants depending on their age and capacity
Belgium	3.0		Tax incentives for 1% (as a result, almost all is <1%)
Denmark	1.0		graduated tax on sulphur content to encourage lower levels
Finland	1.0		

**Table 2.4 continued**

France	4.0		
Germany	1.0		Only for plants > 1 MW
Greece	0.7-3.2		0.7% in Athens
Ireland	-		some SO2 caps force use of some 1%
Italy	3.0		
Netherlands	1.0		Plants must use 1% or meet sulphur caps
Portugal	3.5		
Spain	3.5		
Sweden	-		SO2 caps effectively force 0.2-0.8%; graduated sulphur tax on fuel sulphur

**Table 2.5: Expected Reductions in SO<sub>2</sub> Emissions from HFO for Selected Sulphur Limits (based on 1999 data)**

Region	Current Mass of SO <sub>2</sub> ** (tonnes/year)	Average Sulphur Level (% wt.)	Possible Limit (% wt.)	Assumed Average Sulphur Level (% wt.)	New Mass of SO <sub>2</sub> (tonnes/year)	Reduction in SO <sub>2</sub> emissions (tonnes/year)
<i>Limit = 2.0%</i>						
Atlantic	146,346	2.200%	2.00%	1.60%	106,455	39,891
Quebec	54,174	1.249%	2.00%	1.60%	54,174	-
Ontario	60,180	1.919%	2.00%	1.60%	50,164	10,016
Prairies	13,926	1.324%	2.00%	1.60%	13,926	-
B.C.	2,686	1.726%	2.00%	1.60%	2,490	196
CANADA	277,312	1.761%	2.00%	1.60%	227,209	50,103
<i>Limit = 1.5%</i>						
Atlantic	146,346	2.200%	1.50%	1.20%	79,841	66,505
Quebec	54,174	1.249%	1.50%	1.20%	52,044	2,130
Ontario	60,180	1.919%	1.50%	1.20%	37,623	22,557
Prairies	13,926	1.324%	1.50%	1.20%	12,622	1,304
B.C.	2,686	1.726%	1.50%	1.20%	1,867	819
CANADA	277,312	1.761%	1.50%	1.20%	183,998	93,314
<i>Limit = 1.0% (same as European Union's 2003 limit)</i>						
Atlantic	146,346	2.200%	1.00%	0.80%	53,227	93,119
Quebec	54,174	1.249%	1.00%	0.80%	34,696	19,478
Ontario	60,180	1.919%	1.00%	0.80%	25,082	35,098
Prairies	13,926	1.324%	1.00%	0.80%	8,415	5,511
B.C.	2,686	1.726%	1.00%	0.80%	1,245	1,441
CANADA	277,312	1.761%	1.00%	0.80%	122,665	154,647
<i>Limit = 0.5%</i>						
Atlantic	146,346	2.200%	0.50%	0.40%	26,614	119,732
Quebec	54,174	1.249%	0.50%	0.40%	17,348	36,826
Ontario	60,180	1.919%	0.50%	0.40%	12,541	47,639
Prairies	13,926	1.324%	0.50%	0.40%	4,207	9,719
B.C.	2,686	1.726%	0.50%	0.40%	622	2,064
CANADA	277,312	1.761%	0.50%	0.40%	61,333	215,979

**Notes:**

- Assumed average sulphur level is 80% of regulated limit
- HFO totals include HFO used for refinery consumption
- Assuming all sulphur converted to SO<sub>2</sub> (and none to SO<sub>4</sub>) then mass of SO<sub>2</sub> = 2 x mass of sulphur
- Source: Environment Canada, *Sulphur in Liquid Fuels - 1999*

**Table 3.1: Regional Supply of LFO**  
 (Source: Statistics Canada publication 45-004 - 1999)

LFO	Volume (m <sup>3</sup> )				
	Production	Exports	Imports	Sales	Refinery Consumption
Atlantic	4,634,456	3,212,567	10,173	1,549,467	2,275
Quebec	2,080,480	343,677	20,814	1,723,545	404
Ontario	1,155,023	173,560	14,200	1,262,197	15,033
Alberta	84,217	-	-	34,643	-
Rest	300,950	16,261	11,539	325,541	175
<b>CANADA</b>	<b>8,255,126</b>	<b>3,746,065</b>	<b>56,726</b>	<b>4,895,393</b>	<b>17,887</b>
<b>Percent breakdown</b>					
Atlantic	56%	86%	18%	32%	13%
Quebec	25%	9%	37%	35%	2%
Ontario	14%	5%	25%	26%	84%
Alberta	1%	0%	0%	1%	0%
Rest	4%	0%	20%	7%	1%
<b>CANADA</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>	<b>100%</b>

**Table 3.2: Sources of Imported LFO**  
(Source: Revenue (Customs) Canada - 1998)

Country	Light Fuel Oil								CANADA	Percent
	Atlantic	Quebec	Ontario	Prairies	B.C.	Yukon	NWT/Nun.			
<b>UNITED STATES</b>	<b>36,028</b>	<b>0.1</b>	<b>622</b>	<b>0.2</b>	<b>11,927</b>	<b>7,751</b>	-	<b>56,329</b>	<b>93%</b>	
US Virgin Islands	32,597							32,597	54%	
Washington					7,949			7,949	13%	
Arkansas					3	7,751		7,754	13%	
Arizona					3,974			3,974	7%	
Maine	2,812							2,812	5%	
Louisiana	619							619	1%	
Wisconsin			299					299	0%	
Michigan		0.019	223					223	0%	
Texas			69					69	0%	
Other	0.02	0.1	31	0.2	0.8			32	0%	
<b>NON-US</b>	-	<b>4,180</b>	-	-	-	-	-	<b>4,180</b>	<b>7%</b>	
Neth. Antilles		4,180						4,180	7%	
Other		0.01						0	0%	
<b>TOTAL</b>	<b>36,028</b>	<b>4,180</b>	<b>622</b>	<b>0.2</b>	<b>11,927</b>	<b>7,751</b>	-	<b>60,509</b>	<b>100%</b>	

Note: only 1998 data available only

**Table 3.3: Contribution of Imports: Percent of Demand**  
(Source: Statistics Canada publication 45-004 for 1998 & 1999)

Region	Percent of LFO demand in 1998	Percent of LFO demand in 1999
Atlantic	0.2	0.7
Quebec	< 0.1	1.2
Ontario	0.4	1.1
Alberta	< 0.1	< 0.1
Rest	4.8	3.5
<b>CANADA</b>	<b>0.4</b>	<b>1.2</b>



**Table 3.4: Destination of Exported Light Fuel Oil (1998)**  
 (Source: Statistics Canada, special request)

<b>Country of destination</b>	<b>Quantity (m3)</b>	<b>Percent of total</b>
United States	2,946,279	94%
Brazil	122,565	4%
Ghana	37,505	1%
Ecuador	33,217	1%
St. Pierre & Miq.	4,276	0.1%
Sudan	60	0.002%
Cuba	13	0.0004%
<b>Total</b>	<b>3,143,916</b>	<b>100%</b>

**Table 3.5: Regulations on Sulphur in LFO**

<b>Jurisdiction</b>	<b>Sulphur Max. (% wt.)</b>	<b>Regulation</b>	<b>Notes</b>
<b>CANADA</b>			
Canada - Federal	-	None	
CGSB (voluntary)	0.5	CAN/CGSB-3.2-M99	Type 0 = 0.3% wt.; Types 1 and 2 = 0.5% wt.
New Brunswick	0.5	Air Quality (83-208 / am. 1995)	
Ontario	0.5	Sulphur Content of Fuels (361-90)	Only applies in Metro Toronto
Quebec	0.5	Petroleum Products (753-91)	Type 00 = 0.2% wt.
<b>US</b>			
US Federal	-	None	
Connecticut	0.3	Section 16a-21a	
Delaware	0.3	SO <sub>2</sub> Emissions from Fuel Burning Equipment (8)	
Massachusetts	0.3	310 CMR 7.05	
New Hampshire	0.4%	Chapter Enf - A 401	
New York	0.2-1.5	Fuel Composition and Use (ch. III, subpart 225.1)	Dependent on region; 0.2% wt. in NYC
Texas	0.3	Environmental Quality (30 part I, ss. 112.9)	Only in Harris & Jefferson counties; Eff 1993
<b>EUROPE</b>			
European Union	0.2	Sulphur Content of Certain Liquid Fuels (93/12/EEC)	Eff. 1994
European Union (2008)	0.1	Sulphur Content of Certain Liquid Fuels (1999/32/EC)	Eff. 2008; option for 0.2% for Spain, Portugal and Greece
Austria	0.1		current limit
Denmark	-		graduated tax
Finland	0.1		current limit
Sweden	-		tax on sulphur in fuel

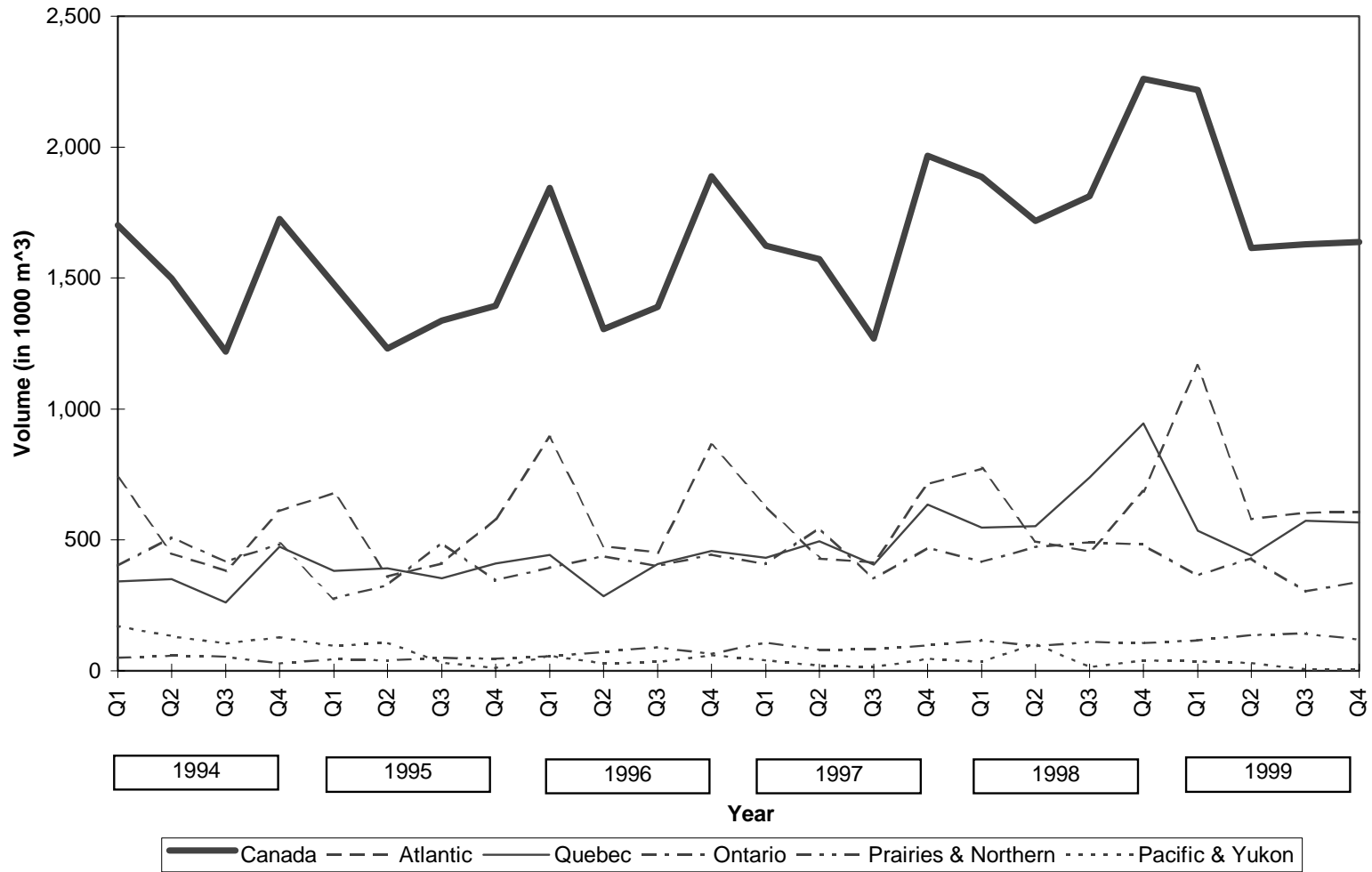
**Table 3.6: Expected Reductions in SO<sub>2</sub> Emissions from LFO for Selected Sulphur Limits (based on 1999 data)**

Region	Current Mass of SO <sub>2</sub> * (tonnes/year)	Average Sulphur Level (% wt.)	Possible Limit (% wt.)	Assumed Average Sulphur Level (% wt.)	New Mass of SO <sub>2</sub> (tonnes/year)	Reduction in SO <sub>2</sub> emissions (tonnes/year)
<b>Limit = 2000 ppm (same as current European Union limit)</b>						
Atlantic	3,140	0.132%	0.20%	0.150%	3,568	- 428
Quebec	6,944	0.252%	0.20%	0.150%	4,133	2,811
Ontario	4,864	0.223%	0.20%	0.150%	3,272	1,592
Prairies	-	-	-	-	-	-
B.C.	124	0.177%	0.20%	0.150%	124	-
CANADA	15,072	0.203%	0.20%	0.150%	11,097	3,975
<b>Limit = 1500 ppm</b>						
Atlantic	3,140	0.132%	0.15%	0.113%	2,676	464
Quebec	6,944	0.252%	0.15%	0.113%	3,100	3,844
Ontario	4,864	0.223%	0.15%	0.113%	2,454	2,410
Prairies	-	-	-	-	-	-
B.C.	124	0.177%	0.15%	0.113%	124	-
CANADA	15,072	0.223%	0.15%	0.113%	8,354	6,718
<b>Limit = 1000 ppm (same as European Union's 2008 limit)</b>						
Atlantic	3,140	0.132%	0.10%	0.075%	1,784	1,356
Quebec	6,944	0.252%	0.10%	0.075%	2,067	4,877
Ontario	4,864	0.223%	0.10%	0.075%	1,636	3,228
Prairies	-	-	-	-	-	-
B.C.	124	0.177%	0.10%	0.075%	124	-
CANADA	15,072	0.223%	0.10%	0.075%	5,611	9,461
<b>Limit = 500 ppm (same as current on-road diesel limit)</b>						
Atlantic	3,140	0.132%	0.05%	0.038%	892	2,248
Quebec	6,944	0.252%	0.05%	0.038%	1,033	5,911
Ontario	4,864	0.223%	0.05%	0.038%	818	4,046
Prairies	-	-	-	-	-	-
B.C.	124	0.177%	0.05%	0.038%	26	98
CANADA	15,072	0.223%	0.05%	0.038%	2,770	12,302

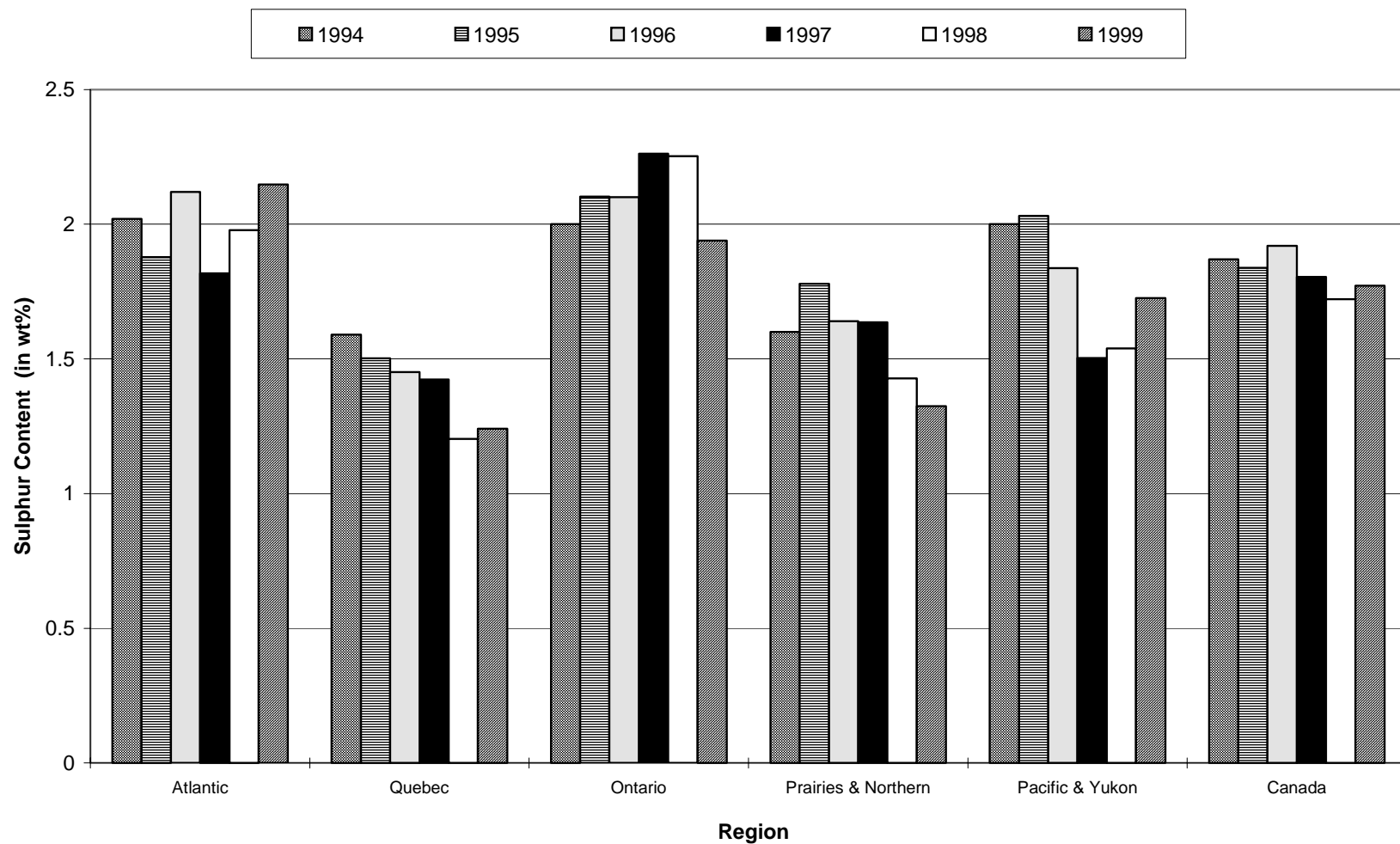
**Notes:**

- Assumed average sulphur level is 80% of regulated limit
- HFO totals include HFO used for refinery consumption
- Assuming all sulphur converted to SO<sub>2</sub> (and none to SO<sub>4</sub>) then mass of SO<sub>2</sub> = 2 x mass of sulphur
- Source: Environment Canada, *Sulphur in Liquid Fuels - 1999*

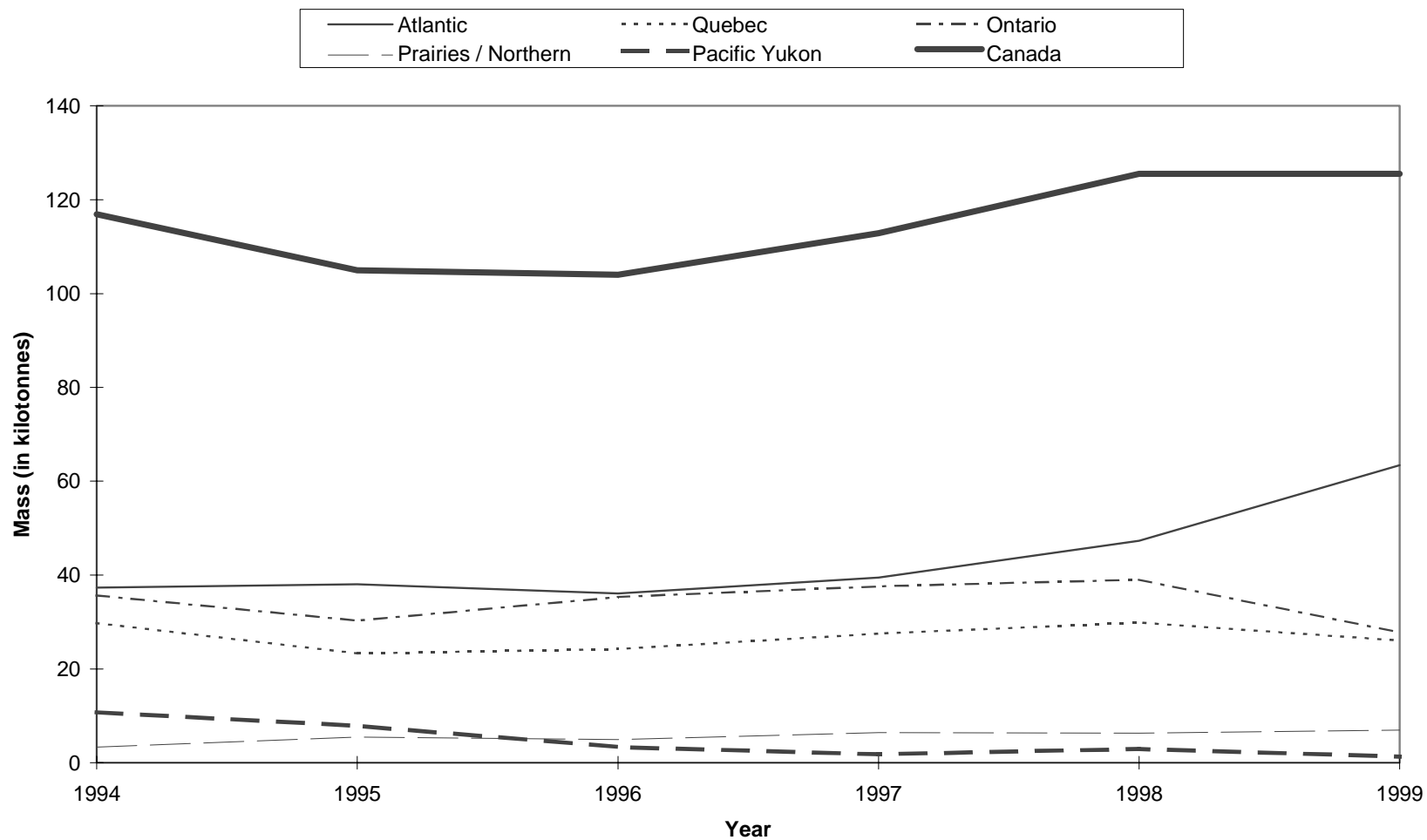
**Figure 2.1: Volume of Heavy Fuel Oil Produced or Imported by Region during 1994-1999**



**Figure 2.2: Average Sulphur Content of Heavy Fuel Oil by Region during 1994-1999**



**Figure 2.3: Total Mass of Sulphur in Heavy Fuel Oil  
by Region during 1994-1999**



**Figure 2.4: Average Sulphur Content of Heavy Fuel Oil by Refinery during 1994-1999 and Importer during 1998-1999**

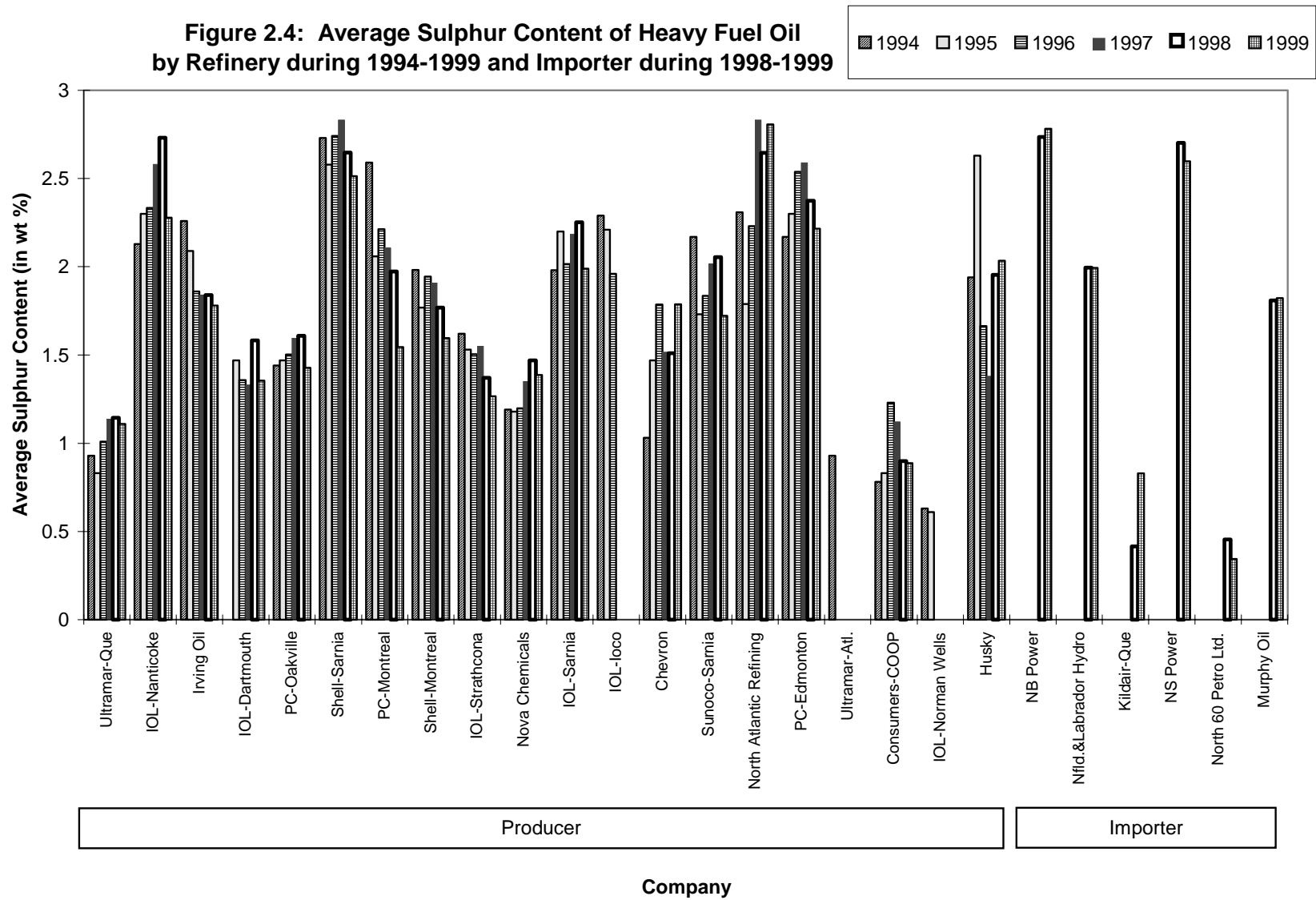


Figure 2.5: Price Difference - LS HFO vs. Reg. HFO

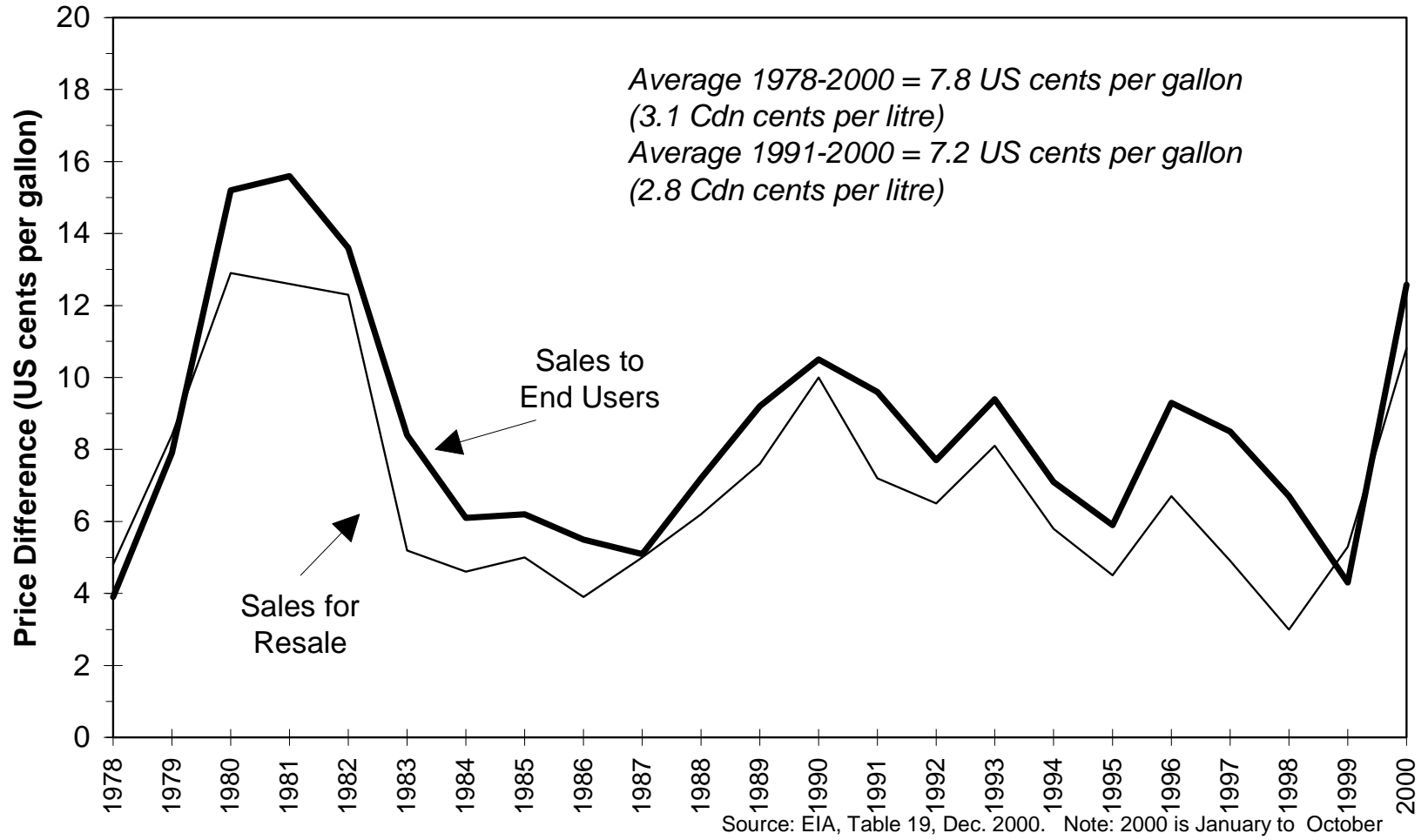
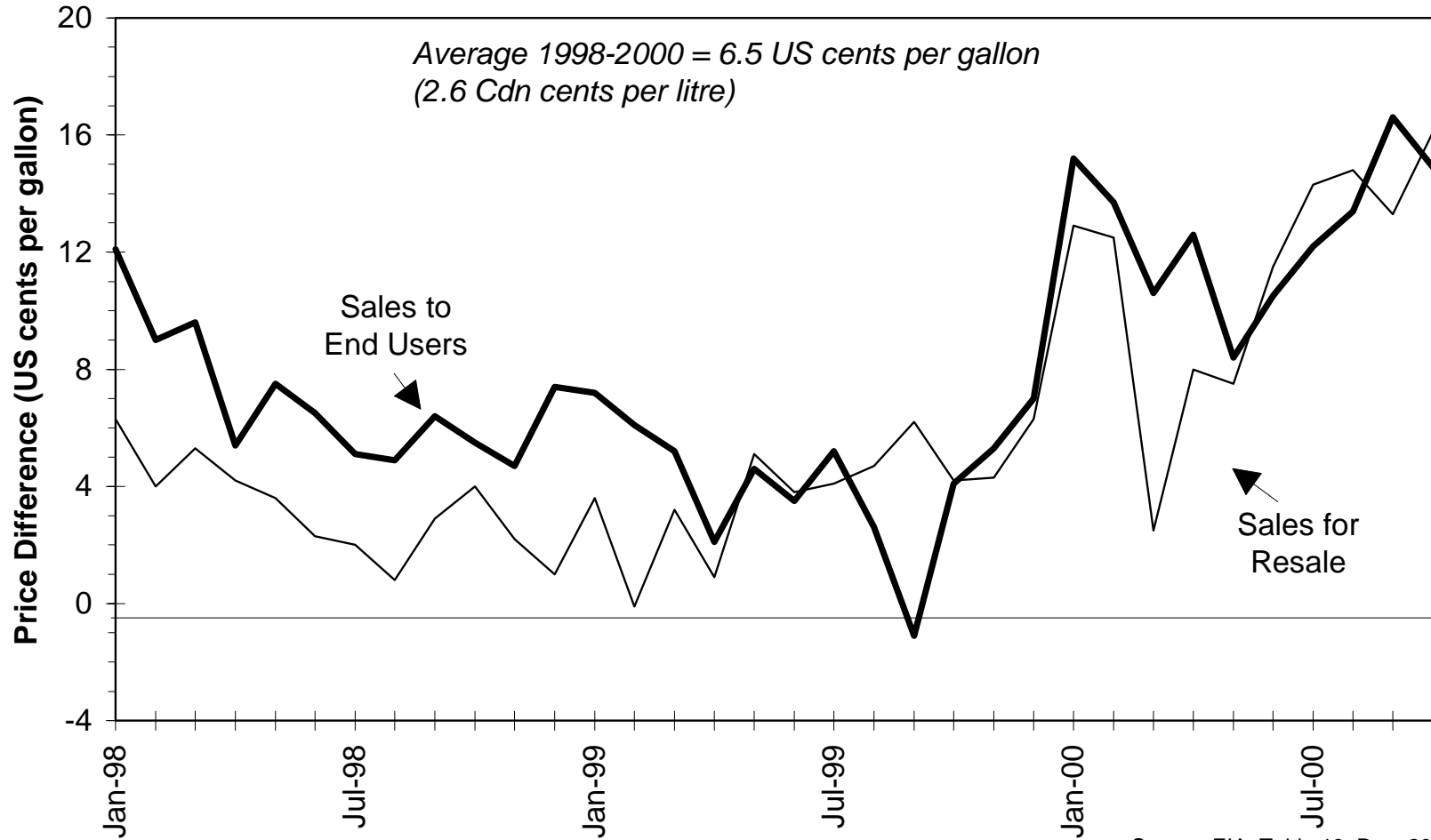
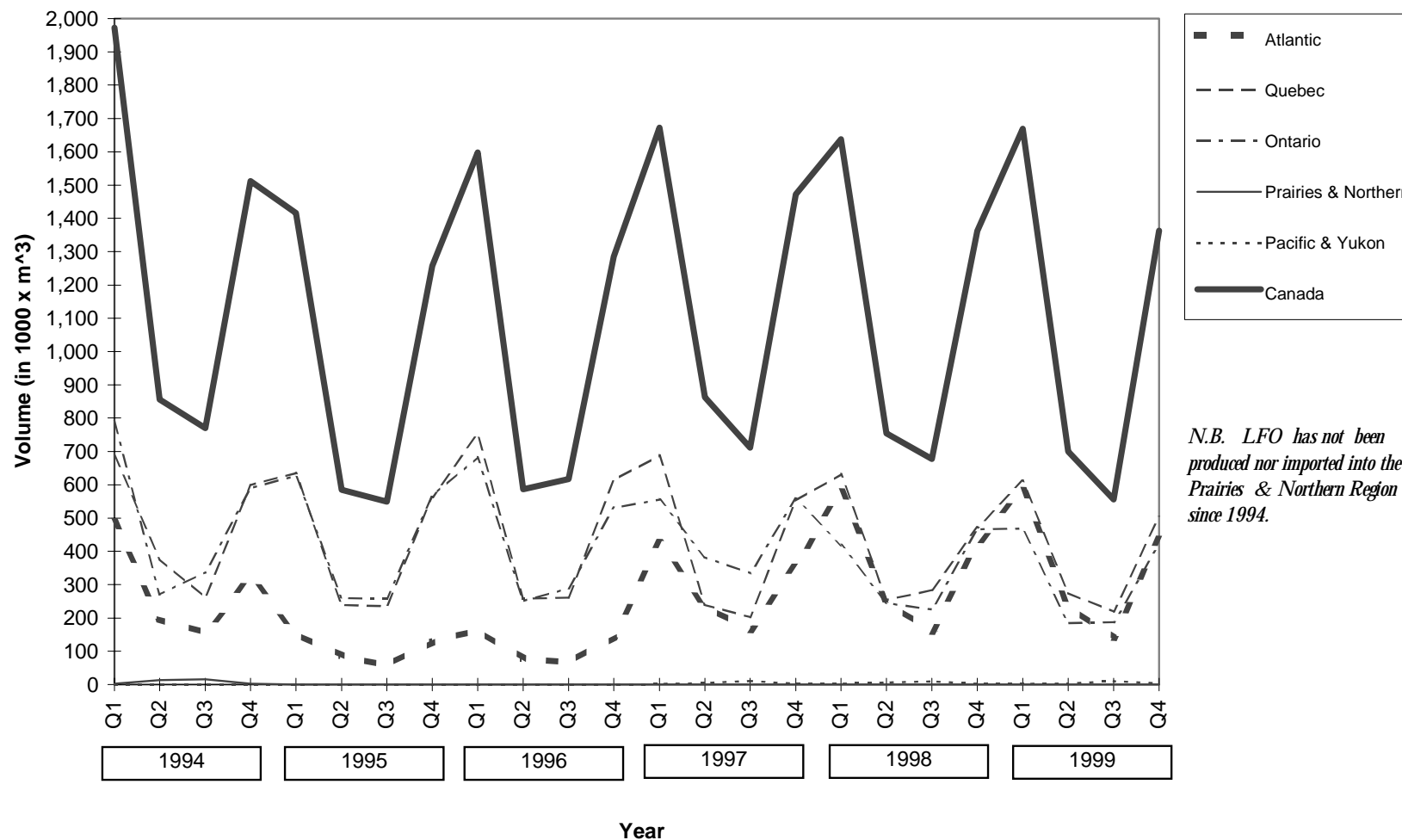




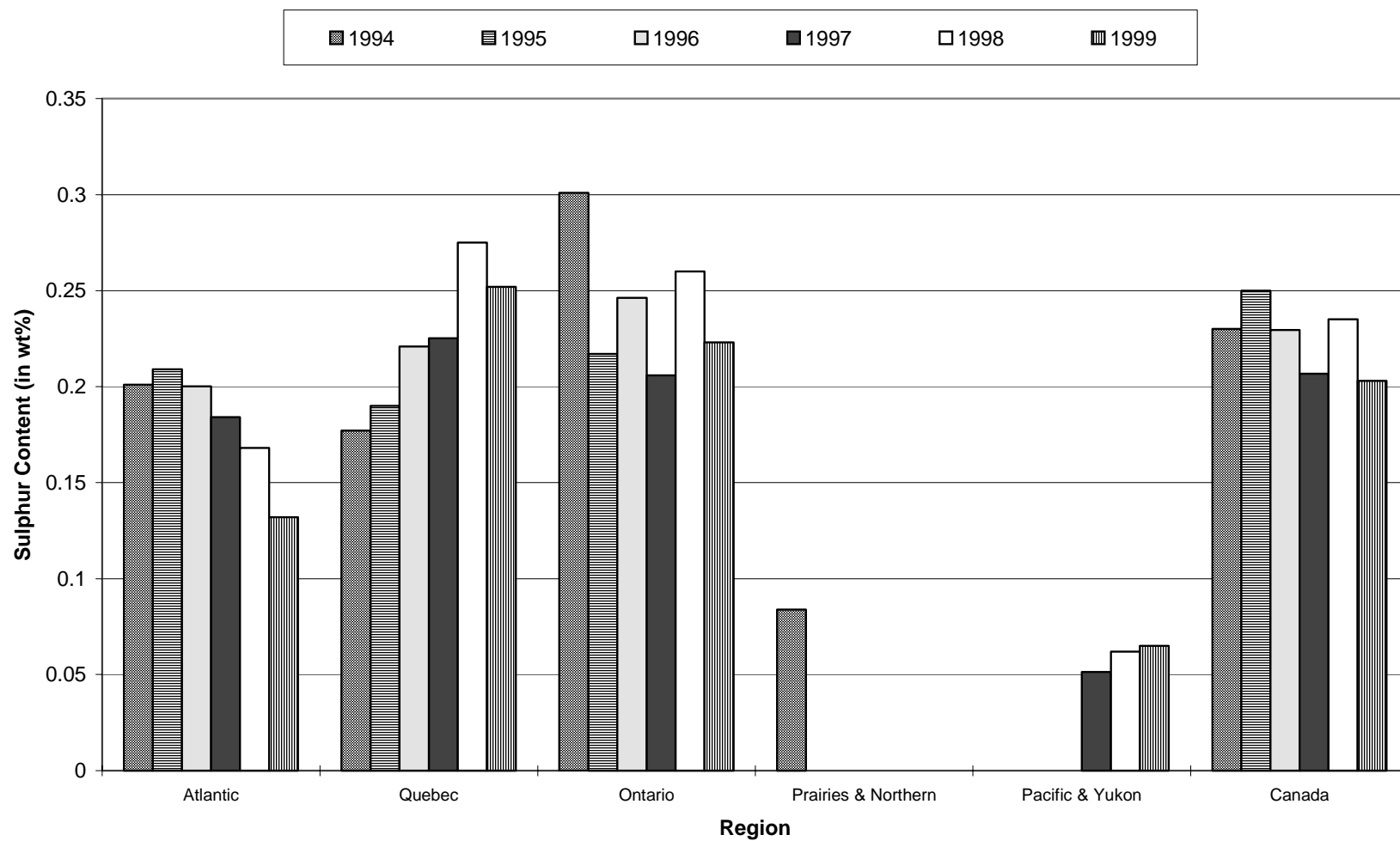
Figure 2.6: Price Difference -- LS HFO vs. Reg. HFO



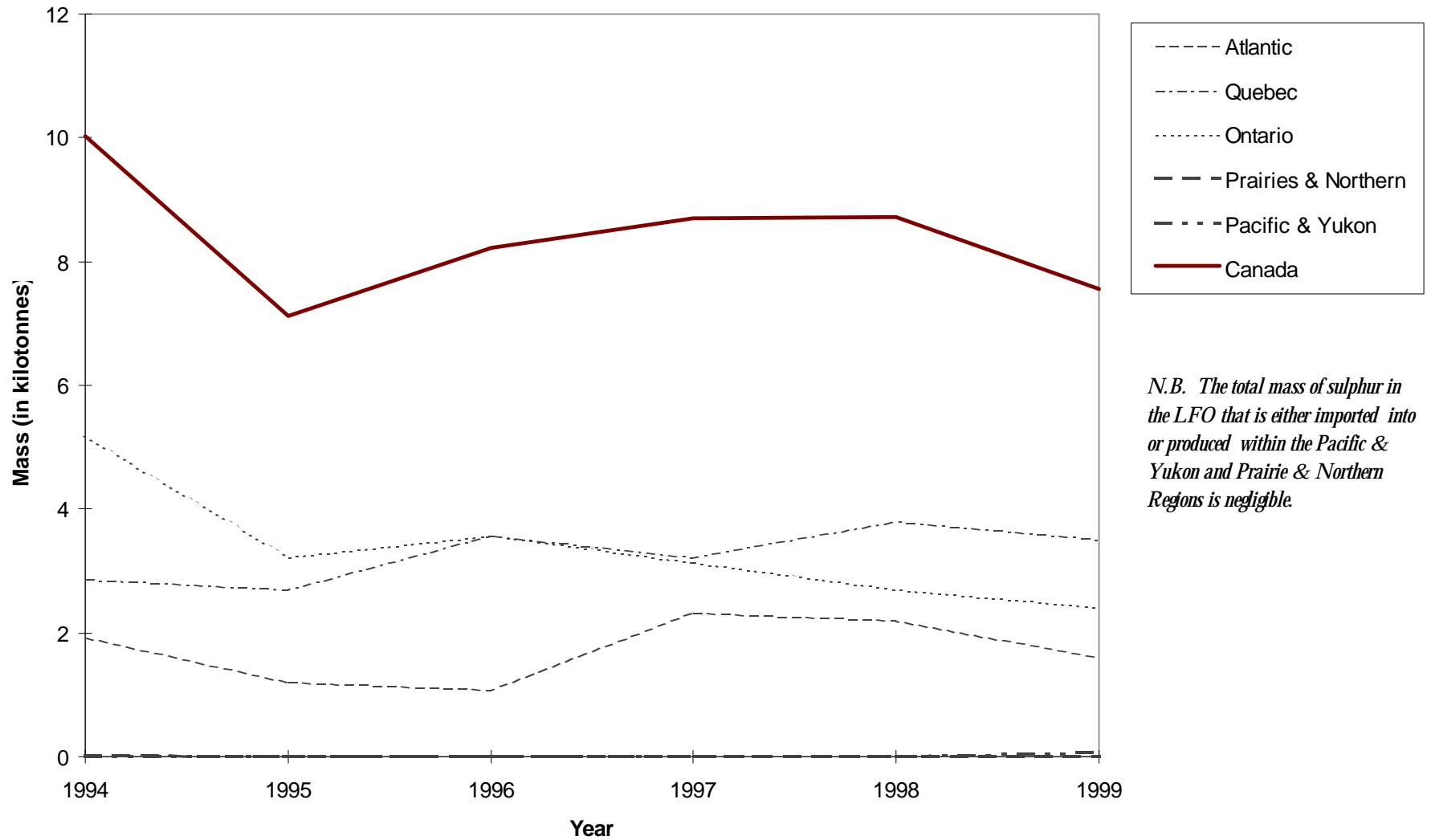
**Figure 3.1: Volume of Light Fuel Oil Produced or Imported by Region during 1994-1999**



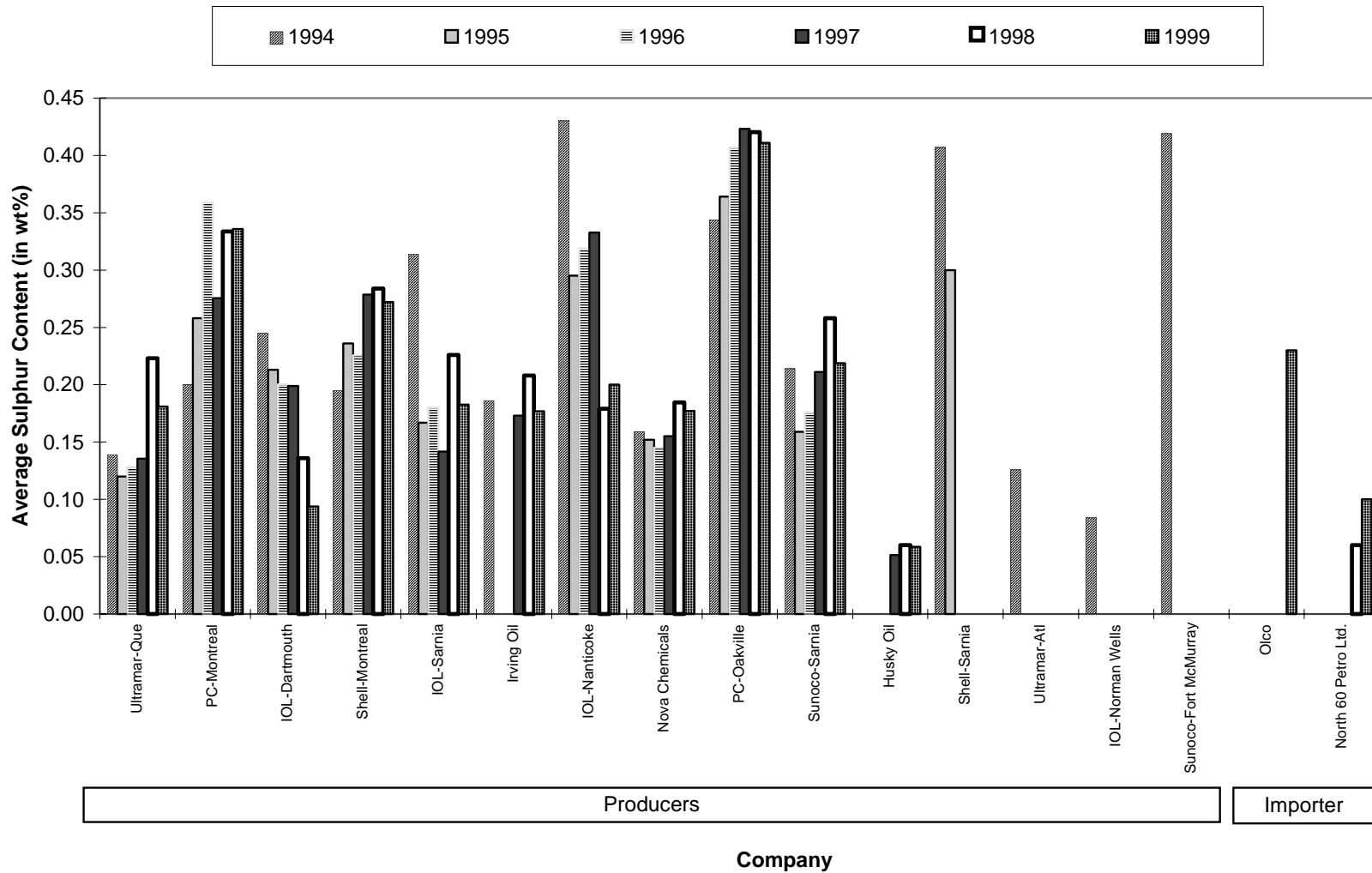
**Figure 3.2: Average Sulphur Content of Light Fuel Oil by Region during 1994-1999**



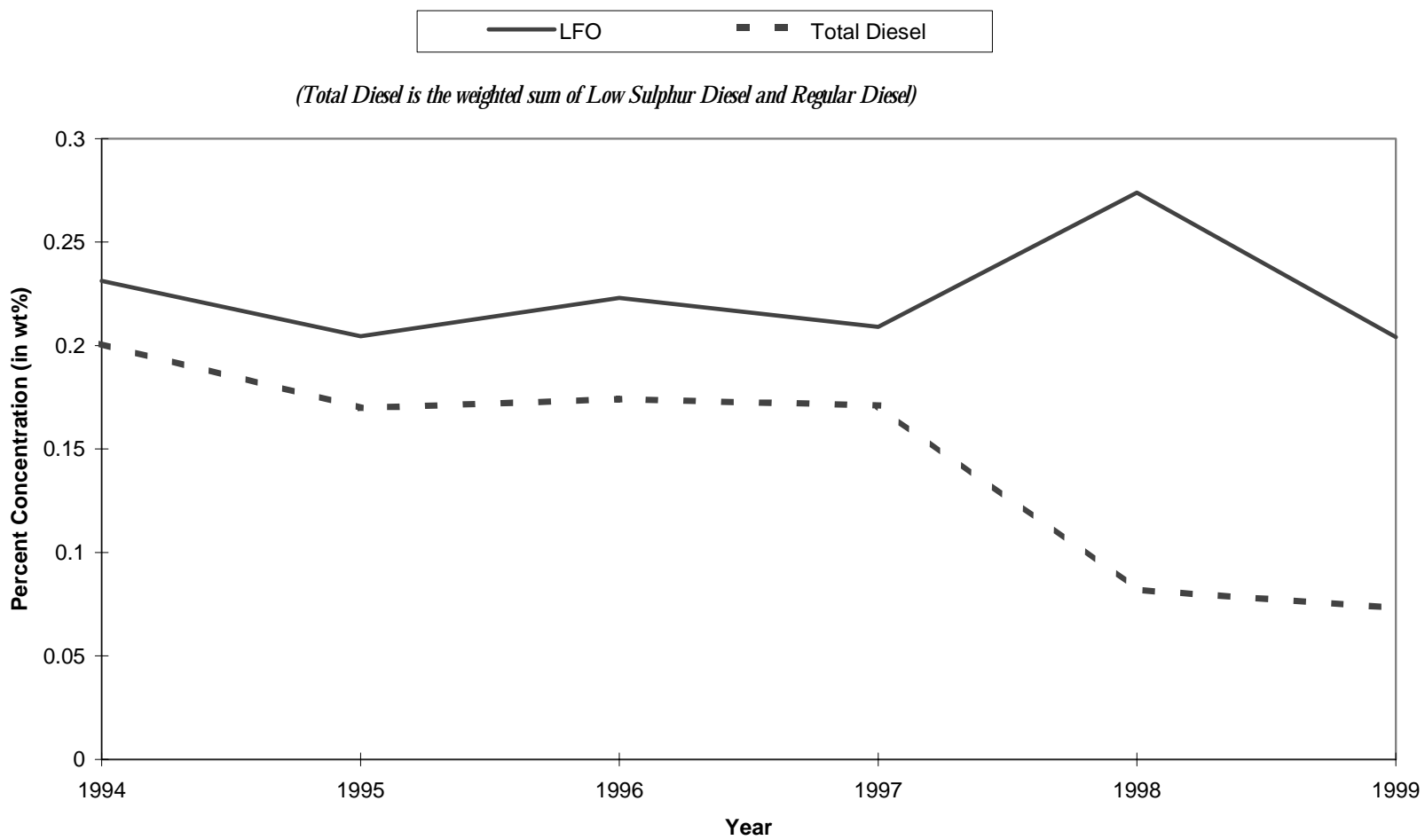
**Figure 3.3: Total Mass of Sulphur in Light Fuel Oils  
by Region during 1994-1999**



**Figure 3.4: Average Sulphur Content of Light Fuel Oil by Refinery during 1994-1999 and Importer during 1998-1999**



**Figure 3.5: Percent Concentration of Sulphur in Light Fuel Oil and Diesel during 1994-1999 in Atlantic, Quebec and Ontario Regions**



*(Total Diesel is the weighted sum of Low Sulphur Diesel and Regular Diesel)*

**Figure 3.6: Total Sulphur Mass in Various Fuels in Atlantic, Quebec and Ontario Regions during 1994-1999**

