



BUILDING A TALENT TRUST



Ontario Centres of  
Excellence

Where Next Happens



# TOU rates and vulnerable households: Electricity consumption behavior in a Canadian case study

---

*Sarah Ivy Simmons and Ian H. Rowlands*

*Department of Environment and Resource Studies*

*sisimmon@fes.uwaterloo.ca*

## **Ontario's Smart Metering Initiative and Time-of-use Rates**

- The Ontario government has committed to installing smart meters in 800,000 households by 2007 and in all 4 million households by 2010 (Ontario Energy Board, 2007).
- The new smart meters will allow time-of-use (TOU) electricity rates to be implemented across the province (Ontario Energy Board, 2007).
- Benefits of smart meters include:
  - Customer control of electricity costs
  - Feedback on electricity consumption
  - Precise billing
- TOU rates are intended to:
  - Increase fairness – consumers pay an amount that reflects the actual cost of electricity at the time it was produced.
  - Reduce peak use of electricity – reduces the need for expensive, extra generating capacity (Social Housing Services Corporation, 2006)

- The TOU rates are designed to be cost neutral – households whose electricity consumption behavior is similar to the provincial average will pay the same on their electricity bill (Ontario Energy Board, 2007).
- Milton Hydro was the first and is currently the only local distribution company to implement TOU rates on a large scale in Ontario.

### ***Energy use in vulnerable households and the effects of TOU rates***

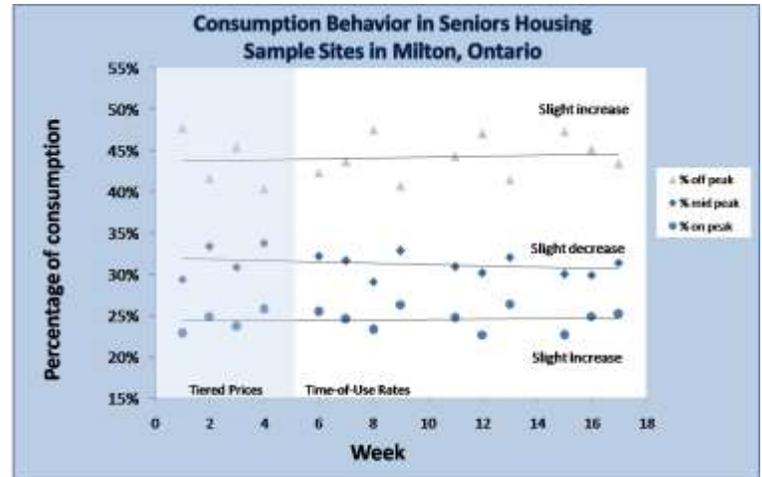
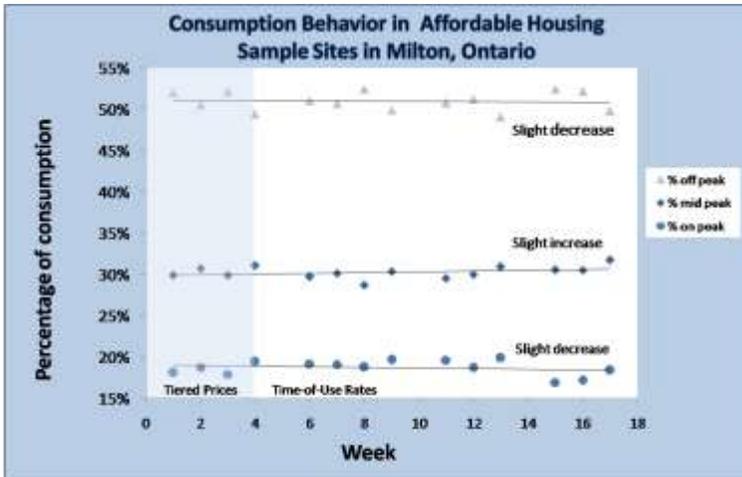
- Lower-income households typically use less energy than the average consumer; as a result their ability to conserve is reduced (Brandon and Lewis, 1999).
- However, lower-income households are more likely to live in electrically heated homes and to use inefficient appliances (Herter, 2007; IndEco, 2003).
- When confronted with an increase in energy costs, lower-income families tend to make “lifestyle cutbacks”, while higher-income families tend to invest in energy conservation measures (Dillman and Dillman, 1983).
- Renters are not likely to invest in energy efficiency and therefore curtailment is the only option to reduce consumption (Black et al, 1985).
- Senior-headed households generally use less electricity than non-senior-headed households; however, they pay proportionally more of their annual income on electricity (Warriner, 1981).
- The impact of TOU rates on vulnerable households is uncertain.
  - TOU rates may be beneficial for lower-income households if they consume the majority of their electricity during off-peak periods or they are able to shift consumption to off-peak periods (Blocker, 1985).
  - Lower-income households may be affected disproportionately by high electricity rates during peak periods if they cannot shift or conserve electricity during on-peak periods and they are unable to invest in energy saving technologies (Social Housing Services Corporation, 2006).

## ***Research Question and Methods***

- What are the financial and behavioral impacts of TOU electricity rates on vulnerable households?
  - Ten expert interviews were conducted in June and July 2007 with Ontario professionals working in government, environmental non-profit and citizen advocacy organizations to provide context for the study.
  - Hourly electricity consumption data were collected from 200 units in two affordable housing and two seniors housing complexes in Milton, Ontario between June and September 2007 to determine the change in the cost of electricity and consumption behavior arising from the implementation of TOU rates.

## ***Interviews with Ontario's Experts***

- Mixed opinions about the financial implications of TOU rates on vulnerable households:
  - Very dramatic and very negative – versus – very minimal and positive impacts.
  - Empower those with the ability to control electricity costs.
  - Penalize those who are at home during the day.
- Senior-headed households and lower-income families with children were expected to be at greatest risk of bill increase under TOU rates.
  - At home during peak periods when cost of electricity is the greatest.
  - Temperature requirements for health reasons.
- Lower-income households are less likely to have a “discretionary load”.
- Working poor have less flexibility in their schedule to take advantage of off-peak rates.
- Lower-income and senior headed households often feel that they are already doing all that they can to conserve.
- Concerns about the speed of implementation of new rate scheme and rate affordability.



**Figure 1.** For each week of the study period (June – September 2007), the consumption patterns for the sample sites are represented as the percent of total electricity consumed by the units during off-, mid- and on-peak periods. The weeks with holidays are omitted.

Tiered Rates	Tier 1 <small>First 600 kWh</small>	Tier 2 <small>Above 600 kWh</small>	Average	
Price per kWh	\$0.053	\$0.062		
% of Consumption (Affordable Housing Sites)	78.9%	21.1%	\$0.055	
% of Consumption (Seniors Housing Sites)	98.0%	2.0%	\$0.053	
TOU Rates	Off-Peak <small>(10pm-7am)</small>	Mid-Peak <small>(7am-11am, 5pm-10pm)</small>	On-Peak <small>(11am-5pm)</small>	Average
Price per kWh	\$0.032	\$0.072	\$0.092	
% of Consumption (Affordable Housing Sites)	53.0%	29.0%	18.0%	\$0.054
% of Consumption (Seniors Housing Sites)	47.0%	31.8%	21.2%	\$0.057

**Table 1.** Hourly electricity consumption data collected from the sample sites between June and September of 2007 were used to calculate the percent of total electricity consumed during each tier and each peak. The average cost per kilowatt-hour under each rate structure is also shown.

Affordable Housing	June	July	August	September
Average	-\$0.30	-\$0.84	-\$0.23	-\$1.47
Min, Max	-\$9.95, \$4.29	-\$10.05, \$3.16	-\$13.37, \$6.31	-\$10.36, \$3.22
Seniors Housing	June	July	August	September
Average	\$2.05	\$1.66	\$2.31	\$0.83
Min, Max	-\$0.64, \$5.89	-\$0.71, \$4.88	-\$0.45, \$5.84	-\$1.39, \$3.22

**Table 2.** Hourly electricity consumption data collected from the sample sites between June and September of 2007 was used to calculate the monthly cost of electricity under the tiered and TOU rate structures. The difference is shown above. A negative value indicates that the cost of electricity is less under the TOU rate structure.

## ***Discussion of Preliminary Findings and the Continuation of this Research***

- Only slight changes in consumption behavior are detected during the study period - Affordable housings units decreased on-peak consumption while seniors housing units increased on-peak consumption. Preliminary statistical analysis suggests that these trends are not significant.
- Affordable housing units pay a lower average price per kWh under the TOU rate structure while seniors housing units pay a lower average price per kWh under the Tiered rate structure.
- Although the average difference in the cost for electricity between the rate structures is negligible, some households in affordable housing appear to benefit from a TOU rate structure.
- The next phase of this research involves the analysis of household consumption with respect to household characteristics that will be collected using a brief questionnaire.
- This project is expected to be completed in June 2008. Results will be available from the lead author at that time.
- See also [www.fes.uwaterloo.ca/research/greenpower/projects/response\\_systems.html](http://www.fes.uwaterloo.ca/research/greenpower/projects/response_systems.html).

## ***References***

- Black, J. S., Stern, P.C. & Elworth, J. (1985). Personal and Contextual Influences on Household Energy Adaptations. *Journal of Applied Psychology*, 70[1], 3-21.
- Blocker, T. J. (1985). Reforming Electricity Rates: Benefits to Low-Income Households. *Population Research and Policy Review*, 4[1], 67-84.
- Brandon, G., & Lewis, A. (1999). Reducing Household Energy Consumption: A Qualitative and Quantitative Field of Study. *Journal of Environmental Psychology*, 19, 75-85.
- Dillman, D.A., Rosa E. A., & Dillman, J.J. (1983). Lifestyle and Home Energy Conservation in the United States: The Poor Accept Lifestyle Cutbacks while the Wealthy Invest in Conservation. *Journal of Economic Psychology*, 3, 299-315.
- Herter, K. (2007). Residential Implementation of Critical-Peak Pricing of Electricity. *Energy Policy*, 35[4], 2121-2130.
- IndEco Strategic Consulting Inc. (2003). *DSM for Low Income Consumers in Ontario*. Retrieved October 22, 2007, from [www.lowincomeenergy.ca](http://www.lowincomeenergy.ca).
- Ontario Energy Board. (2007). *Ontario Energy Board Smart Price Pilot: Final Report*. Retrieved October 23, 2007 from [www.oeb.gov.on.ca](http://www.oeb.gov.on.ca)

Social Housing Services Corporation. (2006). *Electricity Metering and Social Housing in Ontario*. Retrieved October 22, 2007 from [www.shscorp.ca](http://www.shscorp.ca).

Warriner, G. K. (1981). Electricity Consumption by the Elderly: Policy Implications. *The Journal of Consumer Research*, 8[3], 258-264.

## ***Acknowledgements***

Thank you to Milton Hydro Distribution Inc. for your partnership and for providing the researchers with electricity consumption data. Thank you to the Ontario Centre of Excellence for Energy and Milton Hydro Distribution Inc. for your continued financial support of this project. Thank you to the Department of Environment and Resource Studies at the University of Waterloo and the Ontario Centres of Excellence Professional Development Awards for funding to attend the Behavior, Energy and Climate Change Conference (November 7-9, 2007).