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**COMMERCIAL RETROFITS - WHO DOES WHAT**

A number of recent studies have argued that energy retrofits and conservation measures can be cost-effective methods of reducing building energy consumption.<sup>1</sup> Although office buildings are classified among those buildings with the highest energy consumption, demolition and reconstruction is usually not viewed as being the best solution, since this typically involves costs of two to three times those associated with retrofitting (even for high cost retrofitting operations).<sup>2</sup> Of course, in addition to reducing energy consumption, energy renovation of existing buildings is, among other things, an important tool for improving prevailing indoor thermal comfort conditions.

While many commercial buildings in Canada and elsewhere have undergone various types of retrofits, there has been relatively limited analysis of the actual retrofits that have been made or of the determinants and consequences of such activities. In the Canadian case, this stems to a large degree from a lack of appropriate data. This data gap has recently been addressed by a Natural Resources Canada / Statistics Canada survey of commercial buildings – the Canadian Commercial and Institutional Buildings Energy Use Survey (CIBEUS-2000).

In a recent paper presented at the 23<sup>rd</sup> Annual North American Conference of the International Association for Energy Economics held in Mexico City, and contained in the proceedings of that conference, David Ryan, Denise Young, and André Plourde reported on work using data from CIBEUS to investigate the determinants of various forms of commercial building retrofits undertaken in Canada. In this newsletter we highlight some of the information reported in that paper concerning recent retrofit activity in the commercial and institutional sectors in Canada.

<sup>1</sup>See, for example, M. Carriere, G. Schoenau, and R. Besant (1999), "Investigation of Some Large Building Energy Conservation Opportunities using the DOE-2 Model", *Energy Conservation and Management* 40: 861-872.

<sup>2</sup>Caccavelli, D. and H. Gugerli (2002), "TOBUS – A European Diagnosis and Decision-Making Tool for Office Building Upgrading", *Energy and Buildings* 34: 113-119.





# RETROFITS IN COMMERCIAL BUILDINGS IN CANADA

David L. Ryan & Denise Young

CIBEUS, which covered census metropolitan areas in Canada as well as census agglomerations with populations of 50,000 and over for Atlantic Canada, and populations of 175,000 and over for other provinces, targeted all buildings with an area of at least 1,000 square feet. At least 50% of the targeted buildings were devoted to commercial or institutional activities. Collected data included information on building characteristics, occupancy characteristics, energy efficiency characteristics, and energy consumption. Separate questions were used to gather information about retrofits undertaken in the year 2000 and those undertaken in previous years. The types of retrofits considered in the survey are grouped into one of nine categories: lighting systems, heating equipment, ventilation or air conditioning equipment, basement or foundation, roof – structure or surface, roof – insulation, walls – siding, walls – insulation, and other.

Figure 1 summarizes various aspects of the retrofit information contained in the CIBEUS data set. Overall, 11% of the sample of 3151 buildings

underwent retrofits in 2000, and 22.4% underwent retrofits in the preceding five years. Within this sample, just over 50% of the buildings are between 1,000 and 10,000 square feet, while a further 35% range in size between 10,000 and 50,000 square feet. In general, the proportion of buildings undertaking retrofits, both in 2000 and in earlier years, increases as the size of the building increases, with almost 50% of buildings exceeding 500,000 square feet being retrofitted in 2000 and over 75% being retrofitted in 1995-1999.

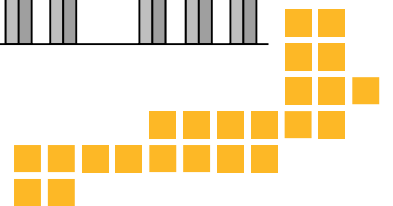
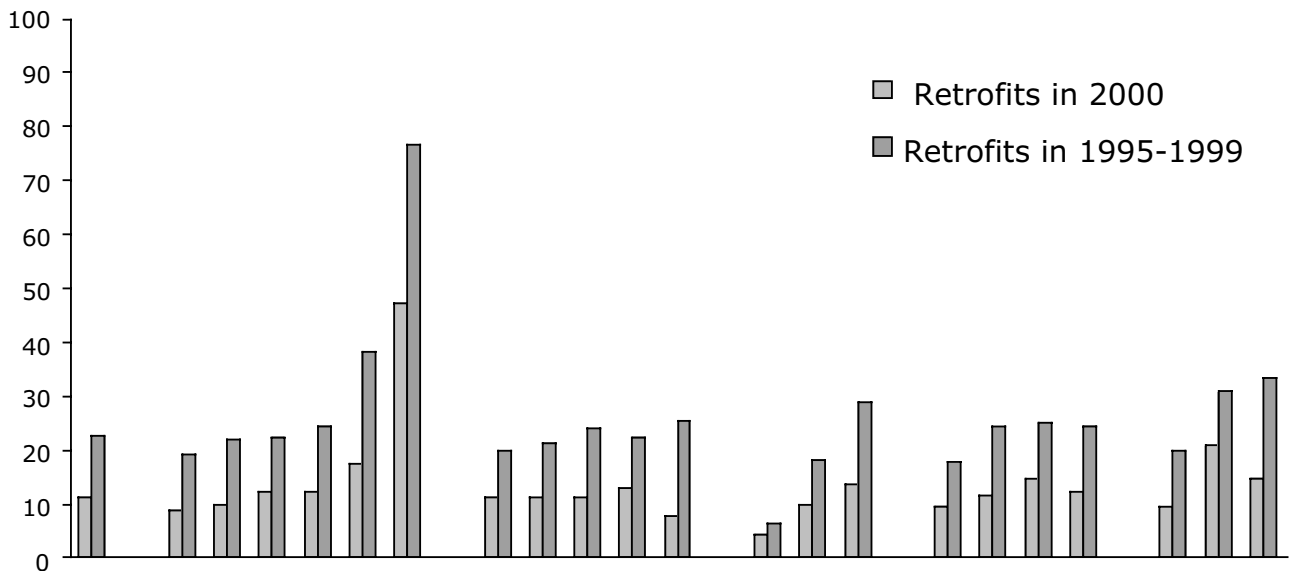
**In general, the proportion of buildings undertaking retrofits, both in 2000 and in earlier years, increases as the size of the building increases.**

Over 75% of the buildings are privately owned, but non-profit and government buildings are the most likely to undergo energy-related renovations. Older buildings (pre-1994), which represent just over half the sample, are more likely to be retrofitted, while those with electricity as the main heating source

(25% of the sample) are the least likely to undergo this process.

Of the buildings that undertook any type of retrofit in 2000, over 60% reported that their retrofit involved only one component while 17% reported

Fig. 1: Retrofitted Buildings by Size, Region, Age, Main Heat Source, & Ownership (%)





that their retrofit involved 3 or more components. Almost 1% of retrofitted buildings reported retrofits that involved all 9 components. Figure 2 shows the top 10 (accounting for almost 75% of all retrofitted buildings) retrofit packages or combinations that were undertaken in 2000. The four main retrofit packages each involved only one component – heating equipment, other, lighting systems, and ventilation or air conditioning equipment – although the fifth main retrofit package (accounting for almost 7% of buildings retrofitted in 2000) involved both heating and ventilation systems. Taking account of the existence of multiple components in a retrofit package, Figure 3 shows the distribution of retrofits among the 9 retrofit components included in the survey. Of all buildings that were retrofitted in 2000, over 23% included a heating equipment retrofit either by itself or in combination with other retrofit components. Ventilation systems were part of almost 17% of retrofit packages, lighting was included in 16% of all retrofit packages, while walls (structure or surface) and walls (insulation) were each involved in only 4% to 5% of all retrofit packages.

While 3.17% of all buildings underwent

lighting system retrofits in 2000, only 1.61% of smaller buildings (between 1,000 and 5,000 square feet) underwent such retrofits, but over 23% of the largest buildings (exceeding 500,000 square feet) did so. There were also differences in the type of retrofits undertaken in different regions – with lighting being more important in B.C., and heating more important elsewhere – possibly reflecting (at least in part) differences in climatic conditions. In non-profit buildings, heating (10%) followed by ventilation (6%) were the most common types of retrofits, while in

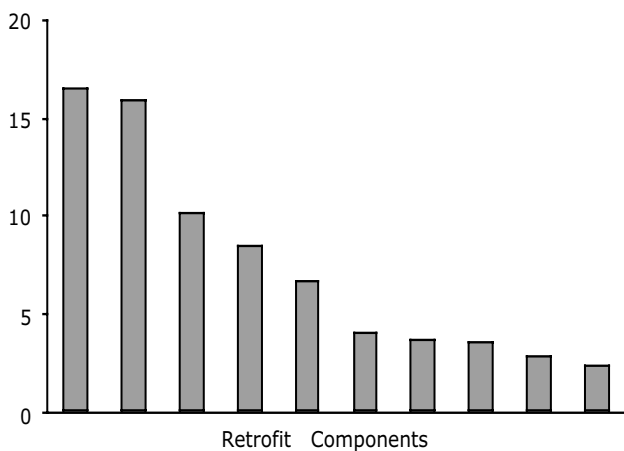
government buildings the most common types were heating (6.3%) followed by lighting (5.4%).

Although these figures reveal differences in retrofit behaviour according to various characteristics of the buildings as well as according to the type of retrofit that is

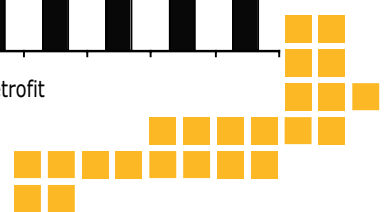
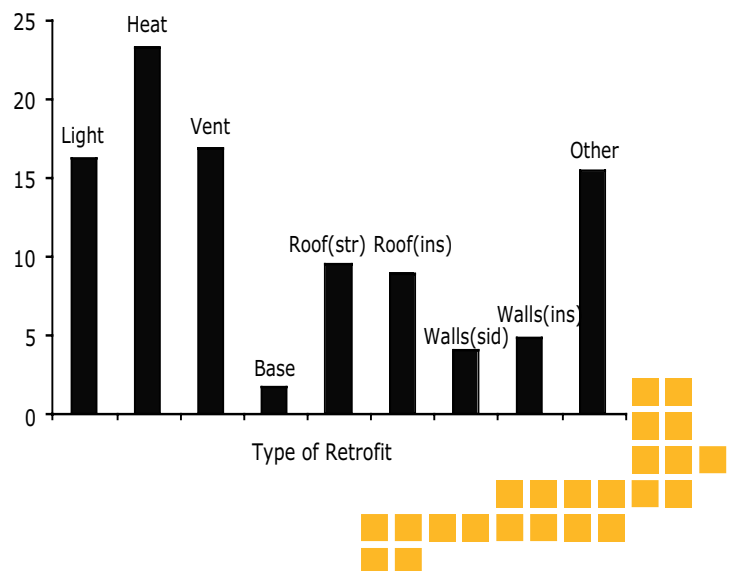
undertaken, they do not reveal the relative importance of these different factors in the decision to undertake a particular renovation. To examine this issue it is necessary to model the decision to undertake a retrofit project in a Canadian commercial building in the year of the survey (2000) as a function of building, owner, and location characteristics. We will report on the results of this analysis in a subsequent newsletter article.

**Of all buildings that were retrofitted in 2000, over 23% included a heating equipment retrofit either by itself or in combination with other retrofit components.**

**Fig. 2: Retrofit Combinations (%) - 2000**



**Fig. 3 Types of Retrofits - 2000**



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## GRADUATE RESEARCH

During the fall and winter academic terms, **Ergete Farede**, **Le Zong**, and **Yufei Zheng** have returned to the Centre. They provide continued research support on projects at the Centre, including the analysis of residential energy use, the disaggregate analysis of the role of weather patterns on energy use in different regions of Canada, and analysis of commercial retrofits and energy efficiency.

**Congratulations to Chris Hughes** on his successful completion of the Economics Masters Program at the University of Alberta with his research project *Analysis of Energy Efficiency in Commercial Buildings in Canada*.

**Darren Herasymiuk** is continuing his MA non-thesis project concerning the energy efficiency of certain types of household equipment.

Over the course of the next three months, the Centre will also have the assistance of **Carolina Aquilar** and **Min Li**. Carolina completed her undergraduate degree at the University of Alberta and is enrolled in the Economics Masters Program pursuing her interest in resource economics. Min Li completed a Masters Degree at Xi'an Jiaotong University and is now pursuing her masters degree at the University of Alberta with an interest in microeconomics.

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## ENERGY ENDNOTES

Building energy measurement guidelines and standards to assess the benefits of energy efficiency strategies and retrofits have been developed to facilitate consistent, comparable analysis.

The International Performance Measurement and Verification Protocol (IPMVP) defines general procedures to achieve reliable and cost-effective determination of savings. This reference is written for general application in measuring and verifying the performance of projects improving energy or water efficiency in buildings and industrial plants. (<http://www.ipmvp.org>)

Other references of interest include:

<sup>1</sup>ASHRAE Handbook, Chap. 39, 1999 HVAC Applications, *Building Energy Monitoring*

<sup>2</sup>Heinemeier, K. E., (1994). *The use of energy management and control systems to monitor the energy performance of commercial buildings*, Lawrence Berkeley National Laboratory report LBL-36119.

<sup>3</sup>Claridge, D. E., et al (1993). *Use of energy management and control systems for performance monitoring of retrofit projects*, Energy Systems Laboratory report, Texas A&M University, ESLTR-91/09-02.

<sup>4</sup>ASTM 1992a, ASTM 1410-92, *Standard Guide for Developing Energy Monitoring Protocols for Commercial and Institutional Buildings or Facilities*

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## PEOPLE NEWS

With André Plourde's relocation to Natural Resources Canada, the Centre has appointed two new Associate Directors, Denise Young in the Department of Economics and Joseph Doucet in the School of Business, both at the University of Alberta.

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## 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](http://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.

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