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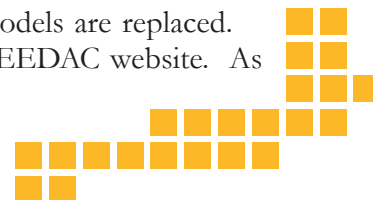
RECENT ANALYSES OF ENERGY USE BEHAVIOUR

In this newsletter we provide an overview of two recently completed CBEEDAC reports which help to highlight the differing nature of the research and analysis undertaken by researchers at the centre. The first of these pertains to the commercial sector, while the second investigates appliance survival in the residential sector.

Based on the observation that commercial buildings vary substantially in their degree of specialization – with some buildings housing a single activity, and others a variety of activities – CBEEDAC researchers Denise Young and Nigel Fish analyzed energy usage patterns when a particular activity is the sole activity, the main activity or only a minor activity in a commercial building. To the extent that different commercial activities have differing energy requirements, it may be possible to manage energy use in a commercial building more effectively when it is used for a single main activity rather than when that same activity is only one of many undertaken within the confines of the building. The authors' empirical investigation, which is highlighted here, focuses on total energy usage and electricity usage patterns for a sample of 608 Canadian commercial buildings that house non-food retail activities.

The second CBEEDAC study that is very briefly summarized in this issue concerns the lifetimes of appliances in a residential environment. Improvements in the energy-efficiency of household appliances have the potential to decrease residential energy use, but these reductions accrue gradually over time as newer appliances replace older models in Canadian households. Based on an examination of appliance replacement patterns in Canada for refrigerators, freezers, dishwashers, clothes washers and clothes dryers, the study, authored by Denise Young, finds that in many cases, the energy savings from improved appliance technologies are unlikely to be realized in the short-run due to the relatively slow rate at which older energy-inefficient models are replaced.

These studies will soon be posted to the CBEEDAC website. As always, we welcome comments and suggestions.



Energy Use Patterns and Occupancy Specialization: Evidence from Buildings Housing Non-Food Retailers

D. Young and N. Fish

Data on Canadian commercial buildings that house non-food retail activities were obtained from the Commercial and Institutional Building Energy Use Survey (CIBEUS), which includes information on physical characteristics, activities, and energy use for the year 2000. Non-food retail activities that were considered included art dealerships, clothing stores, department stores, drugstores/pharmacies, furniture and home furnishings, building materials and hardware, motor vehicle parts and sales, electronics and appliances, optical equipment, camera equipment, and other non-food retail enterprises. Food retailers were excluded due to the specialized food preparation and refrigeration needs that may necessitate much different energy usage patterns, while enclosed and strip shopping malls were omitted given their substantially different building designs and potentially energy usage.

Buildings were categorized as exclusively retail, primarily retail, largely other, and primarily other, based on the proportion of the building comprising retail space. As shown in the table below, average total energy usage and average electricity usage per square foot of building space (exclusive of indoor parking), as well as the variation in these measures across buildings, are lower in buildings that are exclusively or primarily retail compared to buildings

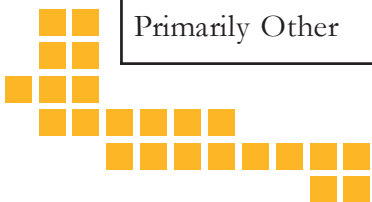
that are primarily or largely dedicated to activities other than non-food retailing.

A regression model was used to distinguish between the impact of increased specialization in retailing activity – measured as the percentage of building space dedicated to non-food retailing activities – and the impacts of other building characteristics on energy and electricity usage. Controlling for the effects of these physical and occupancy building characteristics, the results provide little evidence that increased building occupancy specialization, at least for non-food retailing, leads to improvements in energy efficiency. Rather, differences in energy usage across buildings housing non-food retail activities appear to be driven more by other building characteristics, including the type of main activity in the building.

Thus, there are not likely to be significant gains in energy efficiency that would accrue from increased retail specialization in buildings that house retail activities. While this result cannot readily be generalized to other types of buildings, since there appears to be relatively little scope for policy initiatives to impact on the distribution of activities within or across buildings, it is likely that other avenues for achieving energy efficiency are more likely to have a significant pay-off than will encouraging increased specialization of activities within a commercial building.

Table 1: Energy Use According to Proportion of Retail Space

Category	Proportion of Space Devoted to Retail Activities	Percentage of Sample	Energy Use Avg (Min, Max) (GJ/ Square foot)	Energy Use Avg (Min, Max) (GJ/ Square foot)
Exclusively Retail	100%	44.9%	0.11 (0.01, 0.64)	0.05 (0.01, 0.36)
Primarily Retail	50% - 99%	21.1%	0.11 (0.02, 0.63)	0.05 (0.01, 0.43)
Largely Other	25% - 49%	13.7%	0.16 (0.02, 0.83)	0.06 (0.01, 0.75)
Primarily Other	0% - 25%	20.4%	0.14 (0.01 - 1.20)	0.07 (0.01 - 0.65)



How Long Do Major Household Appliances Survive in Canada?

D Young

The energy efficiency of major household appliances has improved significantly in recent years. These advances in energy efficiency are due in part to regulatory efforts that have led to the imposition of standards for household appliances and in part to improvements in technology that would have arisen in the absence of such standards. The extent to which these improvements in energy efficiency will have an impact on overall energy demand, and subsequently on the environment, depends on how quickly the newer and more efficient models replace older models in household use. In other words, the rates at which households replace various appliances have important implications for the realization of household energy demand savings in response to technological improvements.

The 2003 Canadian Survey of Household Energy Use (SHEU03) contains information on retirement ages for appliances such as refrigerators, freezers, dishwashers, clothes washers and clothes dryers, as well as household energy use and building and household characteristics. Table 2 below summarizes responses to questions concerning the approximate ages at which various appliances were replaced. As the values in this table show, for each of the five appliances, there have been retirements in all 7 of the age groups for all five appliances, with the most common age at replacement being either 11 to 15 years (dishwashers, dryers) or 16 to 20 years (refrigerators, freezers, clothes washers). The distributions of retirement ages, however, vary across appliances.

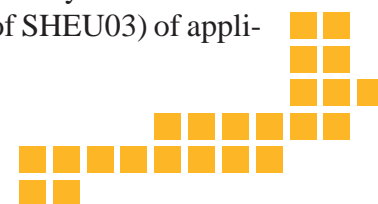
Table 2: Age Distribution (Percentage) of Appliances when Replaced

Approximate Age	Refrigerator	Freezer	Dishwasher	Clothes Washer	Clothes Dryer
3 years or less	5.5	2.8	6.7	3.6	4.6
4 to 5 years	3.5	4.6	5.8	3.3	3.3
6 to 10 years	12.5	11.0	22.7	14.3	10.9
11 to 15 years	22.4	13.9	29.1	27.4	28.0
16 to 20 years	26.2	27.8	23.0	29.1	26.5
21 to 25 years	15.3	18.9	9.5	13.2	15.8
26 years or more	14.6	21.0	3.1	9.1	11.0

Of all appliances considered, dishwashers are the most likely to be replaced within 5 years of purchase. Dishwashers are also the least likely appliances to survive beyond 20 years in household use. Clothes washers and dryers exhibit similar patterns to each other in terms of retirement age, with the bulk of these appliances being replaced after 11 to 20 years of use. The appliances most likely to survive beyond 20 years

of use are refrigerators and freezers. Almost 30% of refrigerators were used for over 20 years before a newer model was purchased. For freezers, almost 40% survived for more than 20 years, with over 20% surviving more than 25 years.

By combining this information on the age of appliances at replacement with survey information on the current ages (at the time of SHEU03) of appli-





Appliance Survival (cont'd.)

ances for households that had not yet replaced their older models, empirical survival curves can be constructed and survival rates calculated, where the survival rate refers to the cumulative proportion of appliances surviving past a specified age. Overall, the results of this analysis indicate that the linear survival curves typically used in energy demand modeling exercises may be reasonably accurate for lower age ranges. However, they would generally overestimate the replacement rates of appliances in the older age ranges in Canada, leading to underestimates of the number of older appliances in use and overestimates of energy savings that can be expected in any given period from appliance replacement.

In order to quantify the extent to which replacements are affected by household characteristics, a parametric specification of the survival curves is also used. Overall, the results here indicate that the house-

hold characteristics that affect the decision to replace an appliance vary across the five appliances. For refrigerators and clothes washers, replacement behaviour is income-sensitive, suggesting that there may be scope for targeted policies that focus on lower-income households to reduce residential energy use through earlier appliance replacement. However, the most common factor influencing appliance replacement decisions appears to be demographics, with larger households tending to replace appliances at more frequent intervals than smaller households.

Finally, energy savings from improved refrigerator technology may not be realized in the short-run with as many as 25% of households continuing to use older energy-inefficient models alongside the newer models that have been purchased to “replace” these older refrigerators.

GRADUATE RESEARCH

In the fall, CBEEDAC welcomed **Evgeny Prasol**, who joined **Ronggui Liu** as graduate student researchers employed by the Centre. Both these students are undertaking Masters degrees in economics or economics and finance at the University of Alberta. Ronggui previously worked for CBEEDAC over summer on a project on conditional demand analysis, which - in addition to his other CBEEDAC research - he is currently extending into a non-thesis Master's project. A

preliminary version of this work (joint with David Ryan) was presented at the Ann Arbor conference of the International Association for Energy Economics in September 2006. Evgeny has been working on analysis of the Energuide for Houses (EGH) database, in conjunction with **Samuel Gamtessa** who is continuing to work on his PhD dissertation on modelling residential retrofit behaviour using the EGH database.

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.

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