Canadian Home Builders' Association

Association canadienne des constructeurs d'habitations

MEMO

October 10, 2000

To: All Provincial HBA Presidents and Executive Officers
From: Ken Sawatsky, President, CHBA
Re: Red Alert on Climate Change Action Plan

Red Alert

On Friday, October 6th, the Federal Government released it's *Action Plan 2000 On Climate Change*, a set of proposals for meeting Canada's Kyoto targets for greenhouse gas emission reductions. **Federal representatives also informed the CHBA that the federal and provincial Ministers of Energy and the Environment will be meeting on October 16 and 17 in Québec City to review this plan.**

CHBA's National Executive Board has reviewed the proposed federal Action Plan. While it includes some good news for our industry, it also opens the door for further regulation of housing—something our Association has strongly opposed.

As a result, the Executive Board is now asking all provincial HBA Presidents and Executive Officers to take **immediate action** to ensure that their provincial governments are aware of our industry's opposition to the additional regulation proposed in the federal Plan. As indicated above, the federal and provincial ministers will be meeting on October 16 and 17 to consider this Plan. **It is extremely important that they go to this meeting with a clear understanding of our industry's opposition to additional regulation.**

The proposed federal action plan includes two items of direct concern to our industry:

1) A renewed federal commitment to the R-2000 Program, specifically to *"promote construction and purchase of R-2000 houses, support best practices and foster competition in the market".* This is good news and responds to the CHBA's repeated calls for a clear and significant federal commitment to this market-driven initiative.

2) A proposal to *"upgrade the National Model Energy Code for Houses in partnership with the provinces and territories, and promote its adoption and implementation".* At the moment, five provinces have adopted versions of the model energy code. While the federal action plan provides few details, it seems clear that this proposal is

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aimed at increasing the requirements of the National Model Energy Code for Houses and promoting its adoption in all provinces and territories. This contradicts federal and provincial commitments to support voluntary, market-driven approaches to reducing greenhouse gas emissions, and to use regulation only as a last resort.

The CHBA has been providing provincial HBAs with regular updates on the evolution of Canada's Climate Change Action Plan. Previous briefing material sent to you outlines the CHBA's reasons for opposing energy codes for residential housing. Please use this information in your discussions with provincial government representatives. In addition, a point-form briefing note highlighting the major issues related to energy codes for housing has been prepared and is appended to this memo.

I have also attached portions of a report produced by Natural Resources Canada (NRCan) entitled *Energy Efficiency Trends in Canada 1990 to 1998* which the CHBA also received last week. This report confirms our Association's point that housing is the only sector of the economy that has actually reduced energy use and greenhouse gas production over the last decade. NRCan reports that energy efficiency in housing improved by 12.5% during this period of time—this includes all homes, old and new. This is a remarkable achievement and proof beyond doubt that market-driven approaches work in our industry. We must ensure that all levels of government recognize and understand this.

Let me stress again how important it is for your Association to take **immediate action** to ensure your provincial government understands our industry's opposition to the adoption of an upgraded energy code for houses. It is quite likely that some of the pressure to include an enhanced energy code in the Climate Change Action Plan is coming from the provinces. We need to do everything possible to change this situation before final decisions are made. That means taking action now.

Thank you for your help

Attachments:

1) Excerpt from *Action Plan 2000 on Climate Change*
2) Discussion points on an Enhanced Energy Code for Houses.
3) Excerpts from *Energy Efficiency Trends in Canada 1990 to 1998*

Discussion Points on an Enhanced Energy Code for Houses

1) Housing is the only sector of Canada's economy that has managed to reduce energy use over the last decade. A recent Natural Resources Canada (NRCan) report shows that, overall, the average Canadian home is 12.5% more energy efficient today than in 1990. Even though more than 1 million new homes have been built during that period, the total amount of energy used in homes has actually decreased. Given this achievement, additional regulation is unwarranted.

2) The NRCan report also points out that a considerable portion of the greenhouse gas emissions related to housing is produced through the generation of electricity. As a result of utility mismanagement, electricity-related emissions have increased over the last decade. According to NRCan, if these electricity-related emissions are excluded, the residential sector has cut emissions by 4.9%, close to the Kyoto target of 6% to be achieved by 2010 - 2012.

3) The improved energy efficiency of Canada's housing stock is the result of industry-led and market-driven changes. In relation to Canada's Kyoto commitments, housing provides the only "success story" to date. Our industry should be encouraged to continue this good work, not penalized through additional and unwarranted regulations like upgraded energy codes.

4) Throughout the years of consultation with the housing industry on how Canada could best meet its Kyoto Climate Change obligations, the federal and provincial governments have repeatedly committed themselves to seek voluntary, market-driven approaches rather than additional regulation. The proposal to upgrade and expand the use of energy codes for housing contradicts this commitment.

5) Additional regulation of our industry through an upgraded Model National Energy Code for Houses will undermine the viability of the very market-driven approaches that have worked so well. In addition, an upgraded energy code for houses will create added regulatory compliance costs for both government and our industry—costs which will compromise housing affordability and consumers' ability to invest in more energy efficient and environmentally responsible homes. Additional progress towards meeting Canada's climate change targets through energy efficiency in housing requires support for market-driven action, not additional regulatory infrastructure.

6) Through agreement between the federal and provincial governments, Canada is moving towards adoption of Objective-Based Building Codes. The Canadian Commission for Building and Fire Codes, the lead-agent in this process, has rejected entrenchment of energy codes in the National Building Code. Any action to promote adoption of an upgraded Energy Code for Houses by provinces will undermine efforts to modernize Canada's building code system and eliminate unnecessary building code requirements.

Municipalities

Municipalities are a key partner in efforts to reduce GHG emissions and to improve air and water quality. Recognizing their important role, in Budget 2000 the Government of Canada provided $125 million through two funds designed to help municipalities take action.

The Green Municipal Enabling Fund ($25M) is a five-year fund that provides grants to cost-share audits and feasibility studies on projects designed to reduce GHG emissions and improve air and water quality.

The Green Municipal Investment Fund ($100M) provides loans and loan guarantees to enable recipients to carry out projects such as energy efficient building retrofits and public transit systems.

4. Buildings

Buildings, including residential, commercial and institutional, contribute directly to Canada's GHG emissions by burning fossil fuels to generate heat. This represents 10 percent of total emissions in Canada. In addition, the buildings sector contributes indirectly to GHG emissions through electricity consumption, such as lighting and power for work places.

The greatest immediate potential to reduce GHG emissions is through improving the energy efficiency of existing houses and buildings. Over the long term, however, the most cost-effective approach lies with building to the most energy efficient level possible in new construction. In addition to GHG reductions, actions in these areas will result in substantial benefits including greater home comfort, buildings and homes that are healthier for our families, and dollar savings.

Measures in *Action Plan 2000:*

- *Commercial Retrofits* — Encourage high-efficiency commercial and institutional building retrofits by providing information to decision-makers on the economic and environmental benefits, assessing increased access to financing and providing financial incentives, as well as workshops, publications and expert advice to help commercial entities take action.
- *Residential Buildings* — Broaden the existing *EnerGuide for Houses* rating system and promote construction and purchase of R-2000 houses. *Action Plan 2000* will support best practices, foster competition in the market, and develop retrofit guidelines for builders and renovators.
- *Standards for Equipment and Appliances* — Improve the energy efficiency of appliances through the development of standards for residential, commercial and industrial equipment. Accelerate the penetration of high-efficiency products by providing marketing and product certification assistance to encourage the purchase of "best in class" products.
- *Energy Code* — Upgrade the *Model National Energy Code for Houses* in partnership with the provinces and territories, and promote its adoption and implementation.

These measures build on existing Government of Canada programs such as:

- *Commercial Building Incentive Program* — Provides financial incentives to encourage building owners to incorporate energy-efficient technologies and practices in designs for new commercial and institutional buildings.
- *Energy Innovators Plus* — Encourages Canadian organizations to make energy-efficiency improvements throughout their operations to lower costs and reduce GHG emissions.
- *Renewable Energy Deployment Initiative* — Provides direct financial incentives to encourage businesses, government departments and others to install proven, cost-effective space/water heating and cooling systems that use renewable-energy sources. It also provides market development and industry infrastructure support.

Residential Sector

Definition: The residential sector in Canada includes four major types of dwellings: single-detached homes, single-attached homes, apartments and mobile homes. Energy is used primarily for space heating, space cooling, water heating and operating appliances and lighting.

Highlights

- From 1990 to 1998, energy use (E) in Canada's residential sector decreased by 2.4 percent, or 32 petajoules. This decrease was the result of a combination of factors:
  - There was a significant increase in aggregate activity (A) in the residential sector (measured using an index derived from the number of Canadian households and the floor area of dwellings). Had only activity changed over the period, residential energy use would have increased by 214 petajoules from 1990 to 1998.
  - Structure (S), the percentage of energy used for different end-uses also put some upward pressure on energy consumption. Had only structure changed over the period, residential energy use would have increased by 16 petajoules.
  - Changes in weather (W), specifically an unusually warm winter in 1998, also had a significant impact on energy use. Had only weather changed over the period, residential energy use would have decreased by 68 petajoules.
  - Aggregate energy intensity decreased by 16 percent in the residential sector. However, energy efficiency improved by 12.5 percent. Had only energy efficiency (EE) changed over the period, residential energy use would have decreased by 165 petajoules.
- Greenhouse gas (GHG) emissions from the residential sector were 69.3 megatonnes in 1998, down 0.7 percent from 1990. The discrepancy between the decrease in emissions and the decrease in energy use is primarily due to a switch to more GHG-intensive fuels to produce electricity.

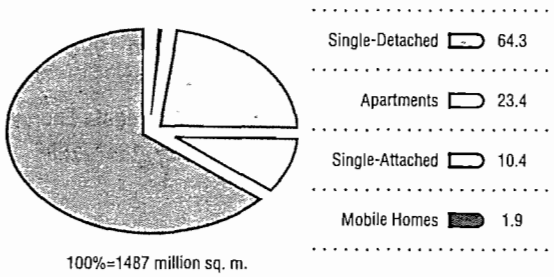
The Energy/Emissions Barometer – Residential Sector

3.1 Overview – Energy Use and Greenhouse Gas Emissions

In 1998, energy use in the residential sector totalled 1288 petajoules, or about 16.8 percent of secondary energy demand in Canada. Greenhouse gas emissions from residential energy use were 69 megatonnes, or about 15.3 percent of total greenhouse gas emissions from secondary energy use.

The residential sector comprises four major types of dwellings: single-detached, single-attached, apartments and mobile homes. As illustrated in Figure 3.1, single-detached dwellings are the predominant type, accounting for about two thirds of the residential floor space in Canada in 1998.

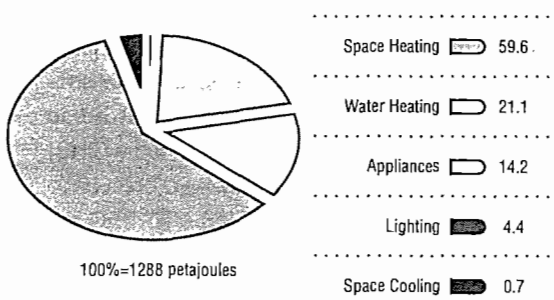
Figure 3.1: Distribution of Floor Space by Type of Dwelling, 1998 (percent)



100%=1487 million sq. m.

Figure 3.2 shows the five main end-uses of energy in the residential sector. In 1998, 80.7 percent of the energy consumed in this sector was used for space heating and water heating. Appliances and lighting were also major energy users, with space cooling accounting for only a small portion of total energy consumption.

Figure 3.2: Distribution of Residential Energy Use by End-Use, 1998 (percent)



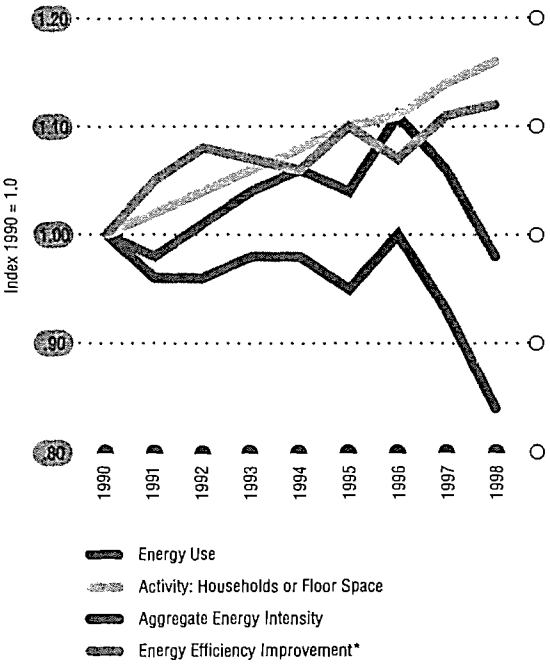
100%=1288 petajoules

Natural gas and electricity are the two main types of energy used in the residential sector. In 1998, natural gas accounted for 44.6 percent of the total and electricity for 36.2 percent. The energy source varies according to its end use – natural gas is the main source of energy for space and water heating, while most appliances use electricity.

3.2 Trends in Energy Use

Figure 3.3 illustrates the trends in residential sector energy use, aggregate energy intensity, activity and energy efficiency from 1990 to 1998.

Figure 3.3: Residential Energy Use, Aggregate Energy Intensity, Activity and Energy Efficiency, 1990–1998 (index 1990 = 1.0)



*This report presents an index of energy efficiency improvements while previous reports presented an index of the effects of energy efficiency on energy use.

During this period, residential energy use decreased by 2.4 percent, from 1319 petajoules in 1990 to 1288 petajoules in 1998. At the same time, activity increased by 16.2 percent. In the case of the residential sector, activity is measured using an index derived from the number of households and the floor area of dwellings (in the review period, floor area increased by 17.2 percent and the number of households increased by 14.2 percent).[1] Aggregate energy intensity decreased by 16.0 percent and energy efficiency improved by 12.5 percent.

Residential energy use decreased by 2.4 percent between 1990 and 1998 despite a 16.2 percent increase in activity.

Only two end-uses recorded declines in energy use between 1990 and 1998 – space heating and appliances, which accounted for a 4.0-percent drop in residential energy use. This was offset somewhat by an increase in the use of energy for water heating, space cooling and lighting, which accounted for a 1.6-percent increase in residential energy use. The net result, as noted above, was a 2.4-percent decrease in overall residential energy use.

Growth in the number of households and in floor area are key factors affecting residential energy use. As shown in Figure 3.3, the 16.2-percent growth in activity had a significant impact on residential energy demand. Over the 1990 to 1998 period, close to 1.5 million new households were created in Canada, and the total floor area of dwellings increased by approximately 218 million square metres.

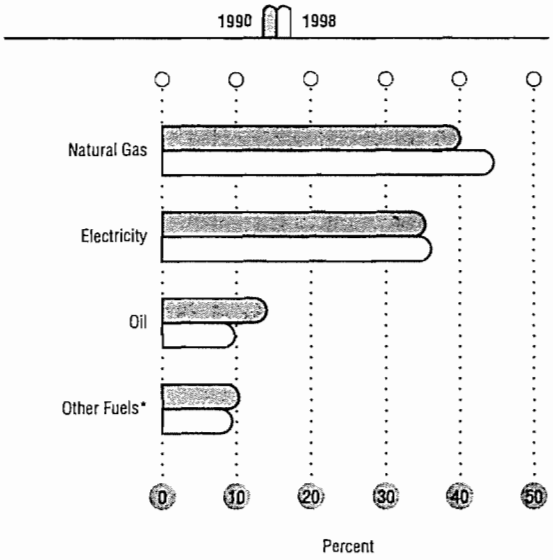
Changes in Fuel and End-Use Shares

Figure 3.4 provides a breakdown of fuel use in the residential sector in 1990 and 1998. The most notable change in the two years was the move away from oil to natural gas. Oil's share of residential fuel use decreased by 4.4 percentage points between 1990 and 1998, while natural gas's share increased by 4.5 percentage points. Natural gas increased its share of fuel use for space heating by 5.6 percentage points and for water heating by 6.9 percentage points.

1 The OEE has changed the way activity is measured in the residential sector. For a discussion of the new approach, see the section "Changes in the Factorization Analysis Methodology: A New Activity Variable," on page 17.

These increases were largely a result of the more widespread availability of natural gas and lower natural gas prices relative to electricity. Oil's share of fuel use for space heating declined by 6.0 percentage points and for water heating by 2.0 percentage points.

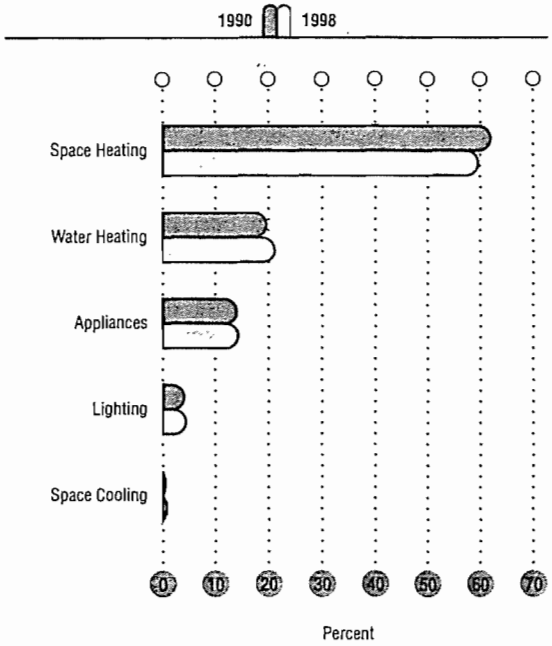
Figure 3.4: Residential Energy Fuel Shares, 1990 and 1998 (percent)



* liquefied petroleum gases, coal, steam, wood

Energy end-uses in the residential sector are illustrated, by percentage share, in Figure 3.5. Space heating recorded the largest decline in its share of energy end-use between 1990 and 1998, largely because the winter of 1998 was warmer than the winter of 1990. The shares of all other end-uses increased. Water heating recorded the largest percentage points increase, at 1.6. On the other hand, space cooling recorded the biggest increase in total energy use, at 57.1 percent, as a result of warmer weather in the summer of 1998 and increased sales of air conditioners. Nevertheless, the amount of residential energy used for space cooling – 0.7 percent in 1998, compared to 0.4 percent in 1990 – remains a small amount of the total energy used in the sector.

Figure 3.5: Residential Energy End-Use Shares, 1990 and 1998 (percent)



Changes in the Factorization Analysis Methodology: A New Activity Variable

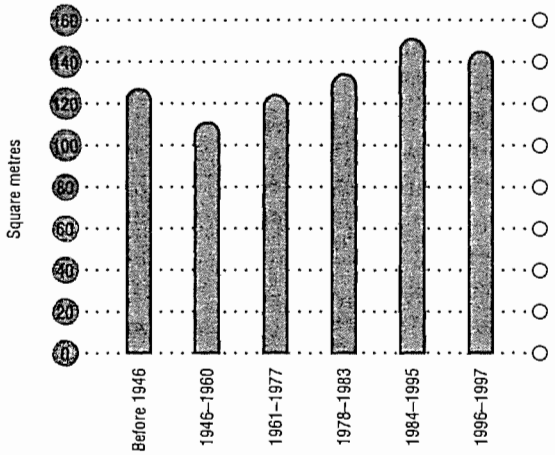
Activity is one of four factors considered by the OEE in its analysis of energy use in the residential sector (the impact of all four factors are discussed later in the chapter). In previous reports, activity was measured as the number of households in Canada. While analysts believed that using the floor area of houses would produce more meaningful results, insufficient data on floor area was available until 1999, when the results of the *1997 Survey of Household Energy Use* (SHEU) became available. This survey was conducted by Statistics Canada on behalf of the OEE. The SHEU data on floor area have now been combined with data on the number of households (also provided by Statistics Canada) to arrive at an estimate of the total floor area of Canadian houses by province, house type and period of construction.

The addition of the floor area variable to the activity measurement is a significant development. While the number of households is a good indicator of activity when assessing energy end-uses such as appliances and water heating (which are affected by the number of occupants in the household), it is less useful for analysing end-uses such as space heating, space cooling and lighting (which do not change notably based on the number of occupants). For these latter end-uses, floor area is a better indicator of activity.

To address this issue and improve its factorization analysis for the residential sector, the OEE has developed an activity index that is a mix of both the number of households and floor space. The factorization results are available for the whole sector as well as for two sub-sectors (household services and floor space services and five end-uses). Floor space services include space heating, space cooling and lighting energy use, while household services include appliances and water heating energy use. The factorization results for the two sub-sectors are weighted according to their share of total residential energy use and then added together to get the sectoral results. Essentially, this means the factorization results for the residential sub-sectors and end-uses are meaningful, but the results for the sector as a whole should be treated with more caution.

This methodology improvement will allow the OEE to account for variations in the floor area of houses over time, which was not previously possible. Suppose, for example, that the number of households was to remain constant over time, but that the floor area of the houses where those households live was allowed to change. Assuming the same number of occupants, it can be surmised that a larger house will require more energy for space heating, space cooling and lighting, but will use the same amount of energy for water heating and appliances. If a trend developed toward larger houses (this has been confirmed by the 1997 SHEU survey, as illustrated in Figure 3.6), the energy intensity of the residential sector (defined as energy over the number of households) would increase, even though the larger houses might require less energy per square metre than smaller houses.

Figure 3.6: Average Floor Area of Dwellings by Vintage (square metre)



Source: 1997 Survey of Household Energy Use

However, now that data on floor area are available, changes in energy intensity will no longer be dependent on the size of the house. For this reason, the results of the factorization analysis presented in the current report will differ somewhat from the results described in previous reports. Having pointed out this discrepancy, the results presented here and in previous reports are reasonably consistent, since the evolution of the two activity variables was similar between 1990 and 1998 (see Figure 3.7).

Figure 3.7: Households and Floor Area Evolution, 1990–1998 (index 1990 = 1.0)

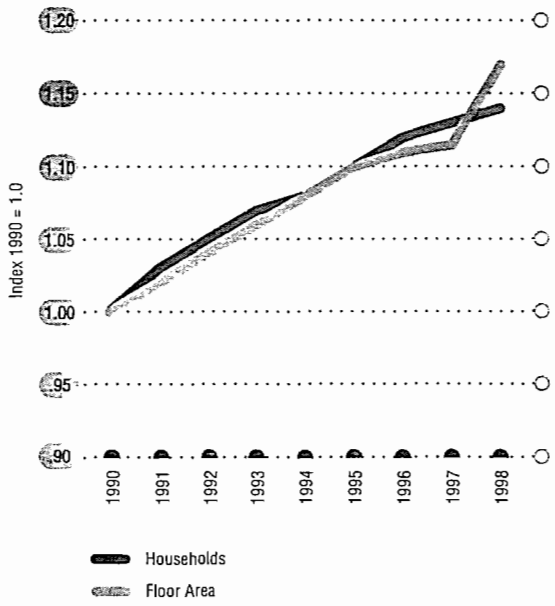
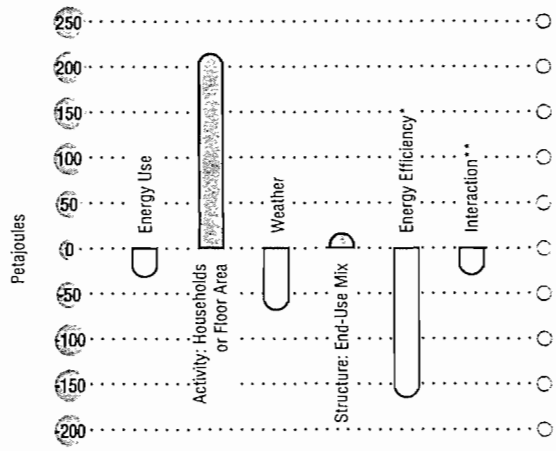


Figure 3.8: Factors Influencing Growth in Residential Energy Use, 1990–1998 (petajoules)



* Represents the effect of energy efficiency improvements on energy consumption.

** For an explanation of this term, see the section called "Notes on Interaction Terms" in Appendix C.

3.2.1 Factors Contributing to Changes in Energy Use

In this report, changes in residential energy use are attributed to four broad factors: changes in activity, changes in weather, changes in structure and changes in energy efficiency. The results of the OEE's factorization analysis (shown in Figure 3.8) reveal that growth in residential energy use between 1990 and 1998 was driven in large part by growth in activity. This increase was offset by significant improvements in energy efficiency, as well as changes in weather. Structural changes had a minor impact on energy use in the residential sector.

Specifically, the analysis revealed that:

- had only activity changed over the period, residential energy use would have increased by 214 petajoules between 1990 and 1998;
- had only weather changed over the period, residential energy use would have decreased by 68 petajoules between 1990 and 1998;[2]
- had only structure (the percentage shares of energy end-uses) changed over the period, residential energy use would have increased by 16 petajoules between 1990 and 1998; and
- had only energy efficiency changed over the period, residential energy use would have decreased by 165 petajoules between 1990 and 1998.[3]

2 The 1998 heating season was significantly warmer than in 1990 (340 fewer degree-days, a decrease of 8.3 percent), which reduced the demand for space heating energy. However, more energy was required for space cooling because the summer of 1998 was warmer than the summer of 1990.

3 Of this amount, 103 petajoules can be attributed to improved space heating energy efficiency, 37 petajoules to improved appliance energy efficiency, 20 petajoules to improved water heating energy efficiency and 5 petajoules to improved lighting energy efficiency. The energy efficiency of space cooling had no impact over the period.

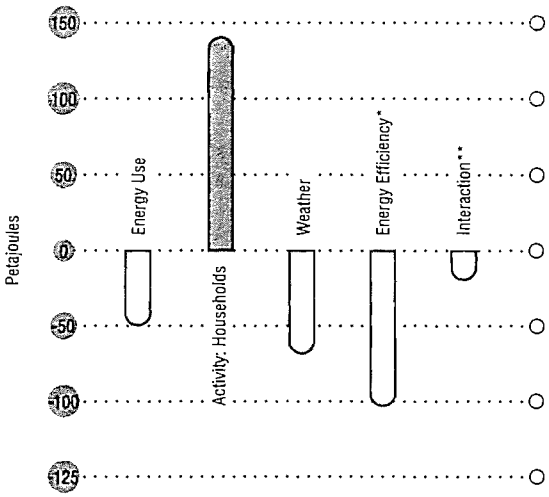
3.2.2 Factors Influencing Space Heating Energy Use

As illustrated in Figure 3.9, the amount of energy required for residential space heating declined by 50 petajoules between 1990 and 1998. This decline is a result of a combination of factors:

- increased activity (growth in the amount of heated floor area) resulted in higher demand for space heating. Had only activity changed, energy use for space heating would have increased by 140 petajoules between 1990 and 1998.
- an unusually warm winter in 1998 helped to offset the increase in activity. Had only weather changed, energy use for space heating would have decreased by 68 petajoules between 1990 and 1998. Even though the 1998 winter was significantly warmer than usual, warmer than usual winter temperatures were also observed in 1990. In fact, the 1990 winter was 7.5 percent warmer than usual while the 1998 winter was 15.2 percent warmer. This means that the 1998 winter is only 8.3 percent warmer than the 1990 winter, which explains why the impact of weather on energy use is lower than might be expected.
- energy efficiency improvements in space heating equipment and the thermal characteristics of houses also helped offset the increase in activity. Had only energy efficiency changed, energy use for space heating would have decreased by 103 petajoules between 1990 and 1998.

The decline in space heating energy intensity over the review period was a result of several factors, primarily improvements in the efficiency of space heating equipment, improvements in the thermal characteristics of new and existing houses, and increases in heated living area. These developments are discussed in further detail in the following pages.

Figure 3.9: Factors Influencing Growth in Residential Space Heating Energy Use, 1990–1998 (petajoules)



* Represents the effect of energy efficiency improvements on energy consumption.

** For an explanation of this term, see the section called "Notes on Interaction Terms" in Appendix C.

The warm 1998 winter helped offset the effect of increased activity on residential energy use.

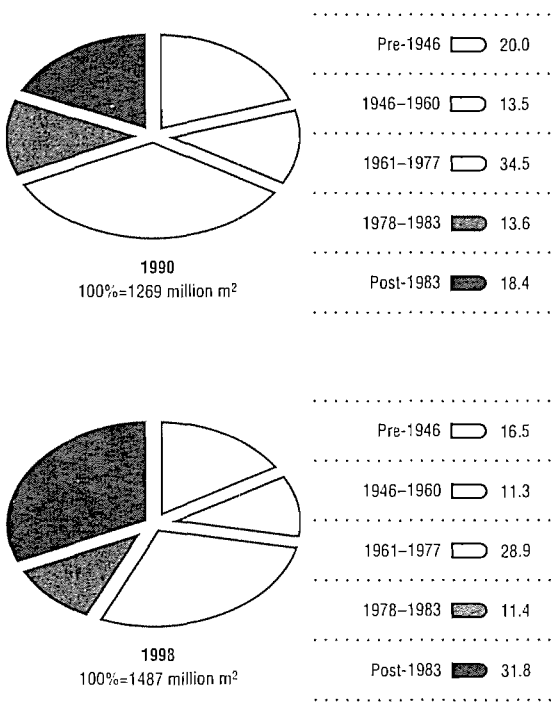
The Market Penetration of New Homes

New dwellings added to the housing stock since 1984 tend to be better insulated and have more efficient equipment than existing homes. This is a result of two factors:

- the development of new and more energy-efficient technologies; and
- revised building codes that have generally increased minimum energy standards for new construction.

However, changes in the proportion of old versus new homes in the Canadian housing stock tend to occur slowly over time. Figure 3.10 shows that the proportion of older homes (those built before 1960) in the housing stock declined from 33.5 percent in 1990 to 27.9 percent in 1998. Over the same period, the proportion of newer homes (those built between 1984 and 1998) in the stock increased from 18.4 percent to 31.8 percent. This relatively slow pace of change reflects the longevity of housing in Canada: older homes are slow to be retired, which means that it takes time for new housing to capture a larger share of the overall housing stock.

Figure 3.10: Housing Stock Floor Area by Vintage, 1990 and 1998 (percent)



Improved Building Shells

New Houses

As noted earlier, the new houses being built today tend to be more energy efficient than older houses. This is illustrated in Table 3.1, which shows, for example, significant differences in air leakage between older (pre-1983) and newer (post-1983) houses. While the results of the *1997 Survey of Household Energy Use* show that an average of 32 percent of all Canadian households experience air leaks from their windows, the problem declines to an average of 22 percent for homes built in 1990 or later.

Table 3.1 also reveals widespread use of double-glazed windows in newer homes. Over the past few years, the use of windows that have two layers of glazing covered with a low-emissivity coating (which reflects heat energy back to its source) and filled with an inert gas (argon) has improved the thermal resistance of windows by 50 percent. In 1998, these windows accounted for about 32 percent of total window sales. They generally perform better than triple-glazed windows and are less expensive to purchase, which could explain why triple-glazed windows are not used in more houses (see Table 3.1).

Existing Stock of Houses

Although older houses are not as energy efficient as new construction, energy efficiency improvements are often made as homes are renovated over time. According to the *1997 Survey of Household Energy Use*, 4 percent of homeowners improved insulation levels in their attics, walls or basements in 1997, while 10 percent added or replaced windows. Of the latter group, 60 percent reported that they had installed standard double-glazed windows.

More Energy-Efficient Space Heating Equipment

Significant improvements have been achieved in the energy efficiency of space heating equipment. In 1998, the annual fuel utilization efficiency (AFUE) rating of new residential oil furnaces was 72 percent, compared to 63 percent in 1990. For natural gas furnaces, the AFUE rating improved from 71 percent in 1990 to 87 percent in 1998.

Figure 3.11 shows a trend toward increased use of energy-efficient units in the Canadian market. The proportion of medium- and high-efficiency gas furnaces installed in Canadian houses climbed from 7.6 percent in 1990 to 22.3 percent in 1998. Conventional natural gas furnaces are no longer sold in Canada. In 1988, mid-efficiency furnaces accounted for 70 percent of total sales and high-efficiency units for the remaining 30 percent of sales.

Figure 3.11: Natural Gas Furnace Stocks by Efficiency Level, 1990 and 1998 (percent)

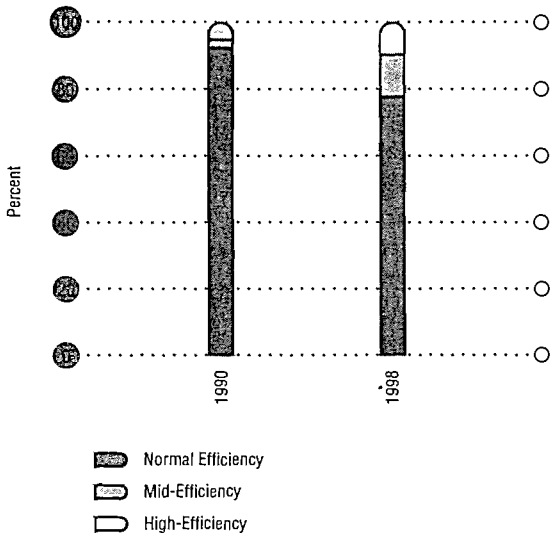
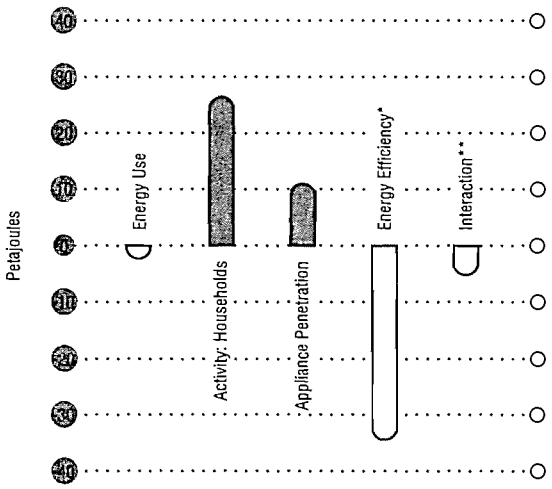


Table 3.1: Thermal Characteristics of Housing Envelope in Canada, 1997 (percentage of households)

	Before 1941	1941–1960	1961–1977	1978–1982	1983–1989	1990–1997	All Houses
Windows							
Triple-Pane	7	9	8	7	7	6	7
Double-Pane	63	74	85	91	90	92	82
Air Leaks Around the Windows	43	31	32	39	27	22	32
Air Exchanger (have and use)							
With Heat Recovery	0	1	3	2	8	11	4
Without Heat Recovery	2	3	5	7	12	15	7
Heated Basement	66	79	85	83	83	86	81

Source: *1997 Survey of Household Energy Use*

Figure 3.12: Factors Influencing Growth in Residential Appliance Energy Use, 1990–1998 (petajoules)



* Represents the effect of energy efficiency improvements on energy consumption.

** For an explanation of this term, see the section called "Notes on Interaction Terms" in Appendix C.

Bigger Houses

As noted earlier in this chapter, the *1997 Survey of Household Energy Use* collected data on the average floor area of Canadian houses. This information, combined with data on the number of Canadian households, has resulted in the first reliable estimate of the total floor space of Canada's housing stock. A clear trend has emerged since the 1960s toward constructing larger new houses (see Figure 3.6 on page 18).

Fuel Switching

The issue of fuel switching is mentioned briefly on page 16, under the section "Changes in Fuel and End-Use Shares." Specifically in relation to space heating, natural gas increased its share of the residential market from 47.7 percent in 1990 to 53.3 percent in 1998. To a lesser extent, there was also fuel switching for space heating from oil to electricity. Natural gas and electric furnaces both tend to be more efficient than oil furnaces, which contributed to an overall decline in space heating energy intensity.

3.2.3 Factors Influencing Appliance Energy Use

As illustrated in Figure 3.12, energy use by appliances decreased by 2 petajoules between 1990 and 1998. This decrease is a result of:

- growth in activity (the number of Canadian households), which increased appliance energy use by 26 petajoules between 1990 and 1998;
- changes in structure (increased market penetration of various appliances), which increased appliance energy use by 11 petajoules; and
- appliance efficiency improvements, which helped offset the increase in activity and changes in structure. Had only energy efficiency changed, appliance energy use would have declined by 34 petajoules between 1990 and 1998.

The structural changes noted above are illustrated in Figure 3.13, which shows the market penetration rates of 10 types of appliances between 1990 and 1998. Among major appliances, the most significant increases were recorded by dishwashers, whose market penetration went from 42 percent of households in 1990 to 51 percent of households in 1998. Electric clothes dryers also recorded a significant increase in market penetration, from 70 percent of households in 1990 to 76 percent in 1998. The percentage of Canadian households that had refrigerators and clothes washers also increased between 1990 and 1998, although to a lesser extent. About 22 percent of households had two or more refrigerators in 1998, compared to about 18 percent in 1990.

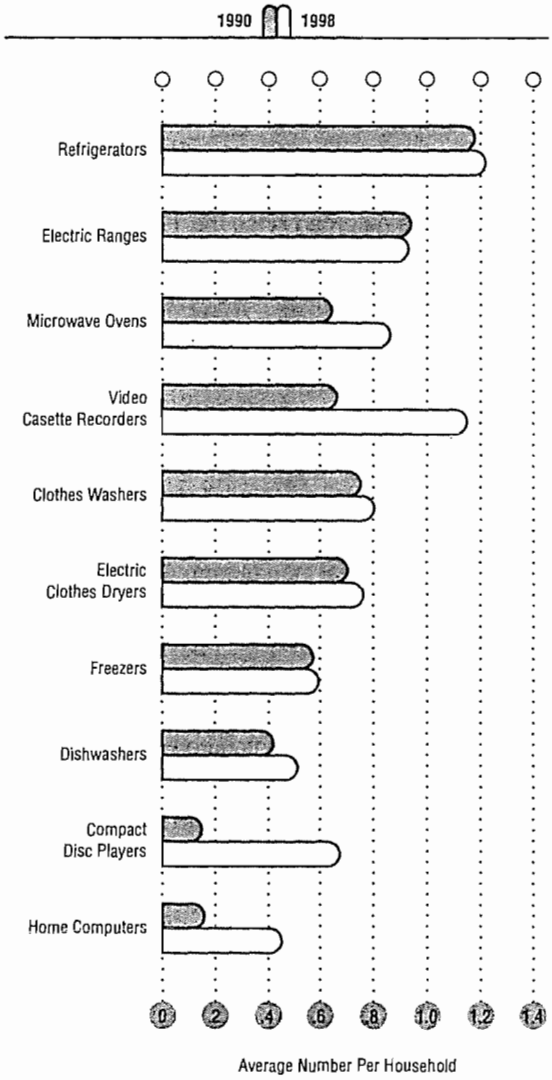
The increased availability and more aggressive marketing of "new" electric devices has also increased appliance energy consumption in the residential sector. Such new products include compact disc players, home computers, video cassette recorders and DVD players. Among the more established products, compact disc players and computers achieved the greatest increase in market penetration between 1990 and 1998. In 1990, for example, only 15 percent of households had a compact disc player, compared to 67 percent in 1998. The proportion of households owning a computer increased from 16 percent in 1990 to 45 percent in 1998.

DVD players came onto the market only in early 1997, but approximately 110 000 units had been sold in Canada by the end of 1998.[4]

Microwave ovens have also recorded rapid growth in market penetration. The percentage of Canadian households with microwave ovens increased from 64 percent in 1990 to 86 percent in 1998. According to the *1997 Survey of Household Energy Use*, 70.0 percent of households which own a microwave oven use it daily to reheat food, while 11.7 percent use it daily to cook food.

Many other electric appliances found in Canadian homes (e.g., televisions, radios, clocks, small kitchen appliances, etc.) also have the potential to consume large quantities of energy. According to a 1996 study conducted by the Canadian Residential Energy End-Use Data and Analysis Centre (CREEDAC), in 1993 such appliances consumed 1300 kWh per year per household,[5] which is equivalent to the energy consumed by two new refrigerators.

Figure 3.13: Penetration Rates for Household Appliances, 1990 and 1998 (average number per household)



4 This number was obtained from U.S. sales data collected by the Consumer Electronics Association. The data is available at http://www.thedigitalbits.com/articles/cemadvdsales.html. A factor of 10% was applied to the U.S. data to obtain a Canadian figure.

5 Canadian Residential Energy Use Data and Analysis Center, *Residential Electrical Energy Use Associated with Miscellaneous Appliances in Canada*, Halifax, 1996.

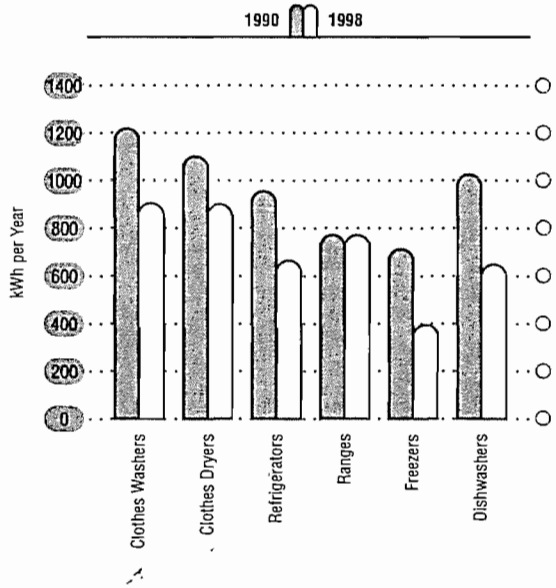
More Energy-Efficient Appliances

The 2-petajoule decrease in appliance energy use noted earlier (see page 23) would have been far greater if not for substantial activity growth between 1990 and 1998. This growth contributed to a rise in appliance energy use of about 26 petajoules. However, the substantial improvements in appliance energy efficiency that were observed more than compensated for this growth in activity.

As illustrated in Figure 3.14, most new appliances were significantly more energy efficient in 1998 than in 1990. For example:

- new freezers were 44.6 percent more efficient in 1998 than in 1990;
- new dishwashers were 36.8 percent more efficient; and
- new refrigerators were 30.6 percent more efficient.

Figure 3.14: Energy Efficiency Trends of Appliances, 1990 and 1998 (kWh per Year)



Efficiency Gains Outweigh Move to Bigger Appliances

Manufacturers of major household appliances have dramatically improved the energy efficiency of their products. While some of these gains have been offset by consumer trends toward buying larger appliances than in the past, the energy efficiency improvements still outweigh the larger size of new appliances. For example, an average refrigerator sold in 1998 consumes 36.6 percent less energy than the average refrigerator found in the overall stock. The increase in energy efficiency in new appliances has had an impact on the average energy efficiency of the total stock of refrigerators. In 1998, an average refrigerator found in a Canadian home (all types included) consumed about 1048 kWh per year, compared to 1525 kWh in 1990. This 31.3 percent reduction in energy use was possible even though the average size of refrigerators increased by 9.5 percent between 1990 and 1998.

Please refer to *Table A* for *Appliance Efficiency Gains for Refrigerators.*

Table A: Appliance Annual Energy Consumption (kWh/Year)

	1990 Stock	1998 Stock	1998 New Unit
Refrigerator	1525	1048	664
Freezer	1291	896	396
Dishwasher	1275	924	648
Clothes Washer	1326	1118	905
Electric Clothes Dryer	1314	1087	901

Sources: Residential Energy Use Model (1999) and CAMA (1998)

Overview of the Appliance Market

Figure A provides data on the four major energy-consuming household appliances. A visual analysis of the data indicates that models sold in 1990 consumed more energy per unit than models sold in 1998. In some cases, the unit energy consumption of clothes washers, dishwashers and refrigerators decreased even when the size of the appliance increased.

The only exception is for freezers, where the data seem to indicate that 1998 models were less efficient than those sold in 1990. These data are distorted by the fact that some freezers on the market in 1998 were significantly larger than those available in 1990. However, as shown in Figure B2, 83.1 percent of the freezers sold in 1998 had lower energy requirements than almost all of the freezers sold in 1990. As a result, large freezers with high energy requirements had only a minor impact on the overall energy consumption of the stock of freezers sold in 1998.

Please refer to Figures A1 through A4 and B1 through B2 for Appliance Energy Consumption.

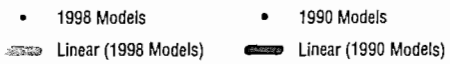


Figure A1: Unit Energy Consumption for Clothes Washers

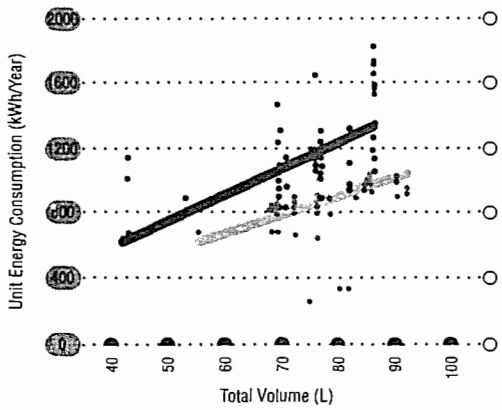


Figure A2: Unit Energy Consumption for Dishwashers

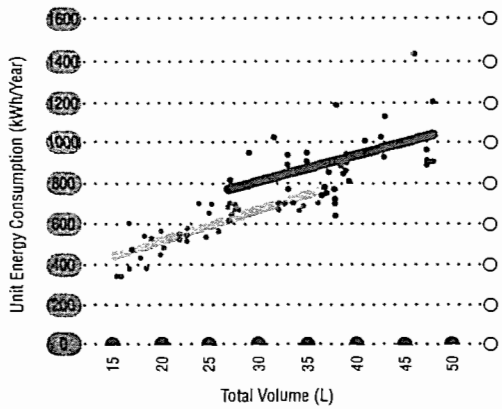


Figure A3: Unit Energy Consumption for Freezers

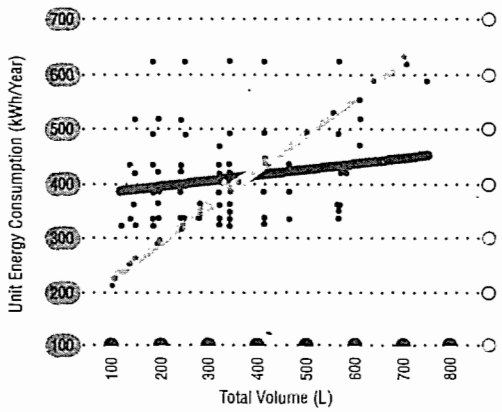


Figure A4: Unit Energy Consumption for Top-Mount Auto-Defrost Refrigerators

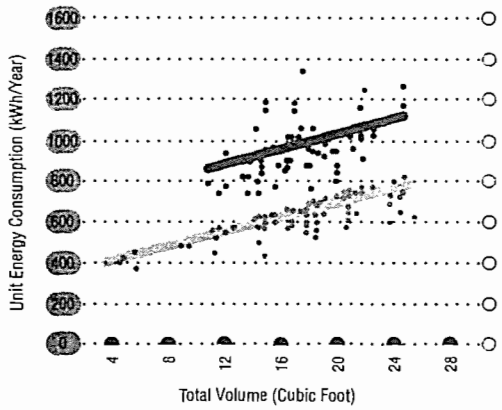


Figure B1: Shipments – Type 3 Refrigerators

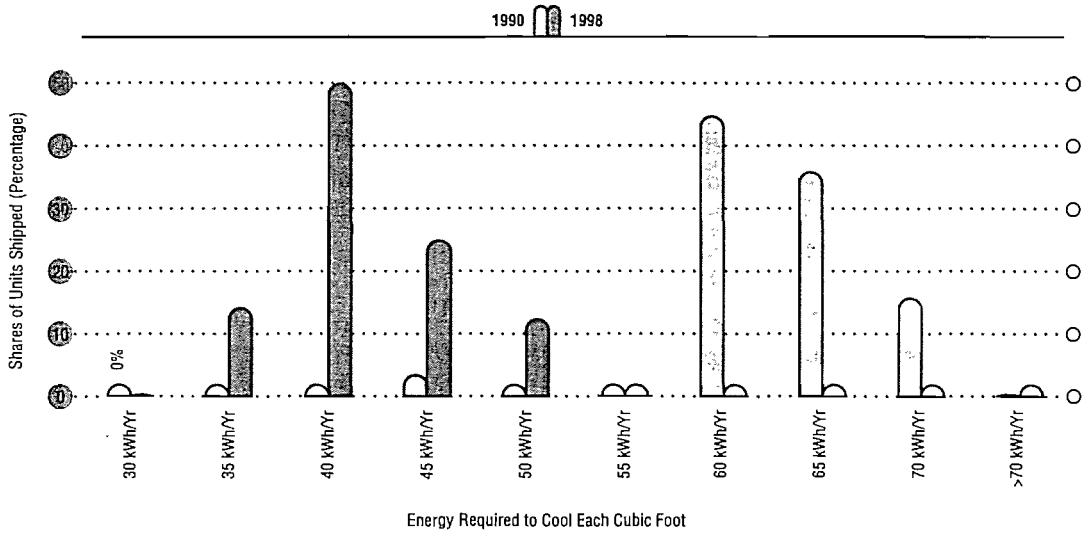
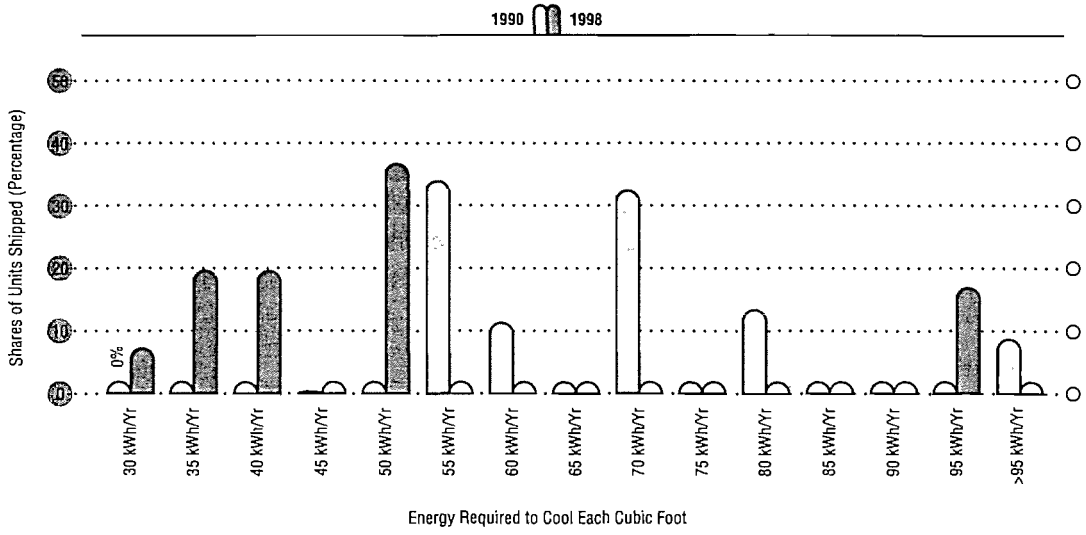


Figure B2: Shipments – Type 10 Freezers



3.2.4 Factors Influencing Other Energy End-Uses

Water Heating Energy Use

The amount of energy used for residential water heating increased by 14 petajoules between 1990 and 1998. Growth in the number of households (as well as the fact that more households now have two water-using appliances: a dishwasher and a clothes washer[6]) resulted in a 37-petajoule increase in energy use for water heating. This increase was partially offset by significant improvements in the energy efficiency of water heating equipment. New dishwashers were 36.8 percent more energy efficient in 1998 than in 1990, and new clothes washers were 25.7 percent more energy efficient. Had only energy efficiency changed over the period, energy use for residential water heating would have decreased by 26 petajoules between 1990 and 1998.

Another factor offsetting the increase in energy use for water heating was a small decrease in household size – in other words, the number of persons per household. The size of households decreased by 3.8 percent between 1990 and 1998 (from 2.62 persons per household in 1990 to 2.52 in 1998).[7]

Space Cooling Energy Use

Space cooling accounted for less than 1 percent of total residential energy use in 1998. However, the use of air conditioners is growing. In 1998, 21.2 percent of residential floor area in Canada was serviced by a central air conditioner, compared to 14.5 percent in 1990. The 1997 Survey of Household Energy Use revealed that approximately 47 percent of households equipped with a central air conditioner use it to cool their homes for at least half of the summer.

As is the case with household appliances and heating equipment, manufacturers have improved the energy efficiency of air conditioning units over the past decade.

Lighting Energy Use

Electricity for lighting accounted for 4.4 percent of total residential energy use in 1998, based on a study conducted by the Canadian Residential Energy End-Use Data and Analysis Centre. Using data collected through the *1993 Survey of Household Energy Use*, CREEDAC has estimated that the average annual energy consumption of lighting is about 1767 kWh per dwelling.

3.3 Trends in Greenhouse Gas Emissions

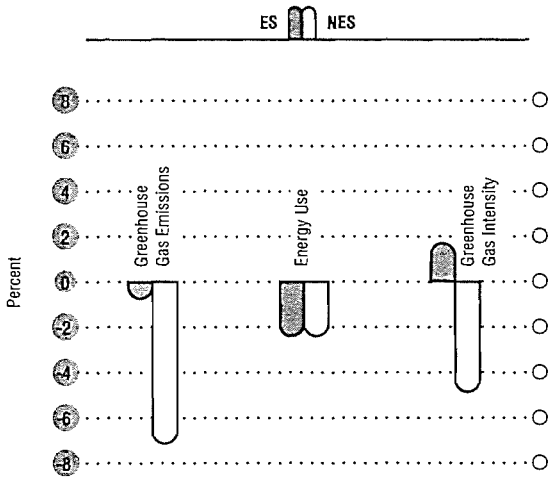
Energy use in the residential sector produced 69.3 megatonnes of greenhouse gas emissions in 1998, a decrease of 0.7 percent from the 1990 level (69.8 megatonnes). Almost 41.6 percent of 1998 residential emissions were indirect emissions, meaning that they resulted from electricity generation (this issue is discussed further below). Figure 3.15 shows that the greenhouse gas intensity of residential energy use increased by 1.7 percent over the review period when emissions from electricity generation are included. If we exclude those emissions, the greenhouse gas intensity of residential energy use decreases by 4.9 percent instead of increasing.

Greenhouse gas emissions in the residential sector were 69 megatonnes in 1998, a decrease of 0.7 percent from 1990

6 Approximately 88 percent of the energy used by dishwashers and 92 percent of the energy used by clothes washers is used to heat the water. The remaining energy is used by the appliance's electrical motor.

7 Statistics Canada, *Household Facilities and Equipment* (cat. no. 64-202), Ottawa, Ontario, October 1995; and Statistics Canada, *Survey of Household Spending* (Cat. No. 62F0041), Ottawa, Ontario, December 1999.

Figure 3.15: Growth in Greenhouse Gas Emissions, Energy Use and Greenhouse Gas Intensity, Residential Sector, 1990–1998 (percent)

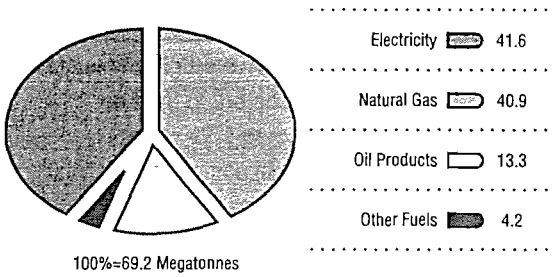


ES: Electricity End-Use Emissions Scenario
NES: No Electricity End-Use Emissions Scenario

There is a significant discrepancy in the rate of decline in greenhouse gas emissions (0.7 percent) and the rate of decline in residential energy use (2.4 percent) between 1990 and 1998. This is due to changes in the types of fuels used to generate electricity. Those changes are explained in more detail in Chapter 2 of this report.

As a result of these changes, electricity has displaced natural gas as the largest source of greenhouse gas emissions from the residential sector. As shown in Figure 3.16, electricity accounted for 41.6 percent of the sector's emissions in 1998, compared to 40.9 percent for natural gas.

Figure 3.16: Residential Greenhouse Gas Emissions by Fuel Type, 1998 (percent)



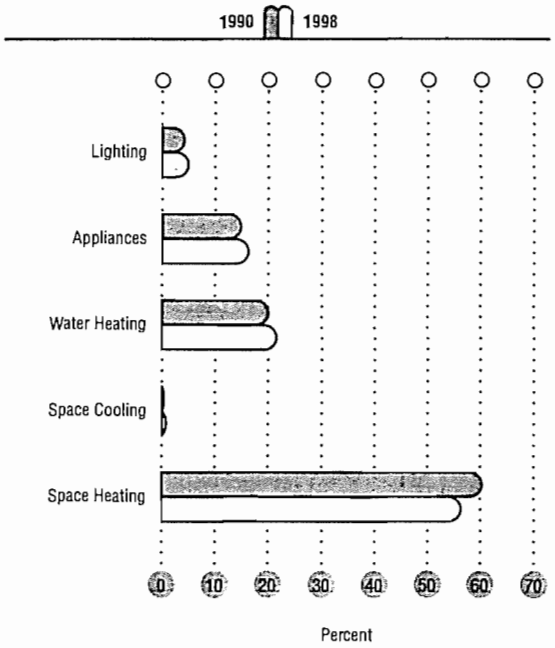
From an energy end-use perspective, space and water heating accounted for 77.9 percent of residential sector greenhouse gas emissions in 1998 (see Figure 3.17). Two developments are of note:

- The share of emissions related to space heating decreased by 4.1 percentage points between 1990 and 1998. This is consistent with the fact that space heating made the largest contribution to the overall decrease in residential sector energy use during the review period.
- The share of emissions related to water heating increased by 1.5 percentage points between 1990 and 1998. This is a result of two factors: the 5.3-percent increase in water heating energy demand over the period, and the higher greenhouse gas intensity of electricity in the latter part of the review period.

Appliances, lighting and space cooling all recorded increases in their share of greenhouse gas emissions over the review period, as a result of both increased activity and the increased greenhouse gas intensity of electricity (which accounts for 98.3 percent of the energy consumed by these three end-uses). Specifically:

- emissions from appliance energy use increased by 8.5 percent, even though appliance energy use decreased 1.2 percent;
- emissions from lighting energy use increased by 16.9 percent; and
- emissions from space cooling energy use increased by 73.0 percent.

Figure 3.17: Residential Greenhouse Gas Emissions by End-Use, 1990 and 1998 (percent)



Trends in Greenhouse Gas Intensity – 1990–1998

If we go back to Figure 3.15, we can see that the greenhouse gas intensity of residential energy use increased by 1.7 percent over the review period when emissions from electricity generation are included, going from 52.9 tonnes per terajoule in 1990 to 53.8 tonnes per terajoule in 1998. Had it not been for this increase in intensity, greenhouse gas emissions from the sector would have decreased by 2.4 percent, rather than 0.7 percent over the review period. This would have resulted in greenhouse gas emissions for the residential sector of 68 megatonnes in 1998 instead of the 69 megatonnes that was observed.

In the case where electricity-related emissions are excluded from the total, the greenhouse gas intensity of residential energy use decreases by 4.9 percent, going from 33 tonnes per terajoule in 1990 to 31 tonnes per terajoule in 1998. Had this decline in intensity not occured, greenhouse gas emissions (excluding electricity) for the residential sector would have been 42.5 megatonnes in 1998 instead of the 40.5 megatonnes that was observed.

Two factors have contributed to the increase in greenhouse gas intensity. First, there was a shift in end-use fuel shares toward less intensive fuels (see Figure 3.4 on page 17). Oil's share of residential energy use decreased by 4.4 percentage points between 1990 and 1998, while natural gas's share increased by 4.5 percentage points. Since natural gas is less GHG intensive than oil, this shift had the effect of lowering the GHG intensity of energy use in the residential sector. However, changes in the fuel mix used to generate electricity – which are discussed in Chapter 2 – more than offset this downward pressure.

Changes in the fuel mix used to generate electricity more than offset the shift toward less GHG-intensive fuels.

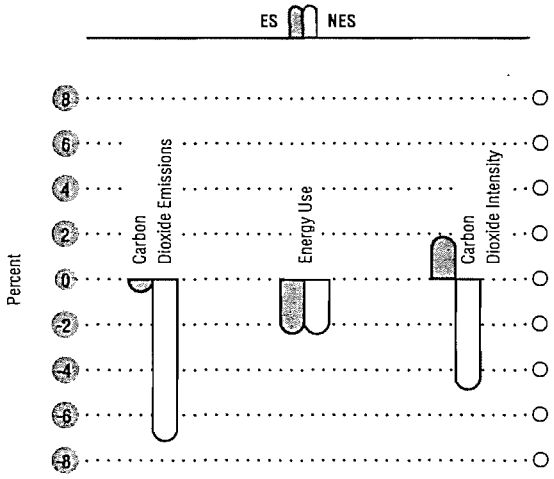
3.4 Trends in Carbon Dioxide Emissions

Energy use in the residential sector resulted in carbon dioxide emissions of 66.9 megatonnes in 1998, which makes up 96.7 percent of all greenhouse gas emissions for this sector. Most of the remaining greenhouse gas emissions come from methane (which represent 2.5 percent of the total greenhouse gas residential emissions). Wood use was responsible for 98.1 percent of residential methane emissions in 1998.[8] This represents a decrease of 0.6 percent from the 1990 level (67.3 megatonnes). Almost 43 percent of 1998 residential carbon dioxide emissions were indirect emissions, meaning

8 The wood-related greenhouse gas emissions that are presented in this report are lower than those presented in Environment Canada's *Canada's Greenhouse Gas Inventory 1997*. The difference arises because NRCan and Environment Canada do not use the same estimate of wood consumption, NRCan's being lower.

that they resulted from electricity generation. Figure 3.18 shows that the carbon dioxide intensity of residential energy use increased by 1.9 percent over the review period, when electricity-related emissions are included. There is a 4.9-percent drop in carbon dioxide intensity if electricity-related emissions are excluded from the analysis.

Figure 3.18: Growth in Carbon Dioxide Emissions, Energy Use and Carbon Dioxide Intensity, Residential Sector, 1990–1998 (percent)

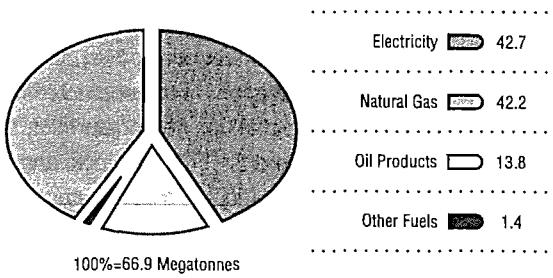


ES: Electricity End-Use Emissions Scenario
NES: No Electricity End-Use Emissions Scenario

As can be seen from Figure 3.18, residential energy use decreased faster than carbon dioxide emissions between 1990 and 1998 (energy use decreased by 2.4 percent while carbon dioxide emissions decreased by 0.6 percent). This is what explains the 1.9-percent increase in carbon dioxide intensity that is mentioned above. As was the case for greenhouse gas emissions, this increase in carbon dioxide intensity is mainly due to changes in the fuel mix used to generate electricity.

As a result of changes in the mix of fuels used to generate electricity, electricity has displaced natural gas as the largest source of carbon dioxide emissions from the residential sector. As shown in Figure 3.19, electricity accounted for 42.7 percent of the sector's emissions in 1998, compared to 42.2 percent for natural gas. The third biggest source of carbon dioxide emissions in the residential sector is oil, which accounted for 13.8 percent of carbon dioxide emissions in 1998.

Figure 3.19: Residential Carbon Dioxide Emissions by Fuel Type, 1998 (percent)



Trends in Carbon Dioxide Intensity – 1990–1998

The average carbon dioxide intensity of energy use in the residential sector increased by 1.9 percent over the review period, from 51 tonnes per terajoule in 1990 to 52 tonnes per terajoule in 1998. Had it not been for this increase, carbon dioxide emissions from the sector would have decreased by 2.4 percent, rather than 0.6 percent. The same factors which came into play in the case of greenhouse gas emissions can explain this increase in carbon dioxide intensity (see section 3.3).

3.5 The Data Situation

Aggregate data on residential energy use are reported on a quarterly basis in Statistics Canada's QRESD (Cat. No. 57-003). Additional data on the characteristics of residential equipment and housing are collected in Statistics Canada's *Survey of Household Spending*, which replaced the previous *Household Facilities and Equipment Survey*.

Additional information has also been collected through two types of surveys sponsored by the National Energy Use Database (NEUD) Initiative: stock surveys and flow surveys.

Stock surveys have two main goals. First, they aim to collect information on the characteristics of energy-using appliances and equipment, the state of dwellings and the building stock, and the profile of consumers (including consumption habits). Their second goal is to collect data on the annual energy consumption of households. Two stock surveys have now been conducted – the *1993 Survey of Household Energy Use* and the *1997 Survey of Household Energy Use*.[9] NEUD is now planning for the next survey.

Flow surveys gather information on variables affecting the housing stock, such as the characteristics of new equipment, new housing and retrofit activities. NEUD has sponsored four flow surveys: the *Survey of Canadian New Household Equipment Purchases* 1994 & 1995, the *Survey of Houses Built in Canada* in 1994, and the *Home Energy Retrofit Survey* (which was conducted in both 1994 and 1995). NEUD has also obtained data on new appliance sales between 1990 and 1998 from the Canadian Appliance Manufacturers Association.

Since the previous report, the principal change made to the modelling methodology and database for the residential sector was the inclusion of the floor area of houses, by province, house type and vintage. These data are now used to derive the space heating load of houses and are also used in the factorization analysis.

9 Although this latter survey collected data for the 1997 calendar year, the survey was actually conducted in 1998.