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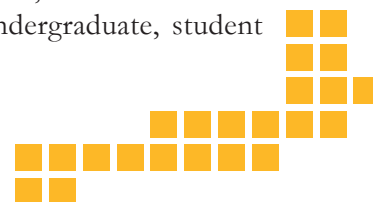
Energy Efficiency and Individual Behaviour

Perhaps one of the most interesting and intriguing aspects of conducting research and analysis in the Building sector, which incorporates the residential, commercial, and institutional sectors, is the interplay between technology and human behaviour. While this is no doubt also apparent in other sectors, the fact that this sector contains so many individual participants, and that the vast majority of these are primarily energy consumers rather than energy producers, likely contributes to the wide variety of effects that are observed.

Much of the research that is undertaken at CBEEDAC reflects our desire to understand both this interplay and the extent to which public policy measures that might be undertaken in this sector in an attempt to increase energy efficiency are, or are likely to be, effective. For example, one of the projects that is currently underway concerns the use of Compact Fluorescent Lights (CFLs) in the residential sector in Canada and the factors that explain their relatively low usage despite their higher energy efficiency and apparent cost savings. Clearly these aspects need to be taken into account when evaluating the potential aggregate energy savings that may be realized through the wider adoption of this technology. Another current project concerns analysis of residential retrofit behaviour, leading ultimately to an examination of the extent to which retrofit incentive programs affect this behaviour.

Other research projects that are currently underway concern determining the amount of energy that is used in particular end uses, and standby power, the amount of energy that is being used when particular appliances are turned on but not in full operation. Without knowledge of the extent of these energy uses, and the associated costs, it would not be surprising if many individuals, households, businesses, or institutions do not make what may appear to be energy efficient choices.

In this newsletter we provide a brief summary of these and some of the other projects that are currently underway at CBEEDAC, in almost all cases involving extensive graduate, and in some cases undergraduate, student involvement.





A Sampling of Current CBEEDAC Projects

Standby Power Consumption

The objective of this project is to assess the standby power energy use of appliances covered in the 2003 Survey of Household Energy Use (SHEU 03). These include: microwave ovens, TVs, VCRs, computers, satellite dish receivers, stereos (component, compact, and portable), telephones requiring an electrical outlet, DVD players, video game systems, and answering machines. Measures to be obtained include the standby power when the appliance is off, the standby power when the appliance is on but not being used, and the power when the appliance is being actively used. Combining these measures with survey data on appliance penetration will facilitate estimation of the standby power requirements of a “typical” household and the share of household energy consumption that is attributable to these requirements. It is also planned to utilize information on prices and expenditures in order to estimate the expenditures associated with this standby power consumption relative to total household energy expenditures.

Determination of Household End-Use Energy Consumption

In the absence of appliance-specific metering, it is almost impossible for households to know how much energy is being consumed by particular appliances. EnerGuide labels that are affixed to new appliances provide an indication of energy use for each appliance in a “typical” setting, but this does not take account of usage patterns that differ across households. Provided information is available on total household energy consumption as well as on the specific appliances that are present in a particular household, one method that has been used in a number of studies is Conditional Demand Analysis (CDA), first developed some twenty-five years ago.

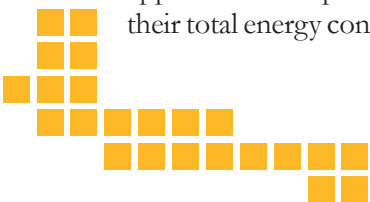
In this project, CDA is applied to data from the 2003 Survey of Household Energy Use (SHEU 03), where respondents provided detailed data on which appliances were present in the household as well as their total energy consumption levels for 2003 by fuel

type. Types of appliances for which information was recorded range from major appliances that include refrigerators, dishwashers, stoves, microwave and conventional ovens, freezers, clothes washers and dryers, space heating and water heating systems, televisions, and personal computers, to smaller appliances such as ceiling fans, satellite television boxes, DVD and VCR players, video game consoles, answering machines and even the number and types of lights. Based on this information, the objective is to estimate energy consumption by these various end uses.

In order for CDA to successfully estimate end-use consumption, variation across households in appliance ownership is crucial. End-use consumption for appliances with extremely high penetration rates, such as refrigerators, cannot be identified, although additional consumption associated with multiple holdings of these appliances can often be determined.

Commercial Energy Use Patterns according to Main and Subsidiary Activities

When a commercial building is used solely for one purpose, or one main activity, it may be possible to manage energy use in that building more effectively than when that same activity is only one of many activities undertaken in a building, or when it is only a minor activity in that building. The Commercial and Institutional Building Energy Use Survey (CIBEUS), which collected data for the 2000 calendar year for a variety of commercial buildings, includes information about the main and other activities undertaken in those buildings. This project involves using CIBEUS data to analyze the different energy usage patterns in buildings when an activity is the sole activity, the main activity, or only a minor activity in those buildings. To ensure sufficient variation across regions, and enough observations where a particular activity is alternatively the sole, main, or a minor activity in a building, the focus of this project is on retail activities.





Analysis of Trends in Retrofit Activity in the EnerGuide for Houses Program

Under the EnerGuide for Houses (EGH) program homeowners undertake an initial EGH evaluation; and if they follow up on the recommendations, have a second post-retrofit audit, and achieve a certain energy performance improvement, they are eligible for a grant. Between 1999 and 2005, the program accumulated a sizable cross-sectional database that contains information on the regional location of the home, vintage, house type, type of upgrades undertaken, the resulting energy and cost savings and EGH rating increase. This project involves analyzing this database to determine what types of retrofits homeowners were more likely to implement and the energy and cost savings that were realized by taking these actions. Additional issues to be examined concern the combinations of retrofits that proved to be the most or the least effective, and the extent to which the results vary by region, age, and type of home.

Energy Savings for Compact Fluorescent Lights (CFLs)

Due to the different technology that is employed, compact fluorescent lights (CFLs) use between one-quarter and one-third as much electricity as incandescent bulbs to provide the same amount of light. According to the most recent (2003) Survey of Household Energy Use (SHEU03), at least one CFL is used in 31.4% of homes in Canada, and in these CFL-using households, an average of 4.38 CFLs are used along with 2.69 halogen lights, 3.08 fluorescent lights, and 20.74 incandescent lights. Remaining households use on average 2.08 fluorescent lights, 2.05 halogen lights, and 20.90 ordinary light bulbs. Obviously if all remaining incandescent bulbs in Canada were to be replaced with CFLs, significant energy savings could be achieved. However, CFLs are not necessarily appropriate or desirable in all situations where incandescent bulbs are currently used, and even in cases where they are suitable, consumers may be reluctant to use them for a variety of

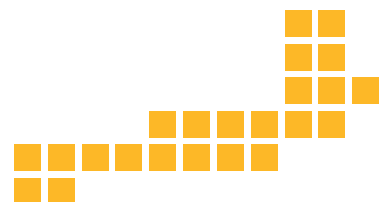
reasons. Indeed, even in households that use CFLs, the average number of CFLs is greatly outweighed by the average number of incandescent lights. Given this context, the purpose of this project is to examine the current penetration of CFLs in Canada, to determine the relative importance of the factors that explain this usage, and hence to assess the potential energy savings of CFLs in the residential sector in Canada.

Analysis of Energy Use Patterns in Shopping Centres

Shopping centres house a variety of commercial activity types such as medical clinics, retail stores, supermarkets, food services, hotels, swimming pools, hair salons, offices, etc. As a result, it is very difficult to classify them under current activity types. The Commercial and Institutional Building Energy Use Survey (CIBEUS), conducted in 2001, collected data for the 2000 calendar year for a variety of building types, including shopping centres. This project involves using CIBEUS data to analyze energy usage patterns in shopping centres.

Analysis using the Buildings Module of Canadian Integrated Modelling System (CIMS)

CIMS is a hybrid model combining bottom-up and top-down approaches, allowing each sub-module (energy sector) to interact in an integrating interface. The model was developed at Simon Fraser University by the Energy and Materials Research Group (which houses CIEEDAC, our sister centre for the industrial sector) in collaboration with M. K. Jaccard and Associates. In this project the effects of utilizing within CIMS some of the observed residential retrofit information contained in the EnerGuide for Houses database will be contrasted with results that were obtained previously with CIMS using stated preference data for this same sector.





GRADUATE RESEARCH

During the fall and winter **Ronggui Liu, Alan Wesley, Samuel Gamtessa, and Nigel Fish** have provided research assistance to the Centre on a variety of projects.

Nigel continues his work on the analysis of standby power consumption of electronic office and household equipment.

Alan is involved in a study of the energy efficiency of compact fluorescent lighting (CFLs) and the use of discrete choice theory in the assessment of market potential for CFLs.

Samuel has been analyzing trends in retrofit activity

in the Energuide for Houses Program in order to determine the types of retrofits homeowners implement and the energy and cost savings associated with certain retrofits.

Ronggui's work is on a project using conditional demand analysis to estimate residential end-use energy consumption.

Junaid Jahangir continues his dissertation work on the effects on consumers of the restructuring of the electricity industry in Alberta.

BUILDING BYTES

Standby Power

The share of household power consumption attributed to household electronic devices while in an “on and inactive” or standby state is estimated to vary from 5% to 15% in developed nations. As the dependence on electronic equipment at home and in the workplace has increased so has the need for policy, technological design and consumer awareness that will reduce energy consumption in our “always on” world. For some of the latest in discussion and information on this issue see:

⁽¹⁾The Economist. *Pulling the plug on standby power*.
March 9, 2006

⁽²⁾Lawrence Berkeley National Lab. *Standby Power Homepage*.
<http://standby.lbl.gov/index.html>

⁽³⁾US Department of Energy. *How to Buy Products with Low Standby Power*. June 2004. http://www.eere.energy.gov/femp/pdfs/standby_power.pdf

⁽⁴⁾Office of Energy Efficiency. Energy Star. Natural Resources Canada.
<http://oee.nrcan.gc.ca/energystar/english/consumers/index.cfm?PrintView=N&Text=N>

⁽⁵⁾European Commission Joint Research Centre. *EU Standby Initiative*. 2005
http://energyefficiency.jrc.cec.eu.int/html/standby_initiative.htm

⁽⁶⁾Marsh, David. *Linear Regulators face extinction*. EDN Europe. November 2005.
<http://www.edn.com/article/CA6262867.html>

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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