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enerInfo BUILDING

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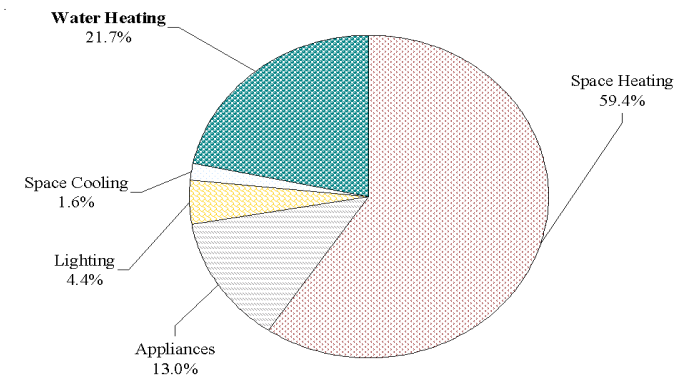
CANADIAN Building Energy End-Use DATA AND ANALYSIS CENTRE commercial • residential • institutional

GETTING INTO HOT WATER

David L. Ryan

Domestic water heating is estimated to be the second largest energy end-use for Canadian households, exceeded only by space heating (Fig. 1), and according to the Energy Use Handbook, 1990 and 1996 to 2002 (hereinafter EUH)[1], produced by the Office of Energy Efficiency of Natural Resources Canada, accounts for approximately 22 percent of total household energy consumption. Indeed, according to EUH, approximately 22% of total Canadian residential greenhouse gas emissions in 2002 were attributed to domestic water heating (DWH), an estimated increase of 13% since 1990. It is against this background that CBEEDAC recently completed a report that reviewed the relevant literature and technology concerning energy consumption for domestic water heating, focusing in particular on current domestic water heater standards and efficiencies, the various types of water heaters available, and the extent to which they are in use across Canada. This article highlights some of the empirical observations from that study.

Figure 1: Canadian Residential Secondary Energy Consumption in 2002 by End Use



[1] http://oee.nrcan.gc.ca/neud/dpa/data_e/Handbook04/Datahandbook2004.pdf

(Getting Into Hot Water *cont'd*)

A typical domestic water heating energy intensity for Canadian households in 2002 was estimated at 25.2 GJ/household (EUH), with electricity and natural gas being the major fuels reported in use for domestic water heating – in 2002, 106.5 PJ of electricity and 180.4 PJ of natural gas were used for this purpose, with electricity contributing 35% and natural gas 59% of the energy required for domestic water heating in Canada (Fig. 2). Data from the 2002 Survey of Household Spending (SHS) show the percentage of homes heating water using electricity and the percentage heating water using natural gas to be identical at 47%, with a further 5% of homes using oil to heat water. However, a more detailed breakdown by year of house construction (Fig. 3) reveals that for houses constructed in the decade since 1990, the use of electricity to heat water has fallen while the use of natural gas for this purpose has increased.

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Interestingly, corresponding information concerning domestic water heating from households that have chosen to complete an initial home energy efficiency evaluation under the *Energuide for Houses Program*[2] (EFHP) is quite different, with a disproportionate share of households that completed this initial evaluation having water heaters that are fueled by natural gas rather than electricity. This over-representation of natural-gas fueled water heaters is particularly evident when attention is focused just on houses constructed between 1991 and 2002, where according to SHS (based on a stratified random sample of 2043 households that represents 1,761,356 Canadian households), 58% of these use natural gas for water heating and 36.5% use electricity, while the EFHP data (a non-random sample of 2043 households) indicates that 72% use natural gas for these purposes while only 23.5% use electricity to heat water. Since, under EFHP, there are monetary reimbursements to the household if they are found to have achieved certain energy savings by the time they undertake a second audit, households that choose to have an initial energy audit (and be included in the database) are more likely to be

Figure 2: Canadian DWH Major Fuel Consumption and Energy Intensity (1992-2002)

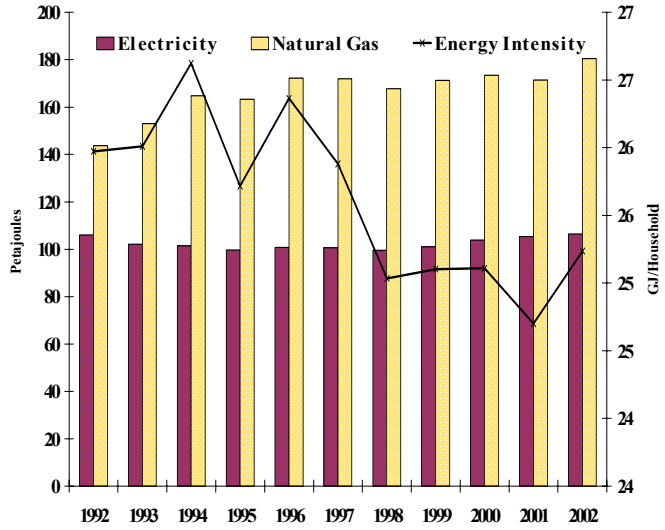
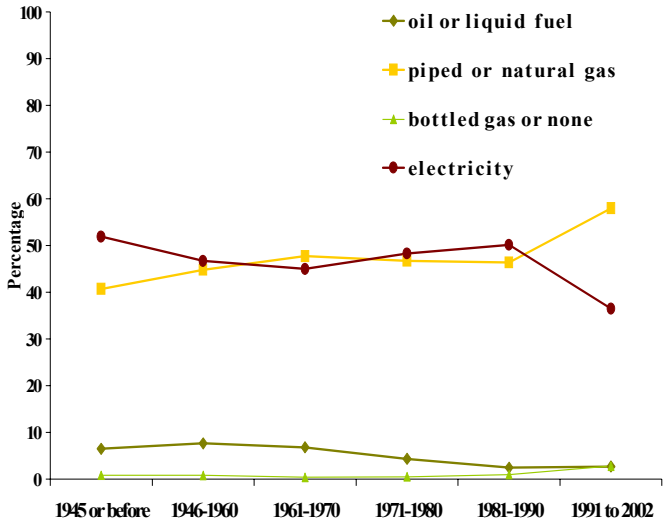


Figure 3: Canadian Domestic Water Heating Fuel Type (%) by Period of Home Construction



[2] For program details, see: http://oee.nrcan.gc.ca/residential/personal/home-improvement/service/service.cfm?attr=4

those that expect to have large potential energy savings and those that are particularly energy conscious. Why these households tend to have water heaters fueled by natural gas is a topic to be investigated further in ongoing CBEEDAC research concerning the EFHP.

The estimated market shares of Canadian water heaters (Fig. 4) tend to reflect the general tendency for new houses to increasingly use natural gas rather than electricity for domestic water heating requirements. The market share of electric water heaters is higher than for natural gas water heaters, but this share is steadily declining over time for electricity and increasing for natural gas. This result appears to be more consistent with the trends in the SHS data rather than in the EFHP data. Of course, over the past 10 years or so a number of factors have changed, and these have no doubt contributed to changes in domestic water heating. According to EUH, average natural gas prices including taxes increased by 93% between 1990 and 2002, while average electricity prices increased by 36% and heating oil prices rose by 40%. During the same time period, the number of Canadian households has increased by 22%, real personal disposable income increased by 1.2% and the total population increased by 13%. Mean household size was calculated at 2.55 persons from the 2001 Census, (Statistics Canada, 2001) but in 2002 is pegged at 2.57 using weighted data from SHS.

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In Canada, the most prevalent type of domestic water heater is the conventional storage tank. While electricity and natural gas are the most commonly used energy sources for the purpose of water heating, this choice differs by region according to fuel cost and efficiency, equipment cost, and by fuel availability. In the Maritimes (apart from Prince Edward Island) and Quebec, the fuel source is primarily electricity, with oil and liquid fuel as the secondary fuel source. From Ontario westward to British Columbia, the primary fuel used is natural gas with electricity as the secondary fuel. Manitoba and British Columbia have a more even mix of electricity and natural gas usage with a minimal amount of oil and liquid fuel use (Fig. 5).

Figure 4: Estimated Market Share of Canadian Water Heaters by Fuel Type (1992-2002)

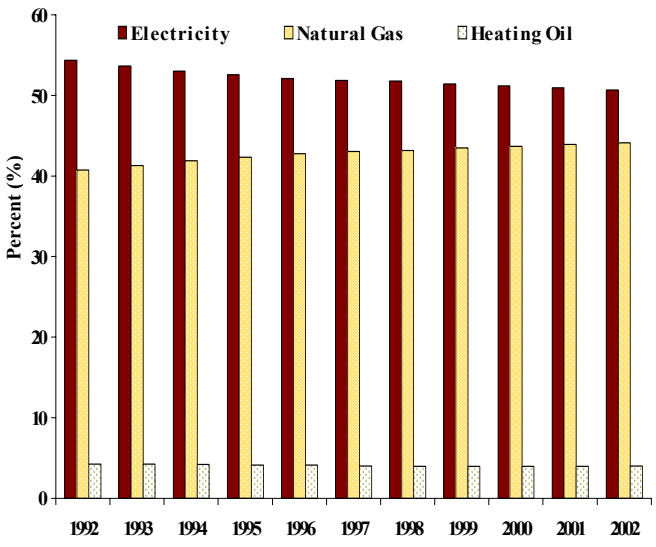
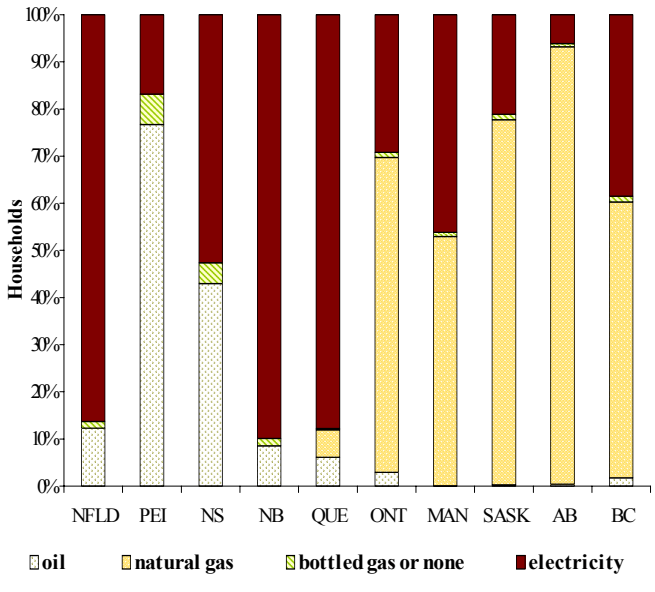


Figure 5: Primary Fuel Source for Domestic Water Heating by Province (2002)



(**Getting Into Hot Water** *cont'd*)

Based on the limited information available in the EFHP database concerning houses that underwent retrofits and had energy audits both prior to and after the retrofits were undertaken (6847 households), it is possible to examine the extent of any domestic water heating fuel switching that accompanied these residential retrofits. In total, only 22 of the 6847 houses changed the fuel used for water heating, with the types of changes varying across Canadian regions. In the Maritimes and Quebec, the use of oil-fueled water heating units tended to decline, while the use of electric water heaters increased. In Ontario, a decrease in electric type heaters was accompanied by an increase in natural gas fired heaters, while in Manitoba the change was in the opposite direction. Saskatchewan, Alberta, and British Columbia use natural gas as the preferred domestic water heating fuel with little or no switching associated with retrofit activity. More detailed analysis is required to determine if the retrofits involve upgrading the existing water heating system to energy efficient storage tanks or demand type systems.

The complete paper, entitled "Domestic Water Heating and Water Heater Energy Consumption in Canada" (CBEEDAC 2005–RP-02), authored by C. Aguilar, D.J. White, and David L. Ryan, is available on the CBEEDAC website.

GRADUATE RESEARCH

This summer Nigel Fish, Ronggui Liu, and Jon Buck provided research assistance on a variety of projects ranging from measuring the standby power consumption of electronic office and household equipment to conditional demand analysis of residential energy end use. In the preceding fall and winter terms, Alan Puongpienr and Samson Amusan explored differences in energy consumption for specific commercial building types in different regions of Canada, while Jian Wang and Ronggui Liu helped piece together commercial and residential energy price series. In addition, Ergete Ferede helped Ryan and Plourde with their efforts to assemble complete residential energy data, and Junaid Jahangir, who completed his Doctoral Candidacy Exam in economics, continued work on his dissertation on the effects on consumers of the restructuring of the electricity industry in Alberta.

BUILDING SERVICES

CBEEDAC has the expertise to provide services to the building sector in the area of data storage and analysis. For more information regarding these services, on becoming a sponsor of CBEEDAC, or about the services provided by other Data and Analysis Centres contact CBEEDAC or see our Web site (www.ualberta.ca/~cbeedac).

CBEEDAC reports are available online in PDF format.

If you house and/or collect data that could become a valuable addition to Canada's Building Energy End Use information system please consider contacting the Centre with your data information.