Electricity metering and social housing in Ontario

April 2006

This 'smart meter' example, provided at Hydro One's Web site, can display several items of information including an indication of the price rate in effect and the time of day (both shown here), as well as the current rate of electricity consumption, amounts of electricity consumed across different periods, and the results of diagnostic tests. However, the strength of smart meters lies in their ability to transmit this information automatically, in this case by a wireless link, although it could be across the wires carrying the electric current that is being metered or across a telephone line. Smart meters can be associated with load control devices that can switch individual appliances and other functions off for brief or longer intervals during periods of high electricity demand.

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Table of contents

1. The challenges addressed by this report

The challenges addressed by this report arise from the Ontario government's direction that by the end of 2010 each separately metered Ontario home—now about four million in total—be fitted with a 'smart meter' that can report on how much electricity is being used and when it is used, and assist in the performance of several other related functions. This appears to be the second or third largest such program in the world after that of Italy, where smart meters are being installed in each of the country's 27 million homes.[1†]

Four million homes in Ontario are to be equipped with a smart meter.

What the Ontario government has done, and why, is set out below in Section 2. Smart meters are described in Section 9.

The challenges are discussed from the perspective of Ontario's approximately 1,600 providers of social housing and, by extension, the occupants of social housing. Social housing can be loosely defined as non-profit rental or cooperative housing (see Box 1).

There are three issues to be recognized. One concerns the replacement of the present 'conventional' meters with smart meters. This is an issue mainly for Local Distribution Companies (LDCs), i.e., the local electrical utilities. As will be explained In Sections 2 and 9, LDCs have been mandated to install smart meters and will be their main beneficiaries. An issue for social housing providers and their tenants is that the cost of installing

Three issues to be recognized.

Social housing in Ontario

The best known examples of social housing in Ontario are the 47 Local Housing Corporations (LHCs) occupied mostly by low-income tenants, many of whom receive assistance through the Ontario Works program (OW) or the Ontario Disability Support Program (ODSP). Municipalities own LHCs and supplement their tenants' rents, which are set according to a provincially determined 'rent-geared-to-income' (RGI) program.

The term social housing also embraces buildings owned and operated by private, not-for-profit corporations, including cooperatives. Many low-income residents of these buildings qualify for the RGI program, but there are also residents who pay 'market' rents and thus attract no subsidy. Confusing the definition further is application of the RGI program to some low-income residents of buildings operated on a for-profit basis. Such buildings are not generally regarded as social housing.

Box 1. Social housing in Ontario. ◀

† Superscript numbers refer to 52 reference and other notes that begin on Page 43.

and maintaining the smart meters will fall on electricity users, as also discussed in Section 9.

The second issue concerns an interpretation that the Ontario government's directive could lead to smart metering of *all* Ontario homes. Much of Ontario's social housing (and some of the other housing stock) is not individually metered. There is one meter for the building—known as a bulk meter—and the cost of electricity is included in the rent. In many cases, individual units could be separately metered only with a large amount of costly rewiring that would likely not be done by LDCs. Social housing providers and occupants are not in a position to bear such a cost. This matter is presently in abeyance but is discussed here in some detail in Section 12.

The third and what may be the most important immediate issue for social housing providers concerns the main reason for the Ontario government's directive. It is to allow for the introduction of time-of-use pricing, discussed in Section 8. Exposing users to higher prices at times when electricity is more expensive to produce could cause reductions in use at those times and consequent reduced costs for producers of electricity (and, eventually, consumers), as well as the greater system reliability because peak loads could be less extreme.

Time-of-use pricing could pose numerous problems for social housing providers, whether or not their units are separately metered. One problem to be elaborated in this report is that social housing occupants may be less able than the average person to adapt to time-of-use pricing without potential damage to health and welfare. Another problem is that present arrangements concerning social assistance payments and rent subsidies do not recognize the potential adverse impacts of time-of-use pricing.

Social housing tenants make almost no contribution to the problem, but will be among the most strongly affected by the solution.

An important consideration—elaborated in Sections 6 and 7—is that social housing occupants make almost no contribution to the problem that time-of-use-pricing is designed to solve, namely reducing day-time consumption during summer weekdays, and yet would be among the most strongly affected by the solution.

The present focus of the smart meter exercise is on time-of-use pricing. Smart meters can also facilitate 'load control', which is another, perhaps more reliable way of reducing use of electricity during peak periods.

Load control—discussed here in Sections 8 and 10—is where the homeowner, building manager, utility or a third party has the ability to arrange that individual appliances or functions be automatically switched off during peak periods. Peak loads can then be managed by arranging coordinated short interruptions of appliances and other uses that normally cycle on and off (e.g., water heaters and air conditioners). A single load-control system can extend across numerous users, who may be in more than one building. Smart meters can be a key part of a load-control arrangement, in conjunction with a computer and appropriate switching.

2. Provincial direction and Ontario Energy Board action

The Ontario government has directed that by the end of 2010 all separately metered homes in Ontario be fitted with 'smart meters' that can report on how much electricity is being used and when it is used, and perform several other related functions.[2] The Ontario Energy Board (see Box 2[3]) was directed to prepare an implementation plan, which was submitted in January 2005.[4] Implementation is to begin on the Minister's approval of the plan, which has not yet been given. The installation is to be done by local distribution companies (LDCs, also known as electricity utilities), with costs to be shared among all their customers.[5]

Smart meters are to be installed primarily to allow time-of-use pricing.

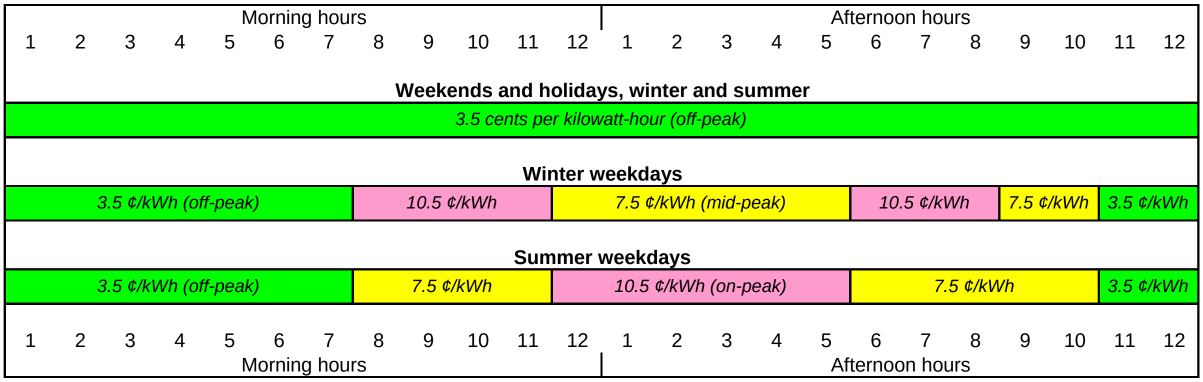
The stated main reason for installing these meters is to allow time-of-use pricing whereby the charge is to be at least three times higher during 'peak' hours of high electricity use than during 'off-peak' hours when less electricity is used.[6] Application of such pricing could reduce overall electricity consumption during these peak hours, thereby reducing the need to provide generating capacity or purchase expensive electricity from outside the province, and reducing the risk of 'brown-outs' and even 'blackouts'.

Moreover, the expensive electricity used only during peak periods can be more polluting than electricity generated for 'base loads', the latter comprising chiefly electricity from hydroelectric and nuclear sources (see Box 7 on Page 13 below and Box 8 on Page 14).

The Ontario Energy Board has also issued a *Regulated Price Plan* (RPP).[7] This is the default arrangement for what is known as the 'power' or 'en-

Box 2. Provincial agencies concerned with electricity. ▶

The **Ontario Energy Board** (OEB) is an adjudicative tribunal that regulates the province's electricity and natural gas sectors in the public interest. The **Ontario Power Authority** (OPA) helps realize an adequate, long-term supply of electricity in Ontario through ensuring investment levels in new supply infrastructure and through supporting the development of a conservation culture. The **Independent Electricity System Operator** (IESO) manages the competitive wholesale electricity market, balances the supply of and demand for electricity in Ontario, and directs its flow across the province's transmission lines. **Ontario Power Generation** (OPG) manages approximately 70 per cent of Ontario's electrical generating capacity. **Hydro One** is Ontario's largest electricity distribution company, selling electricity directly to end users and to local distribution companies. (IESO, OPG, and Hydro One are successor organizations to Ontario Hydro, which ceased operation in 1999. OPA was established in 2004.) The **Ontario Ministry of Energy** oversees the foregoing, implementing provincial legislation and the policies of the Government of Ontario.



▲ Box 3. The Ontario Energy Board's specification of off-peak, mid-peak, and on-peak periods and their prices.

ergy' part of the electricity bill approved for use by residential customers (and some others) who choose not to contract with a electricity retailer.[8]

For residential customers with conventional electricity meters, the present rate is 5.8 cents for the first 600 kilowatt-hours of energy used each month and 6.7 cents per kWh thereafter. During the period November 1 to April 30, the lower rate will apply to the first 1,000 kWh used each month. (The rates are the same for non-residential customers who are on the RPP, but the threshold is 750 kWh throughout the year.)

There is a separate rate schedule in the RPP for customers with smart meters. This schedule provides for three rates according to the time of day. The different periods and the current prices associated with them are set out in Box 3.[9]

Note from Box 3 that the highest rate (for the on-peak period) is charged for seven hours in the winter (four in the morning and three in the afternoon) but for only six hours in the summer (from 11 a.m. to 5 p.m.). The lowest rate (for the off-peak period) is always charged from 10 p.m. to 7 a.m., and also from 7 a.m. to 10 p.m.—i.e., throughout the day—during weekends and holidays

When critical peak pricing is in force, prices could be more than 12 times higher than in off-peak periods.

Eventually, provision is to be made for 'critical peak pricing', to be applied with up to a day's notice when consumption is expected to be exceptionally high. The rate when critical peak pricing occurs could be more than four times the peak rate and more than 12 times the off-peak rate (i.e., it would be in the order of 45 ¢/kWh). The Ontario Energy Board is to bring forward proposals concerning critical peak pricing in May 2006.[10]

3. A note on power demand and energy consumption

This section explains the difference between demand for electric power and consumption of electric energy.

It's hard to understand issues of electricity delivery without knowing about the difference between *power* and *energy* as they are used in connection with electricity generation and use. This section explains the difference between *demand for electric power* (expressed in *watts* or some multiple thereof) and *consumption of electric energy* (expressed in *watt-hours* or some multiple thereof).

Electricity is generated or used at a particular *power* level, usually measured in megawatts of generation or kilowatts of consumption. (A megawatt is 1,000 kilowatts, each of which in turn is 1,000 watts.) Megawatt is usually abbreviated as MW and kilowatt as kW. A generating station may be producing electricity at its rated maximum power output of 500 MW. The homes it serves may be using on average 10 kW of electricity. The generating station would thus be serving about 50,000 homes. (This assumes no line and transmission losses, which in practice could reduce the number of homes that could be served by about 10 per cent.)

When power is being consumed, it is sometimes referred to as *demand*. Thus the homes referred to in the previous paragraph could be said to have an average electricity demand of 10 kW.

Box 4 shows the individual electricity uses in a home that might contribute to a total power consumption—i.e., demand—of 10 kW at 8 p.m. on a winter evening.[11] If this home had electric space heating, its power use at that time could well be 20 kW rather than 10 kW. The amount of power being used in a home at any particular time can change sharply as appliances are switched on and off, the refrigerator compressor cycles, the thermostat switches the heating units on and off, and so on. Across all the homes in a community, more power is likely to be used at 8 p.m. than some hours later at 3 a.m.

Box 4. Possible *power* draw in kilowatts of a home at 8 p.m. on a winter evening (not electrically heated). ▶

Use	kW
Lights (10 at 100-watt)	1.0
Television	0.2
Dishwasher	1.3
Refrigerator	0.5
Coffee-maker	1.0
Microwave	0.8
Two computers	0.3
Clothes washer	0.5
Water heater	3.9
Furnace fan	0.5
Total	10.0

Electricity consumption in homes is billed according to the amount of electrical *energy* that is used, measured in kilowatt-hours (usually abbreviated as kWh). When items drawing one kW of power (e.g., the 10 lights in Box 4) are on continuously for one hour, 1 kWh of electrical energy is consumed. The 0.5-kW compressor in a refrigerator may be on about a quarter of the time, so across 10 hours it will use about 1.25 kWh (i.e., 10 x 0.5 x 0.25).

Box 5 indicates the kind of monthly energy consumption that might result from the items listed in Box 4. The total is 1,000 kilowatt-hours.[12] If this were the total use by an Ontario household during January 2006, the charge for electric energy would be $50.[13] The actual bill would be for roughly twice this amount. As well as the charge for electrical energy, the bill would include charges for delivery, administration, retiring the debt of the former Ontario Hydro, paying for the work of the Ontario Energy Board, and other items. Most of these charges vary with the amount of electrical energy used.

Use	kWh
Lights (10 at 100-watt)	100
Television	50
Dishwasher	40
Refrigerator	100
Coffee-maker	30
Microwave	10
Two computers	30
Clothes washer	20
Water heater	400
Furnace fan	220
Total	1,000

Box 5. Possible monthly *energy* use by the items listed in Box 4.

If electricity were a visible and tangible fluid like water, *power* would be the strength of the flow and *energy* would be the amount of water being pumped. Power—measured, say, in kilowatts—is the instantaneous character of electricity generation or use. Energy—measured, say, in kilowatt-hours—is the longer-term expression of electricity generation or use.

Power is like the strength of flow of water out of a pump and energy is like the amount being pumped.

The main challenge posed by electricity as a fuel is that it is hard to store, except in small amounts in batteries and capacitors. For the most part, suppliers have to produce electricity at the moment it is required. Users have difficulty in storing electricity too, and expect near perfection in the reliability and the quality of the supply (as they do for water, but perhaps even more so for electricity).

4. How demand and price vary with time of day

The wholesale price of electricity can vary considerably from hour to hour.

The $50 charge for electric energy noted near the end of the previous section would be the same for that month no matter when and how the energy was used. However, the wholesale price of electricity—i.e., the cost of generation—in January 2006 varied considerably according to time of day. This is illustrated in the upper part of Box 6 on the next page, which provides actual data on hourly wholesale price and hourly Ontario-wide demand for January 24 and January 25.[14] The average hourly price of electricity—shown by the solid line against the right-hand scale—was $40-60 per MWh (equal to 4.0-6.0¢ per kWh) for most of the two days shown. In the early evenings, the price was much higher (above $80 on January 24 and above $125 on January 25). Peak consumption—at 6-7 p.m. on each day—was a little higher on the second day (22,404 MW vs. 21,765 MW). Low consumption on each day was between 3-4 a.m. It was 15,329 and 15,402 MW.

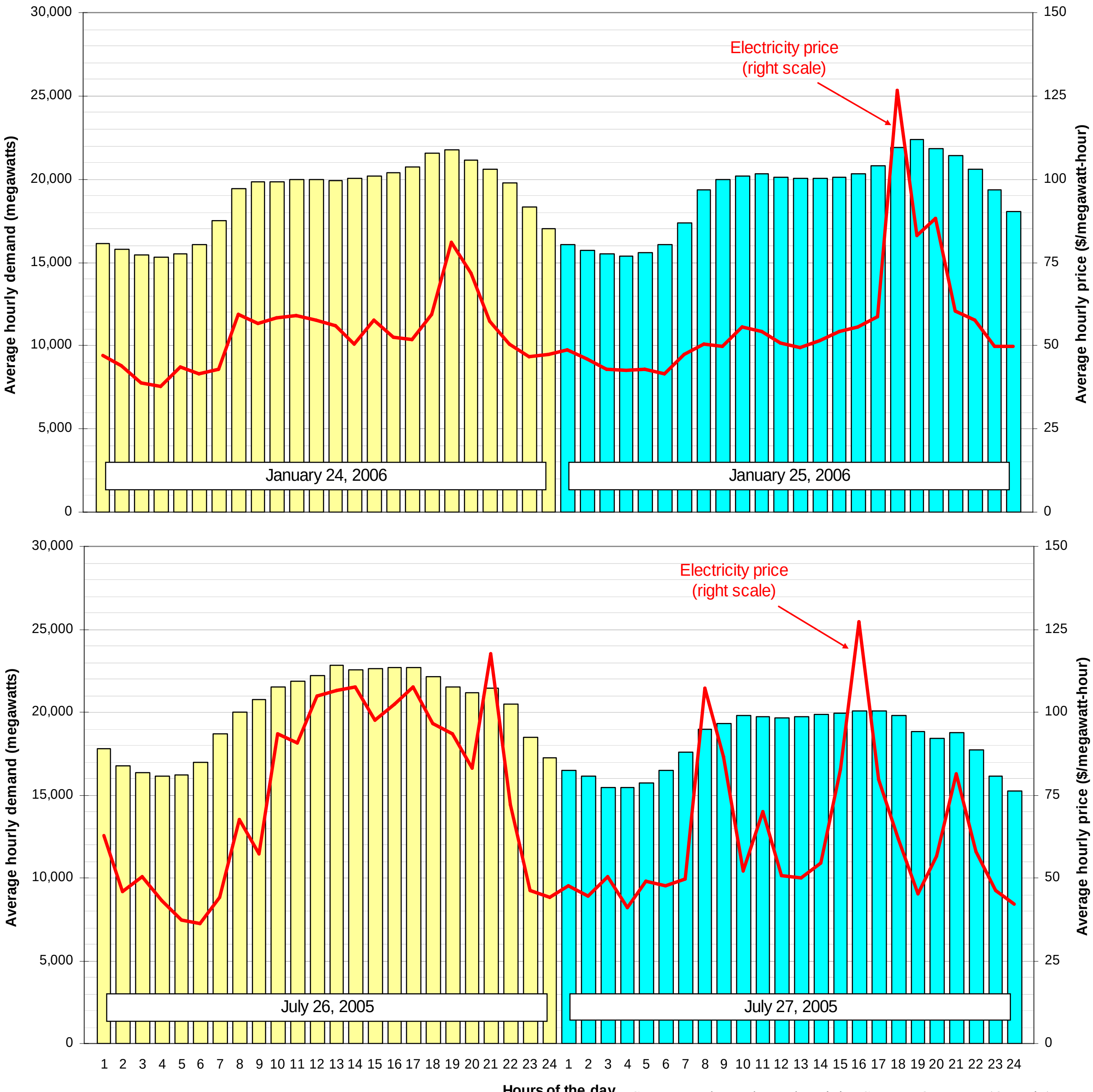
On both of these days in January 2006, particularly the first, a Tuesday, the average temperature was higher than is usual on these dates.

The lower part of Box 6 on the next page shows comparable data for a Tuesday and Wednesday six months earlier: July 26 and 27, 2005. Comparing the two 48-hour periods, July vs. January, the lows and the highs were similar, 15,329 and 15,432 MW, and 22,713 and 22,404 MW, as were the mean values, 18,977 and 19,095 MW. However, in the summer, demand tended to reach a peak earlier in the day. Prices were more often above $75/megawatt-hour in the summer. They averaged $68.56 in July, but only $54.70 in January. The first July day was a little above the average temperature for its date; the second was a little below.

Small changes in demand can trigger large changes in price, but the relationship between demand and price is not perfect.

Two other things might be noticed in Box 6. One is that quite small changes in demand seem to be able to trigger quite large changes in price.[15] The other is that the relationship between demand and price is not perfect. For example, the highest price on these four days occurred on July 27, 2005, which also had the lowest peak consumption.

Prices rise quite steeply when more is being used because producers use their cheapest sources of electric power first and add in more expensive sources as consumption rises.



Source: Independent Electricity System Operator (Ontario)

Box 6.
Hourly electricity use and price for two days in January 2006 and in July 2005.

Time-of-use pricing is designed to achieve two things, compared with flat-rate pricing. One is *fairness*, so that users pay something closer to the actual cost of producing electricity at the time it is used, and thus are not subsidized by other users or in another way.

The other is *reduction in the peak use of electricity*. If some of the peak consumption on each of the four days represented in Box 6 could be moved to the late evening or early morning, the call on expensive, extra generating capacity would be reduced, and so might be the need to reduce voltage ('brown-outs') or cut off supply altogether ('black-outs'). If electricity costs more to use when consumption is high, and less when consumption is low, some of the consumption might be shifted away from the periods of high use.

5. Electricity supply and demand in Ontario

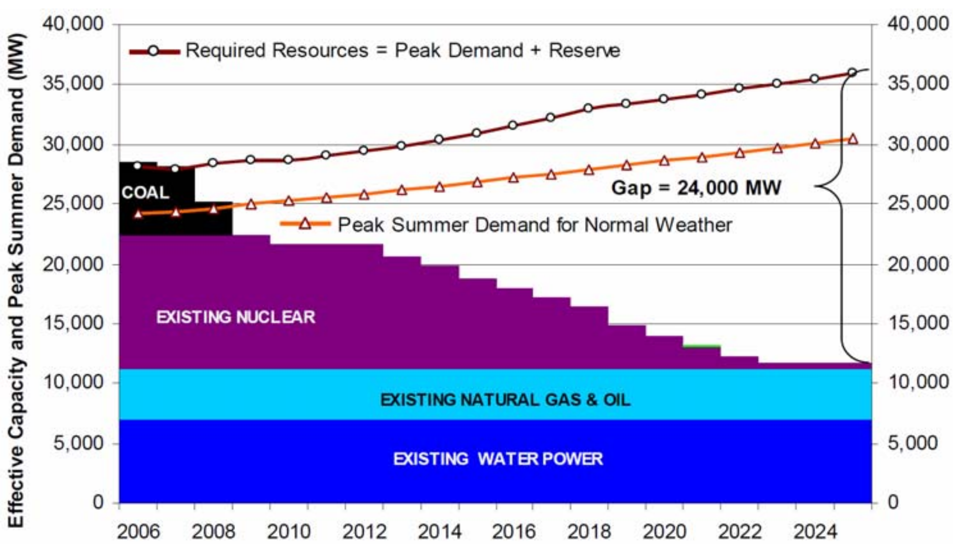
Consumption is rising overall in Ontario, and the provincial government is committed to phasing out coal-fired generating plants. Thus, there is an urgent need to add generating capacity or to reduce consumption, particular during peak periods, or to do both.

There are several scenarios for bridging the gap between supply of electricity and demand for it.

The actual situation is represented in Box 7.[16] Generating capacity now just meets requirements, but will not do so when the coal-fired plants are phased out, and even less so as existing nuclear facilities reach the ends of their lives.

The Ontario Power Authority has developed several scenarios for bridging the gap between supply of electricity and demand for it. The scenario providing for the most reliance on conservation and demand management (CDM) is shown in Box 8 on the next page.[17] In Box 8, 'demand response'—the thin slice at the top of each bar from 2008 on—represents the contribution from shifting consumption from peak periods to other periods, to be achieved mostly through time-of-use pricing.

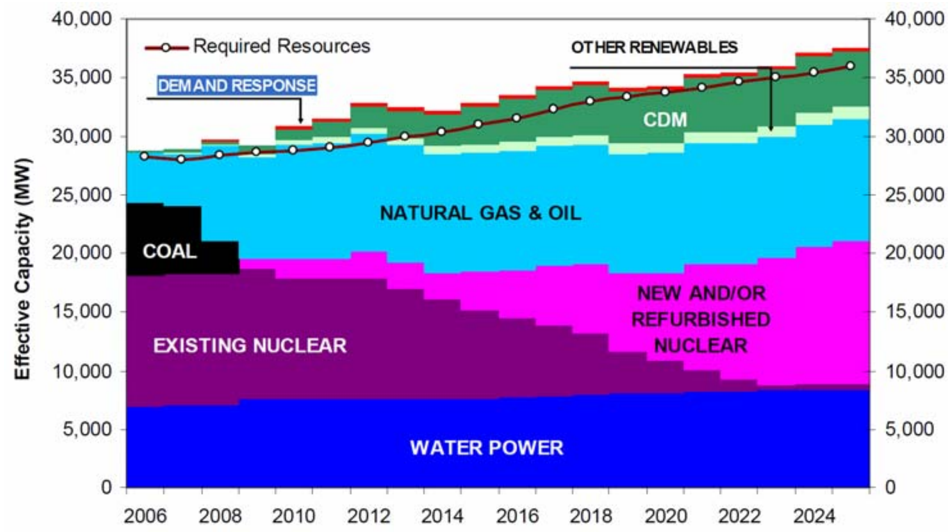
The smallness of the contribution that is expected from shifting consumption away from the peak may be surprising. Specifically, the equivalent of 500 MW of generating capacity is expected to be saved,[18] i.e., about two per cent of the 24,000-MW gap identified in Box 7, and not all of this is to come from the residential sector. Overall, in 2025, time-of-use pricing



Source: Ontario Power Authority

Box 7. Expected demand for electric power in Ontario and availability of generating capacity. ◀

Box 8. This OPA scenario for meeting demand for electric power is the one that assumes the most use of conservation and demand management. ▶



Source: Ontario Power Authority

is expected to reduce peak demand from a potential of about 37,500 MW to a potential of about 37,000 MW, i.e., by about 1.3 per cent (see Box 8).

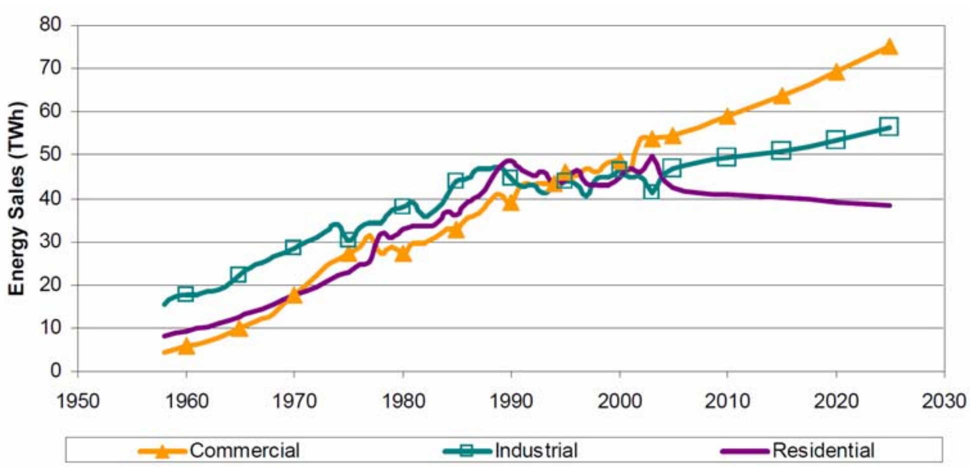
6. Residential consumption of electricity

After rising more steeply than commercial and industrial electricity consumption until 1990, and remaining more or less flat during the 1990s, residential consumption in Ontario may now be beginning to decline and is expected to decline further (even before further conservation and demand management).

This is shown in Box 9,[19] which suggests that *none* of the increase in Ontario's consumption of electrical energy over the next few decades is to come from the residential sector. Overall, according to the Ontario Power Authority, consumption is expected to increase by 20 per cent between 2005 and 2020, from 143 to 161 terawatt-hours (1 TWh = 1 billion kWh), but residential consumption is set to decline from 41 TWh in 2005 to just under 40 TWh in 2020. The residential sector's share of all electrical energy use is expected to decline from 29 per cent in 2005 to 25 per cent in 2020.

None of the increase in Ontario's consumption of electrical energy is to come from the residential sector.

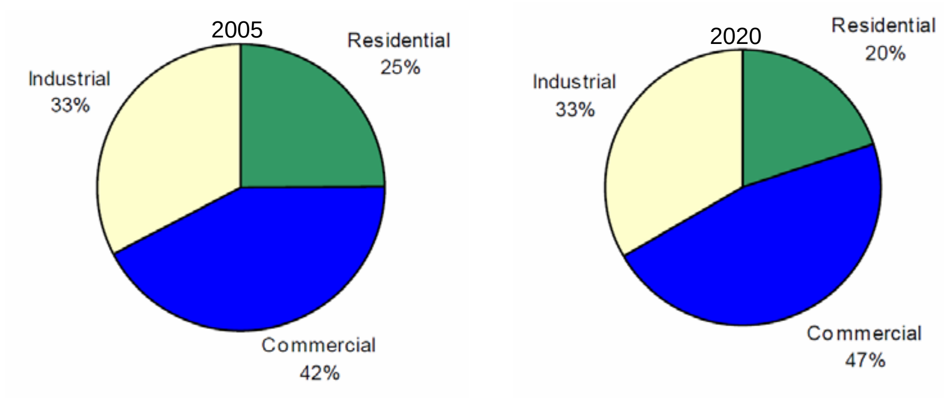
Residential consumption may make an even lower contribution to *peak* electricity use. Moreover, its contribution is expected to fall more, both absolutely and relatively, than this sector's share of electrical energy consumption (again, even before further conservation and demand management). Box 10 on the next page, also from the Ontario Power Authority, shows that the contribution was 25 per cent of the peak (about 6,000 of 24,000 MW) in 2005 and is expected to be only 20 per cent of the peak (about 5,600 of 28,000 MW) in 2020.[20] These percentages can be com-



Source: Ontario Power Authority

Box 9.
Actual and projected consumption of electrical energy by the commercial, industrial, and residential sectors, 1959-2025.

Box 10. Contributions to *peak* power consumption, Ontario, 2005 and 2020. ▶



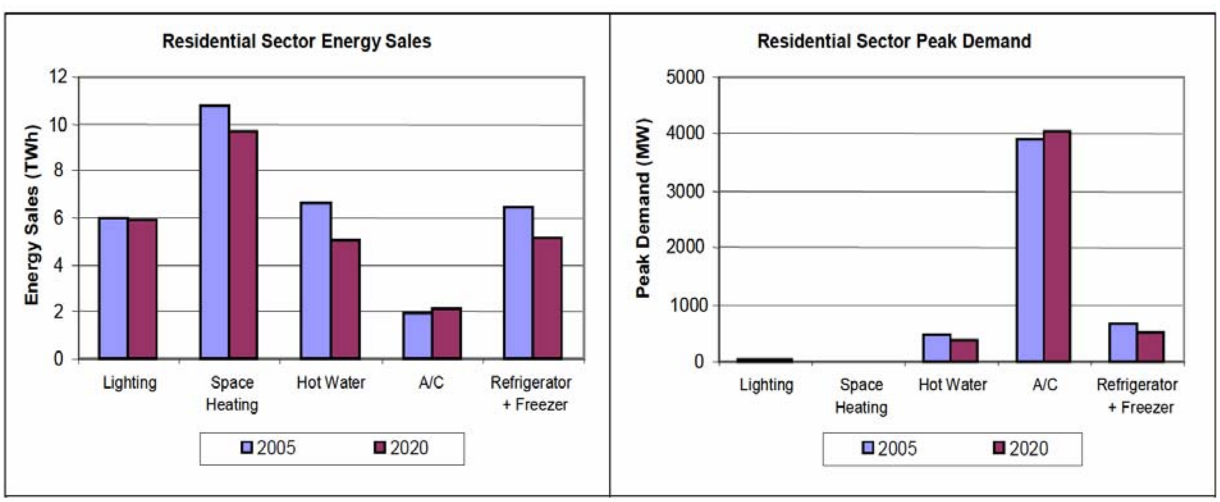
Source: Ontario Power Authority

pared with the 29 and 25 per cent of all energy consumption noted in the previous paragraph.

Another factor is the nature of the residential electric energy consumption and power demand. Overall annual energy consumption is shown in the left-hand panel of Box 11.[21] Space heating is the major element. Contributions to peak demand are in the right-hand panel. Here, space heating does not figure at all, because the peak demand is more likely to occur in the summer. Air conditioning is the major element, followed by refrigeration and freezing.

The point that Ontario's peak demand is increasingly likely to occur during the summer should be stressed. Before 1998, annual peak demand occurred in January or February. Since 1998, except in 2000, annual peak demand has occurred in the summer, in July or August. The difference

Box 11. Contributions of different uses of electricity to total annual consumption of electrical energy (left panel) and to peak demand (right panel). ▼



Source: Ontario Power Authority

between the summer peak and the winter peak is expected to increase with the summer peak being substantially higher than the winter peak by 2015.[22]

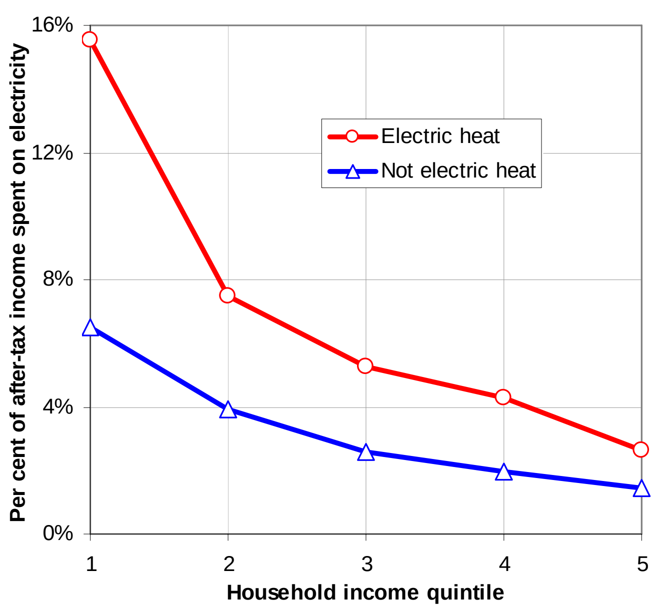
The analysis in this section could point to two conclusions. The first is that time-of-use pricing (see Sections 2 and 8) need not be applied to the residential sector because this sector may already be contributing progressively less to overall consumption in general and peak demand in particular. The second conclusion is that *if* the residential sector is to be exposed to time-of-use pricing, this should be in the summer months only because this is increasingly when peak demand occurs in Ontario.

7. Variation in residential consumption with income

Ontario's lowest-income households spend a disproportionate amount of their incomes on electricity. The direst cases are those who live in house-type buildings heated by electricity, illustrated in Box 12.[23] Data from Statistics Canada's *Survey of Household Spending 2003* suggest that such an Ontario household in the lowest income quintile (annual household income less than $21,800) spent an average of 15.5 per cent of after-tax income on electricity. Such an Ontario household in the highest income quintile (annual household income more than $90,000) spent 2.6 per cent of after-tax income on electricity. The actual average amounts spent on electricity per year were, respectively, $2,243 and $2,871.

Even low-income households in house-type dwellings that were not electrically heated spent relatively large amounts of their incomes on electricity. Such an Ontario household in the lowest income quintile spent on average $967 in 2002, or 6.5 per cent of after-tax income. Such an Ontario household in the highest income quintile spent $1,502, or 1.5 per cent of income.

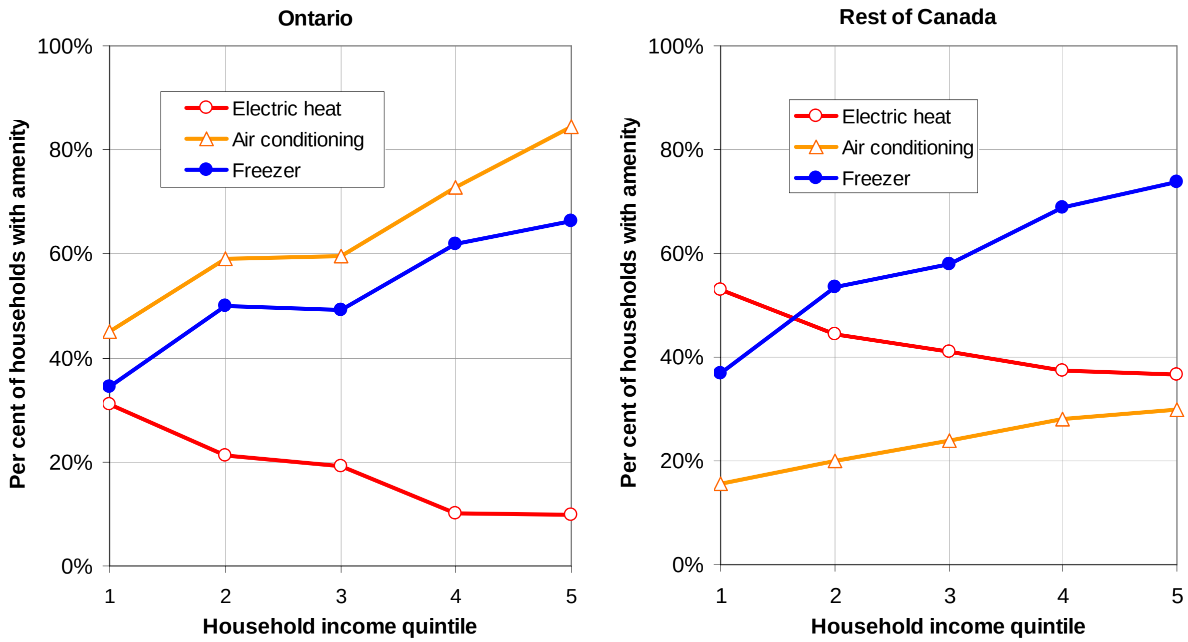
Box 12. Share of household income after personal taxes spent on electricity, by household income quintile and space heating fuel, 2002.



Source: Statistics Canada

Apartment dwellers fare better because they use less electricity, but lower-income households still spend much more of their income on electricity that higher-income households. Data from the *Survey of Household Spending* suggest that low-income households spent 5.0 per cent of their income on electricity, while high-income households spent 1.4 per cent or 0.5 per cent according to whether or not their apartment was electrically heated.

Low-income households have a relatively high share of electric space heating. This is shown in the left-hand panel of Box 13 on the next page, where it can be seen that 31 per cent of households with incomes in the lowest quintile have electric heat, but only 10 per cent of the households in



Source: Statistics Canada

the highest quintile.[24] Box 13 also shows that Ontario's lowest-income households are much less likely to contribute to peak electricity use, because they are less likely to have air conditioning and freezers.

▲ Box 13. Variation in use of electric heat, air conditioning, and stand-alone freezers with income, Ontario (left panel) and the rest of Canada (right panel).

For comparison, the right-hand panel of Box 13 shows comparable data for the rest of Canada. The same variations with income are evident, although overall there is more use of electric heat outside Ontario and less use of air conditioning.

The striking feature of Box 13 is that households with lower incomes are more likely to use electricity for heating and households with higher incomes are more likely to use it for cooling. Smart meters and time-of-use pricing are being introduced above all to reduce peak demand. As noted in Section 6, peak demand is increasingly a summer phenomenon, with air conditioning being the main contributor. However, as noted in discussion of the Regulated Price Plan on Page 7, the present rate schedule for time-of-use pricing applies the highest charges for a longer period in the winter than in the summer, specifically one hour or 17 per cent longer.

Lower-income households are more likely to use electricity for heating and higher-income households for cooling.

It is in the winter when the lowest-income households dependent on more-or-less continuous availability of electricity for heating are likely to be using electric heat. Thus, the time-of-use part of the present Regulated Price Plan would especially penalize lower-income electricity users, even though it is being introduced to address a problem that—to the extent it is caused by residential users—is almost entirely caused by higher-income users.

As well, as illustrated in Box 12, electricity bills can take up a large part of the disposable income of household in the lowest income quintile. Thus, having to pay higher prices for an essential service such as space heating could be especially burdensome.

It's possible that time-of-use pricing in itself will not result in higher prices overall. This could happen if the lower cost of consumption during the lower-rate off-peak period more or less offsets the higher cost during the on-peak period, so that the time-of-use rate schedule is 'price-neutral' to the typical user; and, moreover, system savings are somehow realized that offset the investment in smart meters and the administrative arrangements required for time-of-use pricing (a matter discussed below in Section 9).

Time-of-use pricing could cause the greatest hardships to people with the lowest incomes, even though it is being introduced to address a problem that—in the residential sector—is caused mainly by more affluent people.

Then it would still be possible that people with the lowest incomes would be the most adversely affected. Although data are not available on this point, it may be reasonable to suppose that people with the lowest incomes may be more likely to be home during peak periods, because of disability, retirement or other factors. They would thus be more exposed to the highest prices for electricity.

Many of Ontario's lowest-income households live in social housing managed by clients of the Social Housing Services Corporation. Large numbers of these occupants pay their own electricity bills and large numbers live in electrically heated units. In other cases, the cost of electricity is included in rent and providers will be exposed to higher costs resulting from time-of-use pricing. These matters are discussed fully in Sections 12 and 13 below, preceded by consideration of the effectiveness of time-of-use pricing (Section 8), further discussion of smart meters (Section 9) and load control (Section 10), and a report on a survey of social housing providers conducted by SHSC (Section 11).

The analysis in this section could lead to the conclusion that if the residential sector cannot be exempted from time-of-use-pricing, at least in the winter, as proposed in Section 6, then the social housing sector should seek an exemption.

8. Is time-of-use metering effective?

This section is rather more technical than most of the rest of this report. Readers may want to skip to the bolded concluding paragraph on Page 24.

The discussion in connection with Box 8 on Page 14 above noted that time-of-use pricing is expected to contribute in the order of two per cent of the expected gap between available generating capacity and demand for electricity. The anticipated impact on the residential sector is unclear. If it is assumed that two thirds of the peak-reduction impact of time-of-use pricing will be on the residential sector, and the residential sector accounts for 20 per cent of peak demand (see Box 10), a reasonable conclusion could be that time-of-use pricing is expected to reduce peak demand in the residential sector in 2025 by about 4.4 per cent.[25]

Time-of-use pricing is expected to reduce peak demand in the residential sector in 2025 by about 4.4 per cent.

It's difficult to determine the basis for this anticipated impact. It is consistent with the "reduction in demand of 2-5 per cent" spoken of in the Ontario Energy Board's *Smart Meter Implementation Plan*.[26] However, no analysis of the likely impact of the proposal for time-of-use pricing in Ontario appears to be available.

Indeed, few analyses of the impacts of time-of-use pricing on residential peak demand and overall consumption are available. Also, some of these are misleading. They have reported resulting reductions in peak demand of as much as 21 per cent, but from *volunteer* participants, who are known to be more responsive to time-of-use pricing than participants in mandatory programs.[27]

A more valid procedure, involving 'opt-out' rather than 'opt-in' volunteers, was used in a major study of time-of-use pricing for residential customers in Ontario in the 1980s.[28] Opt-out volunteers are selected according to requirements for sample construction and then given the opportunity to opt out of the program. They are thought to be more similar to the general population than opt-in volunteers. The study examined numerous household types and rate conditions. It found reductions in peak demand as high as 21.4 per cent, but values were typically below 5.0 per cent. Generally, reductions in the summer were a little larger than those in the winter. Reductions for 'all-electric' households were a little larger than for those that did not have electric heating. "For participants with a peak to off-peak price ration of 3.9, changes in winter peak de-

… a major study of time-of-use pricing for residential customers in Ontario was conducted in the 1980s.

mand ranged from an increase of 0.04% to a reduction of 2.44%." (System peak loads occurred in the winters in the 1980s.)

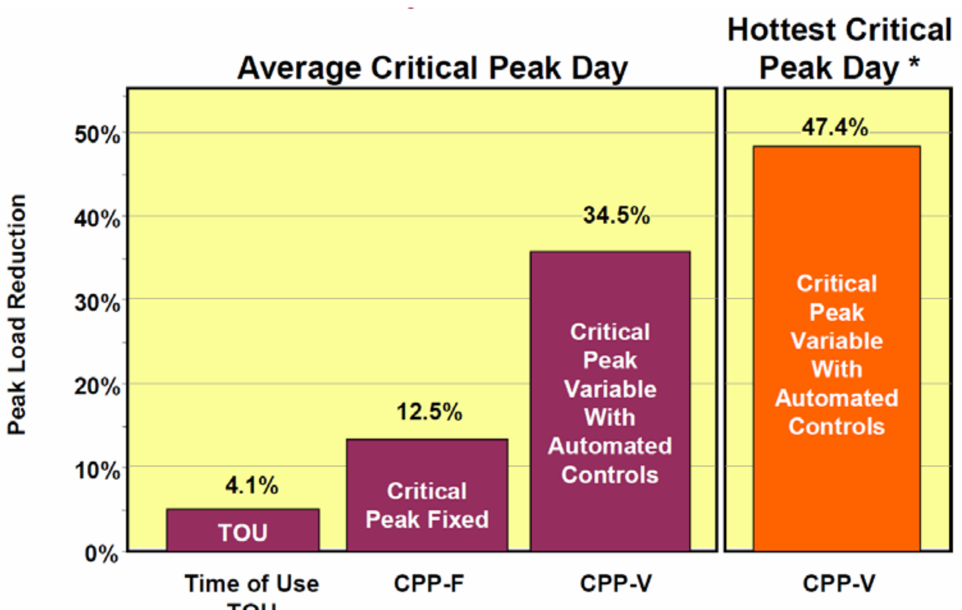
Perhaps the most authoritative recent assessment of the impact of time-of-use pricing has been the California Statewide Pricing Pilot Study.

Perhaps the most authoritative recent assessment of the impact of time-of-use pricing has been the California Statewide Pricing Pilot Study, conducted for three California utilities and two regulatory commissions and assessed by Charles River Associates.[29] The effect of a time-of-use schedule comparable to but less differentiated than that in Ontario's Regulated Rate Plan (see Section 2 on Page 6) was compared with two varieties of critical peak pricing (CPP) imposed on a baseline of time-of-use pricing. In both varieties, CPP was invoked only when demand was expected to be exceptionally high, with notice given on the previous day. In both, the CPP rate was about five times higher than the mid-peak rate and six times higher than the off-peak rate. It was thus a less extreme critical peak price difference than is being discussed for Ontario (see Section 2). In CPP-F, the period of application of the especially high price was fixed; in CPP-V the period was variable, although its duration was part of the previous day's notification.

As well, in the CPP-V condition, electricity users were able to have devices installed at no cost to them that allowed remote control of some of their appliances and other equipment.

Participants in the study were volunteers although unlike the programs noted above they were 'opt-out' rather than 'opt-in' volunteers, i.e., they

Box 14. Results of the California Statewide Pricing Pilot Study: impacts of pricing and other regimes on participating households (details of regimes are in the text) ▶



Source: California Energy Board

were selected according to the requirements of a random sample and then given the opportunity to opt out.

Some of the results of the study are illustrated in Box 14,[30] which shows the reduction in the peak load under some of the pricing conditions.

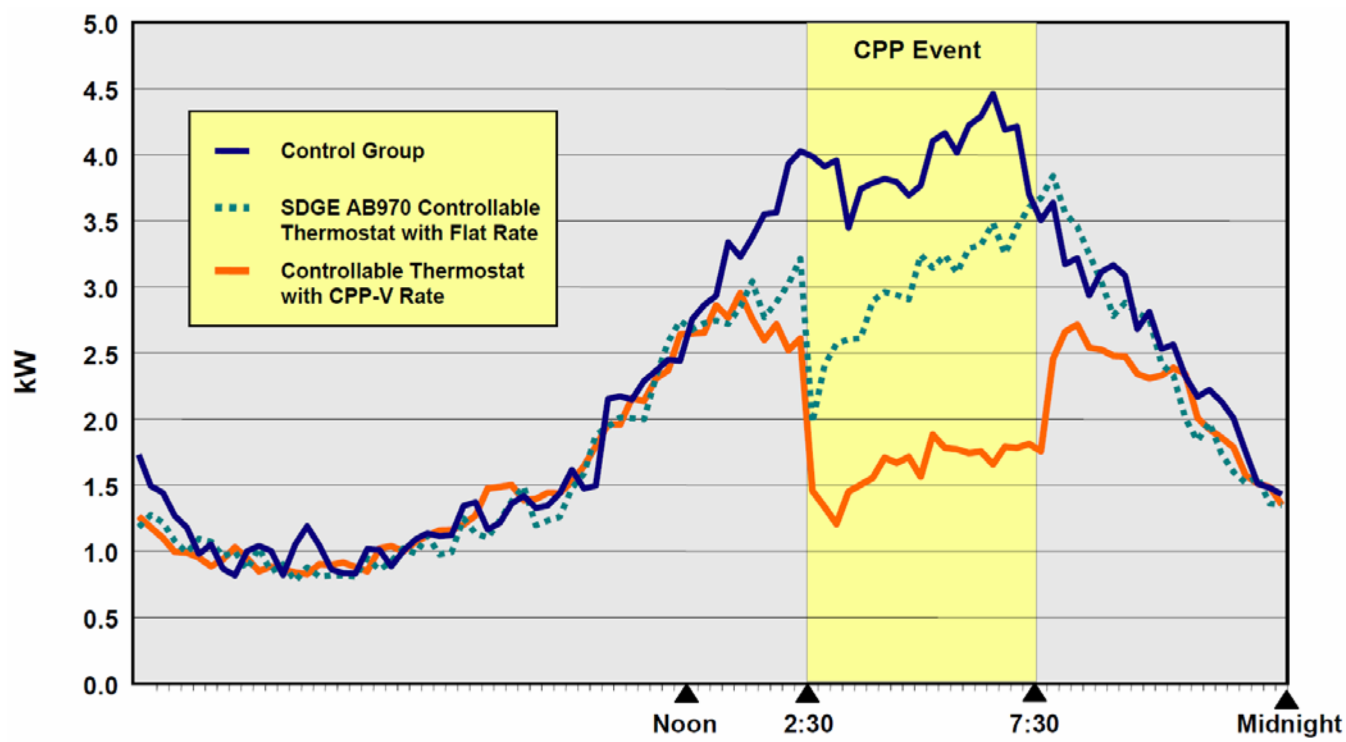
Box 14 shows that the time-of-use (TOU) rate schedule alone produced a 4.1-per-cent reduction in the peak load, and the CPP-F condition produced a larger reduction: 12.5 per cent. The time-of-use part of Ontario's Regulated Price Plan (RPP) might be expected to produce a result between the two but nearer the 4.1 per cent.[31] Thus the expected reduction from application of the time-of-use part of the RPP is in line with the results of the California study.

The most significant finding of the study concerned the impact of load control.

This study also showed that larger differentials between peak rates and other rates produce larger reductions in peak load. This may be gained from the comparison of TOU and CPP-F conditions in Box 14.

The most significant finding of the study concerned the impact of load control, which was applied separately and in conjunction with the CPP-V condition. Load control refers to the remote—usually automated—

Box 15. Behaviour of three groups in the California pilot study; see text for details ▼



Source: California Energy Board

switching off and on of certain electricity uses in order to moderate peak demand. It is discussed more fully in Section 10 below.

Box 14 shows that large reductions in peak load could be achieved when load control was combined with critical peak pricing, and with larger reductions on truly exceptional days. Load control chiefly comprised automatic control of air conditioning thermostats, which could be overridden by participants.

Time-of-use pricing will have no more than a trivial effect on peak demand, more in the summer than the winter

Box 15 shows what happened to three of the pilot study groups on a hot day in August 2003 (the peak temperature was 31.4°C). The group with the lowest use during the critical pricing period (CPP) had both very high prices and load control. The intermediate group had load control only (which could be overridden by customers) and the highest-use group had neither. The combination of load control and critical peak pricing was especially effective, as already noted in Box 14.

The reasonable conclusion from the California study (and others noted here) is that time-of-use pricing doesn't have much of an impact. Critical period pricing does—with its very high differentials and 24-hour warnings—and so does load control. Combination of the last two measures is especially effective.

The conclusion that time-of-use pricing, if introduced for the residential sector, should apply only during the summer has already been pointed to in this report (see Section 6). Confining it to critical peak periods—which would likely always be in the summer—would be a logical refinement of this argument.

9. Smart meters: advantages and disadvantages

The Ontario government's direction concerning smart meters has been discussed so far chiefly in respect of their role of supporting time-of-use pricing, which the Ontario Energy Board has already begun to implement (see Section 2). Smart meters can do much more, as this section sets out. First, the other functions of smart meters are discussed, together with their advantages. Then some of smart meters' disadvantages are noted.

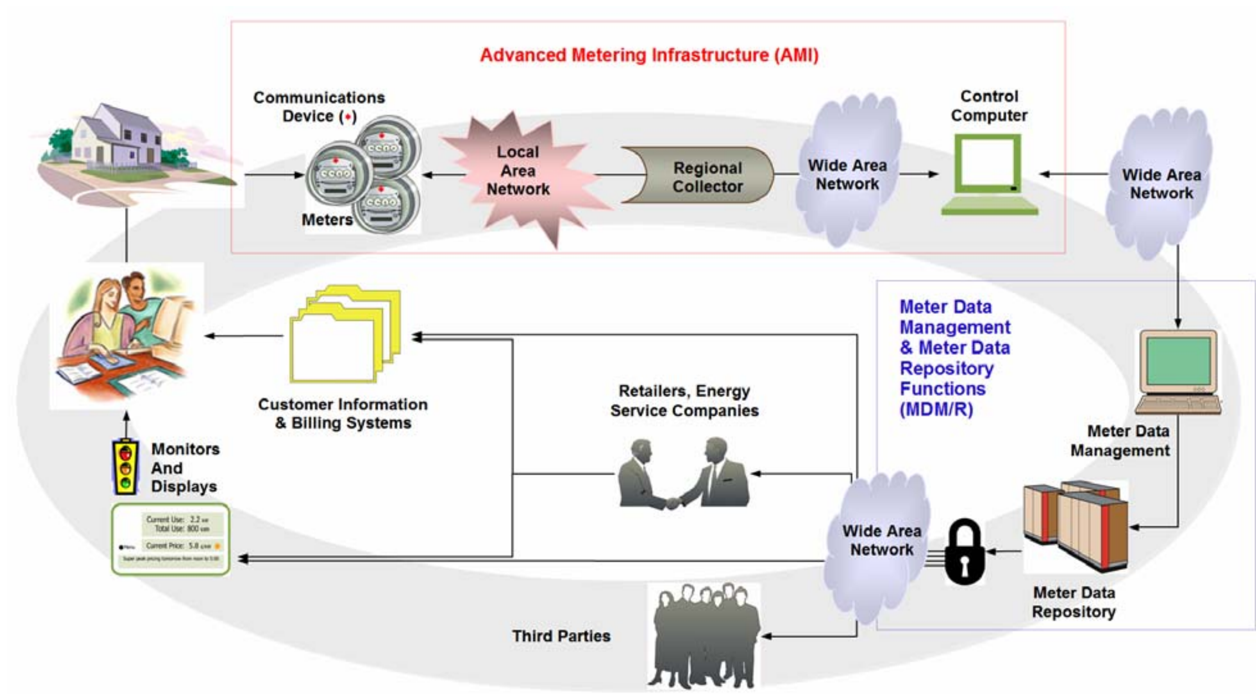
Smart meters can usually do many more things than allow for time-of-use pricing. Their essential feature is that they are able to provide information to a remote computer about the amount of electricity consumed and when it is consumed, by radio signals, via a telephone or cable link, or along the wire carrying the current. Thus, as well as allowing time-of-use pricing, smart meters also make it possible for meters to be read remotely, thereby obviating the need for meter readers to visit users.

The advantages of smart meters can be fully realized when they are the interface point for a two-way communication system between a building's electrical system and the outside world.

Other advantages of smart meters can be realized when they are designed to be the interface point for two-way communication between a building's electrical system and the outside world.[32] The meters being mandated by the Ontario Energy Board are so designed (see Box 16 on the next page).[33] With additional equipment and programming, these smart meters can provide the electrical utility or a third party with a wealth of details about electricity use within a building, even about use of particular appliances. This information, in turn, can be provided to the household or the building manager, or both.

Being able to track consumption can be a necessary requirement for the development of strategies to reduce both peak demand and consumption. This ability may also contribute directly to reduced electricity consumption. A recent overview of several studies suggested that when users had daily feedback on their consumption, rather than the more usual monthly or bimonthly feedback, overall consumption fell by an average of 11 per cent.[34] The impact on peak demand was not given.

As important is the enhanced information available to the utility. As well as allowing time-of-use pricing, it can also facilitate billing for irregular periods, as when occupants move in and out. Indeed the communications system could be arranged so that customers could provide themselves, over the Web, with printed bills for any period.



▲ Box 16. Smart meters and associated systems, as proposed by the Ontario Energy Board.

A more important consequence of enhanced information could be the utility's ability to pinpoint power outages, line irregularities, and meter malfunctions. When each building's electrical system is an interactive part of a large open network, the possibilities for automatic or ad hoc error or fault detection are numerous. Moreover, with precise geographic identification of loads and changes in load, utilities can focus preventive engineering work with increased accuracy.

Load management may be the most important function offered by interactive smart meters. In its grossest form this could comprise remote disconnection of a user from the distribution system, as in the case of vacant premises, persistent non-payment or a fault condition on the user's side of the meter that poses a threat to the system.

Load management may be the most important function offered by interactive smart meters.

More constructive forms of load management could involve remote adjustments to thermostats and remote disabling of appliances and other functions for which brief interruptions would be hardly noticed (e.g., water heaters, clothes driers, and dishwashers), all to reduce peak demand. Such load control could be managed from a distance by the utility or by a third party contracted to manage electricity use. Load control is discussed in more detail in Section 10.

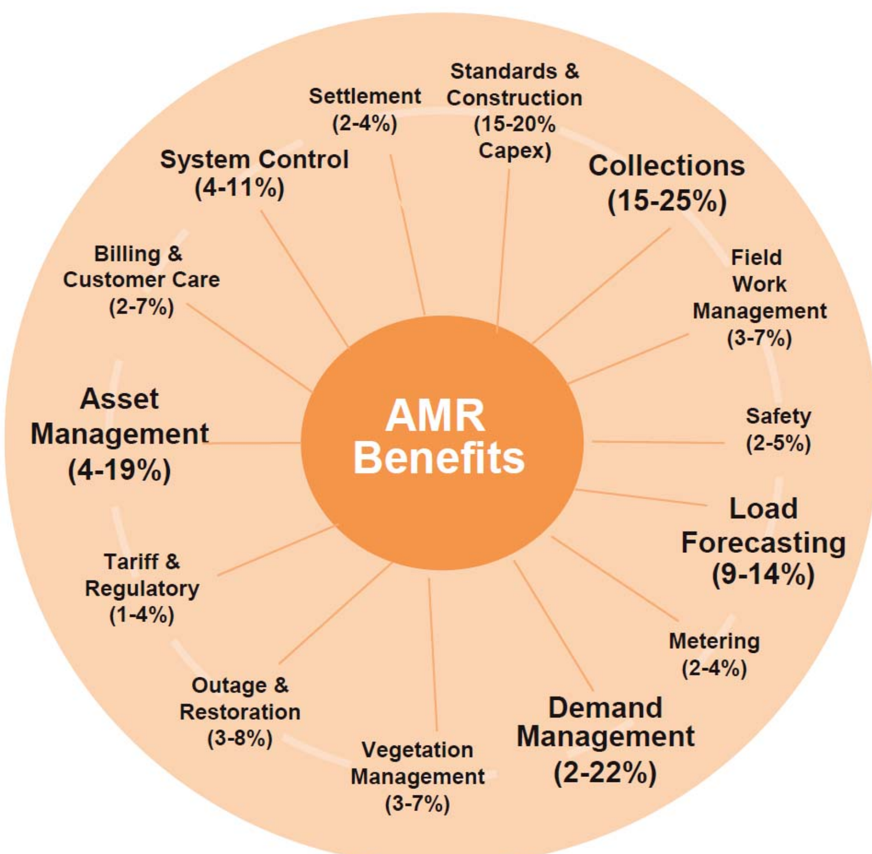
What should be noted from the above account of smart meter functions and advantages is that most of them accrue to the electrical utilities (local distribution companies) than directly to their customers. This is reinforced by the listing in Box 17, produced by a French consultancy concerned to promote installation of smart meters.[35] (Box 17 also shows reported savings in respect of each of these advantages, a matter considered below.)

Most of the benefits of smart meters accrue to utilities.

Ultimately, prices for electricity reflect the utilities' costs. Thus, if smart meters allow utilities to realize net savings—through reduced billing costs, improved fault detection, and reduced need to provide electricity during periods of peak demand—consumers will benefit. Conversely, if utilities install smart meters and cannot achieve savings sufficient to cover installation costs, the result will be an additional burden on electricity users.

Cost is the most evident disadvantage of smart meters. The Ontario Energy Board has suggested that the total cost of installing the required four million or so smart meters—and the associated communications systems—will be in the order of one billion dollars, i.e., about $250 per me-

Three kinds of disadvantage of smart meters.



Box 17. Reported cost savings by North American utilities that have deployed Automated Meter Reading (AMR). ◀

ter. There will also be an annual net operating cost of about $50 million, i.e., about $12 per customer. The OEB has concluded that "when the project is complete, the cumulative costs might require a monthly charge of between $3 and $4 to cover capital and operating costs".[36] The OEB's estimate provides for an annual operating benefit valued at only one tenth of smart metering's annual capital and operating costs. Thus, the financial costs of installing and operating smart meters are expected to far exceed the financial benefits to be gained.[37]

The direct benefits of smart meters to utilities will not produce savings that cover their costs, which will be born by consumers.

The OEB's view of the expected benefits of smart metering is consistent with the low ends of the ranges of the estimates reported in Box 17.[38] However, even if they were consistent with the high ends of the ranges, they would still not cover the estimated costs to the local distribution company of installing and operating them. Justification for smart meters would have to come from other savings, such as savings in construction of new generating capacity, to be used during peak periods only, from reductions in peak demand resulting from application of time-of-use pricing and critical peak pricing. In Sections 5 and 8, the reductions from time-of-use pricing were shown to be quite small.

The second potential disadvantage lies in the complexity of smart meters and their associated equipment. Hardware and software are enormously more sophisticated and reliable than even a decade ago, but expectations of a continuously available supply of electricity remain very high. Moreover, wrong signals—e.g., to change thermostats in the wrong direction or even to disconnect a whole property—could be dangerous. Opportunities for contested billing could increase with smart meter deployment, aggravating consumers and burdening local utilities. Smart meters themselves could be inherently more reliable than conventional meters, because the former are digital and the latter electromechanical, but the complex associated systems could be more problematic.

Smart meters and associated systems are complex, and their actions could be seen as invading privacy.

The third potential disadvantage of the use of smart meters concerns the increased availability of information about behaviour that may be regarded as private. A household's unusual cooking practices could become evident to a utility. There may be no conceivable use for this information, but mere availability of it could be a cause for concern. Police and other agencies concerned with law enforcement might welcome the opportunity for further monitoring of behaviour. Smart meters and associated equipment could, for example, aid in the detection of indoor marijuana production by pinpointing the time and place of unusually high levels of electricity consumption.

Nevertheless, smart meters appear to confer advantages to utilities and the Government of Ontario's direction will help ensure orderly and consistent installation of them. However, unless electricity utilities reap more of the benefits than has been suggested by the Ontario Energy Board, the added cost to consumers may be large. It would be reasonable for utilities to be required to demonstrate cost savings through the deployment of smart meters—other than through imposition of time-of-use pricing—that will cover at least half of the costs of installation and implementation (thereby bringing the increased monthly cost to an average of less than two dollars per customer).

Nevertheless, smart meters should be supported, if their costs to consumers can be lowered.

10. Load control: a complement or alternative to time-of-use pricing

Load control refers to arrangements by the homeowner, building manager, utility or a third party whereby individual appliances or functions are automatically switched off during peak periods, thereby reducing peak demand.

Load control in homes is not a new concept.

Load control in homes is not a new concept. In the UK in the 1950s, electricity utilities provided for the use of electric storage heaters on separate circuits that were energized only during off-peak periods but could release heat throughout the day. For many decades until forbidden to do so by Ontario's *Energy Competition Act 1998*, Toronto Hydro rented water heaters that could be switched off during peak periods by a signal down the power wire. Toronto Hydro is now reintroducing such a program, focussing on central air conditioners that are to be remotely controlled by added wireless switches.[39] Other Ontario utilities had water-heater programs before 1998 and are now introducing new load-control programs similar to that of Toronto Hydro.

Load control can be arranged by the home owner or building operator without intervention by the utility. Devices are available that facilitate remote control of appliances and functions. These can be managed by a special-purpose demand controller located in the building[40] or by a home or other computer.[41] These systems can reduce load during peak periods even if they are not linked to the utility, if the peak period is known and can be programmed into the system. They can also be linked to the utility, usually via the Web, so that the home or building can be part of a larger load-control arrangement.

Wide-area load-control arrangements can be advantageous.

The advantage of linkage to a larger arrangement is that the 'off' periods required of any one appliance or function can be fewer or shorter, or both, while achieving the same overall reduction in peak demand.

For the homeowner or building owner to install a demand controller or computer-based system there has to be an incentive. Time-of-use pricing could provide such an incentive, although the pay-back period with the presently proposed schedule could be many years.[42]

The load control could be managed by a third party. A company specializing in such management could contract with several building owners to achieve a specified level of load reduction, and thus a particular level of savings in energy costs (assuming time-of-use pricing), while maintaining specified levels of comfort and amenity. Through the Web, the company would be able to manage appliances and equipment in numerous buildings, even buildings in different cities.

Such companies are not in existence now because there is no means of paying them. Moreover, savings when time-of-use pricing is in effect may well not be sufficient to ensure commercial realization of such third-party activity.

The cost of installing load control could compare favourably with the cost of constructing and using the equivalent peak generating capacity

The reductions in peak load that can be achieved through load control are considerable. The discussion in Section 8, in connection with Box 14 and Box 15, suggested that load control could reduce household peak demand by at least 20 per cent. The cost of installing load control could compare favourably with the cost of constructing and using the equivalent peak generating capacity.[43] Accordingly, it may be more reasonable for load control to be funded by utilities as an alternative to power purchases rather than by home or building owners in response to time-of-use pricing.

The discussion in Section 8 also noted that load control in conjunction with time-of-use pricing produced larger reductions in peak load than load control alone (see Box 15). This likely happened in part because occupants had some ability to override automatic load controls. Evidently there could be merit in considering load control—funded by utilities—as a supplement to time-of-use pricing.

11. Survey of social housing providers

In preparation for this report, SHSC conducted a survey of Ontario's social service providers, asking questions about the properties, how they heated, who pays fuel bills, and the availability of individual meters, and also about anticipated ease of installing individual meters and receptivity to individual metering.[44] A total of approximately 1,200 questionnaires were distributed. Usable responses were received from 311 providers, who appeared to be mostly representative of all providers (see below).

The response by Toronto Community Housing Corporation was separated out because of its size and variant responses.

Responses in respect of *house-type* units are in Box 18. Separate columns show responses from co-operatives, other providers except Toronto Community Housing Corporation (TCHC), and TCHC. Co-ops were separated out because their occupants are not strictly tenants, and thus could have responded differently to questions involving devolution of payment responsibility to unit occupants. TCHC was separated out because of its size, and also because of the low shares of apartment units with electric heat and the low numbers of all occupants paying their own electricity bills.

Box 18. Responses to the survey of social housing providers: house-type units (see text for details) ▶

	Co-ops	Others except TCHC	TCHC
Total providers	124	186	1
Providers with house-type units	79	97	1
Total house-type units	4,483	12,309	6,876
Units per provider: <10	1	8	0
10-29	15	20	0
30-49	22	20	0
50-74	21	21	0
75-199	19	18	0
200-999	1	6	0
>999	0	4	1
% units with social assistance	23%	42%	33%
% other RGI units	33%	39%	49%
% units with electric heat	22%	23%	37%
% units paying own bills	83%	71%	7%
% not paying, but have own meters	8%	15%	0%

In Box 18—and also in Box 19, which concerns households in apartment-type units—“% units with social assistance” refers to shares of all households in receipt of support from the Ontario Works program (OW) or the Ontario Disability Support Program (ODSP). These households make payments for accommodation according to their income. Shares of other households also having accommodation payments related to income are shown in the rows titled “% other RGI units”, where RGI refers to support received through municipally funded ‘rent-geared-to-income’ programs. As might be expected, the majority of units are subsidized: 57 per cent of represented co-op units, 91 per cent of TCHC units, and 83 per cent of other represented units.

House-type units are less likely than apartment-type buildings to have electric heat; their occupants are more likely to be paying their own electricity bills.

Comparing Box 18 and Box 19, it can be seen that, except for TCHC units, many more apartment-type than house-type units represented in the survey responses have electric heat. Also except for TCHC, many more occupants of represented house-type units are responsible for paying their own bills.

Comparison of the results of this survey on these matters with Ontario results from Statistics Canada’s *Survey of Household Spending*, already discussed in Section 7, could help assess whether the results of the SHSC

	Co-ops	Others except TCHC	TCHC
Total providers	124	186	1
Providers with apartment-type units	68	145	1
Total apartment-type units	4,851	20,825	50,606
Units per provider: <10	3	6	0
10-29	10	27	0
30-49	13	27	0
50-74	15	20	0
75-199	25	44	0
200-999	2	17	0
>999	0	4	1
% units with social assistance	29%	33%	30%
% other RGI units	29%	48%	63%
% units with electric heat	44%	65%	7%
% units paying own bills	33%	12%	5%
% not paying, but have own meters	6%	3%	0%

Box 19. Responses to the survey of social housing providers: apartment-type units (see text for details). ◀

Box 20. Comparison of responses to the survey of social housing providers with results from Statistics Canada's *Survey of Household Spending* (see text for details).

	House-type unit		Apartment-type unit	
	Electric heat	Pay own electricity bills	Electric heat	Pay own electricity bills
SHSC survey of social housing providers	27%	55%	25%	9%
SHSC survey (TCHC responses excluded)	23%	74%	61%	16%
Statistics Canada survey	11%	84%	57%	23%

survey are representative. Comparisons of available data are set out in Box 20.[45] Note that the survey of social housing providers represents *social housing* and the Statistics Canada survey represents *subsidized housing*. There is considerable overlap between the two but there are occupants of social housing who do not benefit from subsidy and there are occupants of other housing who do.

The results of the survey of social housing providers may be representative of all providers, except TCHC in some respects.

Overall, including both house-type and apartment-type units (shown separately in Box 20), 26 per cent of social housing units have electric heat (46 per cent if TCHC units are excluded). This can be compared with the 41 per cent of subsidized units that have electric heat, and the indication in Box 13 above that 31 per cent of households in the lowest income quintile have electric heat.

Overall, 20 per cent of the households in social housing pay their own electricity bills (39 per cent if TCHC is excluded). This can be compared with the 45 per cent of households in subsidized units who pay their own electricity bills.

The similarities among these percentages suggests that the results of the survey of social housing providers may be representative of all providers, that between a third and a half of social housing units are heated by electricity, that electric heating is much more likely in apartment-type units than in house-type units, and that about a third of households in social housing units pay their own electricity bills, more in house-type than in apartment-type units (with TCHC being a significant exception in several respects).

The survey of social housing providers also asked whether they expected it would be easy or difficult to equip all units with individual meters, and whether they would welcome such an arrangement. Responses by provid-

	Co-ops	Others
Easy to provide individual meters	30%	26%
Difficult to provide individual meters	17%	26%
Don't know or other	53%	48%
For individual meters in SH units	49%	60%
Against individual meters in SH units	15%	19%
Don't know or other	36%	21%

Box 21. Responses to the survey of social housing providers (see text for details) ◀

ers to these two questions are in Box 21. Considerable support for individual metering of social housing (SH) units is evident, as is considerable doubt as to how readily it might be achieved.

To give the flavour of *some* of the response to these two questions, sample answers are provided in Box 22 on the next page. These have been chosen primarily for their representativeness of opinions expressed, but also for their brevity.

The cost of installing load control could compare favourably with the cost of constructing and using the equivalent peak generating capacity

Evident from these responses is considerable understanding of the challenges that could be involved in widespread individual metering. There was also concern that housing allowances are inadequate and not necessarily geared to a regime of time-of-use pricing. These matters are addressed in the following sections.

However, as well as the understanding indicated in Box 22 there is the considerable uncertainty displayed in Box 21, particularly with regard to the ease or otherwise of installing individual meters This points to the need for an education program that could be conducted at the right time by SHSC.

Box 22. Comments made by respondents to the survey of social housing providers (see text for details)

Difficult to install individual meters

- The project is an older building with extremely limited space.
- We would have to install separate metering systems for 1,064 units.
- Seniors apartment building and they are not likely open to change.
- Some electrical circuits feed two or three units. Some electrical circuits feed units and common areas.
- Cost, time to coordinate work with contractor and residents, interference with tenants.
- Difficult because at construction of apartment buildings, design was bulk metered.

Easy to install individual meters

- They have already been installed but were disconnected due to Hydro pricing.
- The individual wiring for each unit comes into one electrical panel separate from the common areas.
- Each unit has its own breaker panel within the unit.
- Original, individual meters are in place, but, disconnected in 1979.
- Sub-distribution panel in hall closet on every second floor distributing power to individual units.
- Lots of room in corridor electrical closets.

In favour of individual metering of units

- Keeps costs to landlords down – especially if tenants are not observing conservation strategies.
- People should pay their fair share and this helps prevent abuse of the system. However, the provincial utility scales desperately need to be updated to more accurately reflect actual costs!
- Can identify highest users and know if there are physical (building) problems.
- It makes sense, but service manager might have their say on allowance structure system.
- Equal treatment which would ensure fairness, awareness, and promote conservation. Government subsidies would be required.

Opposed to individual metering of units

- Does not make sense for a building that has over 75% of the members on assistance.
- Cost to housing provider will be enormous; would rather see more financial assistance to lower dependency on electricity via energy management upgrades, etc.
- Administration costs per bill with 41 bills per month would be too costly. All units are different, more outside walls, face north, etc., which will cause marketing problems.
- We have a seniors building; seniors usually don't abuse on the electricity.
- In social housing many tenants are at home during the day during peak business hours.
- Not fair to members living on ground floor who would have high bills. Members on upper floors would have lower bills as heat rises in each house.

12. Individual metering and sub-metering

As can be gathered from responses to the survey (see Section 11), occupants of most social housing units are not billed directly for electricity. Often direct billing would be presently impossible because there are not separate meters for each unit. In some—perhaps many—cases, the units are not separately wired, which would make the introduction of individual metering of units particularly challenging. Nevertheless, the Government of Ontario appears to want *all* Ontario households be fitted with smart meters by 2010 (see Section 2 and particularly the associated Note 2).

In most multi-unit buildings in the social housing sector—and in many in the private rental sector—there is *bulk metering* of electricity, i.e., just one meter for the whole building, even for more than one building. Unless they have a contract with an electricity retailer, providers pay local utilities for electricity according to the Regulated Price Plan (see Section 2), with a provision that allows them to allow each unit to contribute towards raising the consumption level at which the higher price level is in effect.[46]

Metering of each unit in a multi-unit building can be achieved through individual metering or through sub-metering.

Metering of each unit in a multi-unit building can be achieved in two general ways. One is to have *individual metering* whereby each household becomes a customer of the local utility (and perhaps also an electricity retailer). A housing provider that was previously responsible for all electricity purchases would now be responsible only for electricity used in common areas.

Individual metering could be a preferred approach where each unit is wired separately, even if the unit is not presently being separately metered. As can be noted from the survey responses, some units were designed to have individual meters, and may have even had them at one time, but are now part of a bulk-metering arrangement (see Box 22). Installation of smart meters could involve no more than replacing existing meters, adding meters where there once were meters, or adding meters to the power lines serving each unit.

The other way in which consumption in each unit can be metered is through *sub-metering*. Here, the bulk meter is retained, and the housing provider is the only customer of the electrical utility. However, consumption at each unit is metered by the housing provider, who may distribute the costs of electricity accordingly. The provider may use the information from sub-meters only to identify heavy users, who may be asked to use less, and to help locate faults in the building's electrical system.

Both individual meters and sub-meters can be smart meters or conventional meters.

The Ontario Energy Board has put consideration of sub-metering into abeyance.

The Ontario Energy Board began a proceeding in April 2005 to address issues related to sub-metering. In June, the OECD adjourned the proceeding "until there is greater certainty with respect to the implementation of smart meters in Ontario".[47]

The question of how the Ontario Government's smart metering objective is to apply to multi-unit buildings and other complexes that are presently bulk metered is thus unanswered. There are two cases.

One is where the units in the bulk-metered building are ready for individual meters (perhaps because they once had them). For these units there are three options: (i) install individual meters; (ii) install sub-meters; and (iii) do nothing. For the second and third options, bulk metering would continue, with the present conventional meter being replaced in due course by a smart meter. Which of these options can be pursued will depend on the Ontario Energy Board. The OEB may direct, for example, that only the first option can be pursued, with the local utility covering all costs as it would for units that are already individually metered.

The OEB could direct that the third option cannot be followed, but that sub-meters can be installed rather than individual meters. The most favourable strategy for housing providers could well depend on the OEB's direction regarding cost arrangements. If the local utility is to pay for sub-metering, as it would pay for individual metering, then sub-metering could be a reasonable strategy to pursue both for the utility, which would still have only one customer, and the housing provider, which would have more information about consumption and the option of apportioning costs.

The more challenging case is where units in a bulk-metered building are not ready for individual meters or sub-meters.

The more challenging case—for almost everyone involved, but particularly for housing providers—could be where the units in a bulk-metered building are *not* ready for individual meters or sub-meters. Only modest adjustments may be required, but there would still be the question as to who should pay. At the other extreme, complete and very costly rewiring of the entire building may be necessary. Such rewiring could well be beyond the means of the housing provider, and it may be an unreasonable expense for the local utility. It may not be feasible to implement fully the Ontario Government's smart meter directive, if indeed it carries the intention that all individual residences have smart meters by 2010.

Housing providers would still be left with a major challenge. Their conventional bulk meters will be replaced by smart meters. If present plans continue, time-of-day pricing will apply as soon as the smart meters are installed.[48] Housing providers will then be vulnerable to aspects of the application of time-of-day pricing that could adversely impact social housing, as discussed above and returned to in the next section.

Tenants' concerns about sub-metering.

This report is being written chiefly from the perspective of social housing providers. It is nevertheless salutary to note that there is considerable opposition to sub-metering from advocacy organizations concerned with low-income tenants. At the time the Ontario Energy Board's proceeding on sub-metering was ongoing (see above),[49] the Low-Income Energy Network (LIEN) issued a report arguing that requiring sub-metering of multi-unit buildings is a flawed conservation strategy.[50] It said that "Sub-metering shifts the incentive to conserve from the landlord to the tenant. This shift shields the landlord from the responsibility to provide an energy-efficient building and appliances for the use of tenants, and represents a lost conservation opportunity." LIEN proposed too that if metering of separate units proceeds, the units should have individual meters and not sub-meters.

These arguments and the above-mentioned potential concerns about the costs of separate metering concerns suggest that the social housing sector should pay close attention to a possible resumption of the OEB proceeding concerning sub-metering, and take protective action.

13. Challenges and solutions for social housing providers

Two challenges for social housing providers.

Social housing providers face two kinds of challenge. The first is that they could be required to contribute towards the cost of installing sub-meters and towards the cost of rewiring necessary for the installation of individual meters or sub-meters. This is discussed in Section 12 above. The exact nature of this challenge cannot presently be determined as the matter is under consideration by the Ontario Energy Board and not likely to be resolved in the near future. Thus, it's hard to propose a particular course of action other than timely representation to the OEB. The purpose of such representation should be avoidance of direct costs to the social housing sector that cannot readily be recouped in reductions in the costs of electricity to the social housing sector.

In respect of this kind of challenge, the social housing sector shares interests with the rental housing sector, and there could be useful collaboration between the sectors.

The second kind of challenge is that time-of-use pricing could result in especially large increases in electricity costs for providers or for residents, accordingly to who pays for electricity. This could happen for the reasons given in Section 7. They are chiefly that the proposed highest time-of-use rate will apply more during the winter than the summer (even though it is being introduced to address a summer problem), and that social housing residents use unusually large amounts of electricity in the winter because they are unusually dependent on electric space heating. Also, social housing residents may be more inclined than average to be at home during on-peak periods and thus to use electricity at those times.

In the social housing sector, most electricity bills are paid by providers. Limited action can be taken by providers to reduce electricity use overall, but the means to target peak periods are limited. The fundamental problem posed for social housing providers is that use of electricity during peak periods rather than at other periods is to a considerable degree a matter of the behaviour of social housing residents, over which providers usually have little control.

Another challenge is that residents responsible for electricity bills will not be able to pay them.

Many social housing providers favour moving responsibility for meeting electricity bills to residents. However, even where this is possible, it poses a new set of challenges to providers. Chief among them is the real possibility that residents will not be able to meet increased costs of electricity and that providers will still be expected to pay. Even though the formal responsibility for payment would now lie with residents, providers may be perceived as having continued responsibility and may indeed reinforce that perception. Social housing is not a business but a service provided to society by providers and others.

A further issue, discussed in another report,[51] is the apparent inflexibility—and inadequacy—of housing allowances in relation to the more fluid pricing for electricity that would apply with a time-of-use rate schedule. Even if residents were responsible for electricity bills, they might receive little or no benefit from actions to reduce the bills by, for example, shifting use away from on-peak periods when time-of-use pricing applies.

A further issue, discussed in another report, is the apparent inflexibility—and inadequacy—of housing allowances.

Time-of-use pricing is being introduced to expose users more strongly to the consequences of use during peak periods. Social housing residents will likely be usually unresponsive because they will remain unexposed to the consequences. Where they are exposed, they will have little scope for appropriate action chiefly because this action will largely comprise reducing use of air conditioning (see Section 6 above), which they use relatively little.

What may be the most appropriate action on behalf of the social services sector is opposition to some part or all of time-of-use pricing for the residential sector. This would not obviate the value of the Ontario Government's directive concerning smart meters, which have many uses other than allowing for time-of-use pricing.

Because residential consumption of electricity may not be increasing, and may be contributing a declining part of peak demand (see Section 6), a case could be made for exempting the residential sector altogether from time-of-use pricing.

A case could be made for exempting the whole residential sector from time-of-use pricing, particularly social housing.

If the residential sector cannot be exempted altogether, a case could be made for exempting it during the winter months. Peak loads occur increasingly during the summer, as it also noted in Section 6. Even better might be exposure to critical peak pricing only.

If the whole of the residential sector cannot be exempted from time-of-use pricing altogether or during the winter months, a case could be made for exempting the social housing sector throughout the year, or at least during the winter months. The social housing sector makes a minimal contribution to the summer peak loads, but stands to be severely impacted by the application of time-of-use pricing during the winter months.

If introduction of time-of-use pricing for the social housing sector during winter months cannot be avoided, there should be at least a three-year interval between deployment of smart meters and application of time-of-use pricing so as to provide an adequate information base that can be used to develop strategies to shift demand for electricity away from on-peak periods.

The social housing sector should nevertheless be making a fair contribution to the quest for more rational use of electricity in Ontario, taking advantage of the enhanced communications and control that widespread deployment of smart meters will make possible.

Opportunities for load control seem especially advantageous. The discussion in Section 10 suggests they could provide a better return than investment in generating capacity, although this needs to be explored and confirmed. The social housing sector could want to collaborate fully in ventures to use load control to offset peak demand, not the least because they promise reduced electricity consumption and reduced costs overall.

Another possible strategy for the social housing sector would be to purchase electricity from an electricity retailer rather than from a local distribution company, with providers acting separately or in groups, or even as a whole sector under the auspices of SHSC. A variant of this could be for SHSC to establish itself as a retailer or to partner with an appropriate organization that is doing or might do this. The plans of the Association of Municipalities of Ontario's Local Authority Services seem to be especially relevant.[52]

Notes

1 According to the February 2006 consultation document *Domestic Metering Innovation*, produced by the UK's Office of Gas and Electricity Markets (available at http://www.ofgem.gov.uk/temp/ofgem/cache/cmsattach/13745_2006.pdf), Enel, which distributes all residential and most other electricity in Italy, had installed of 24.6 million of a total of 30 million smart meters by July 2005, and has continued to install them at the rate of 40,000 per day. The document reviews Ontario's plans, and notes that the three major utilities in California, responsible for about 15 million customers, propose state-wide installation of advanced metering infrastructure for all small commercial and residential customers by mid-2006. (This probably means that the plan is to begin the roll-out in 2006.)

2 The directive of the Minister of Energy to the Ontario Energy Board is at http://www.oeb.gov.on.ca/documents/cases/RP-2004-0196/smartmeters_directiveJuly14_190704.pdf. The directive concerns installation of smart meters by or for "all Ontario customers", not just residential customers. It does not specify that "all homes" be fitted with smart meters. Two considerations suggest that the intention may be to include all homes in the smart metering project. One arises from the presently stated main purpose of the project, which is to introduce time-of-use pricing (see Note 6 below). It makes little sense to apply such pricing where users are not exposed to the price differences, and unless users have smart meters they cannot be exposed. The second consideration is a comment in Appendix C-2 (Page 119) to the Ontario Energy Board's *Smart Meter Implementation Plan* (see Notes 4 and 37 below) to the effect that about 1.7 million consumers of electricity are bulk metered, and it may be desirable to include them in the smart metering project. (Bulk metering is where an electrical utility provides one meter for a multi-unit building. Unless there is sub-metering of individual units—see Section 12 of this report—occupants of the individual units cannot be charged for electricity according to how much they use.)

3 The Web sites for the six agencies listed in Box 2 are:
Ontario Energy Board: http://www.oeb.gov.on.ca
Ontario Power Authority: http://www.powerauthority.on.ca
Independent Electricity System Operator: http://www.theimo.com
Ontario Power Generation: http://www.opg.com
Hydro One: http://www.hydroone.com
Ontario Ministry of Energy: http://www.energy.gov.on.ca.

4 The Ontario Energy Board's *Smart Meter Implementation Plan* (January 26, 2005) is available at http://www.oeb.gov.on.ca/documents/communications/pressreleases/2005/press_release_sm_implementationplan_260105.pdf.

5 This is a feature of the Ontario Energy Board's *Implementation Plan*. (see Page 8 of the document detailed in Note 4.)

6 For time-of-use-pricing as the main reason for introducing smart meters, see http://www.energy.gov.on.ca/index.cfm?fuseaction=electricity.smartmeters.

[7] Information about the Ontario Energy Board's *Regulated Price Plan* (RPP) is at http://www.oeb.gov.on.ca/html/en/communications/fs_rpp.htm. Note that the rates in this document applied during 2005-2006. New rates, announced on April 12, 2006, and in effect from May 1, are set out in several OEB documents that can be reached from http://www.oeb.gov.on.ca/html/en/communications/pressreleases_2006.htm#260406.

[8] The OEB also regulates other charges that utilities may make in connection with distribution of electricity. Chief of these is the delivery charge touched on here in Section 3 and in Note 36.

[9] Box 3 is based on information provided in the sources detailed in Note 7.

[10] For more information about critical peak pricing, see http://www.oeb.gov.on.ca/documents/rpp_proposal_071204.pdf.

[11] The information in Box 4 and Box 5 has been developed by the author from several sources including http://www.torontohydro.com/electricsystem/residential/appliance_usage/pdf/appliance_usage_guide.pdf, http://www.generatorsales.com/calculator_GOOGLE.ASP and http://www.city.ames.ia.us/ElectricWeb/energyguy/appliances.htm.

[12] 1,000 kWh is also one megawatt-hour.

[13] This assumes the household buys electricity from a local distribution company according the Regulated Price Plan (see Note 6).

[14] Box 6 is based on data from Ontario's Independent Electricity System Operator, specifically on data downloaded from 'Hourly demands' and 'Hourly Ontario Energy Price (HOEP)' at http://www.ieso.ca/imoweb/marketdata/marketSummary.asp. For more about the HOEP, see Note 15. The prices shown in Box 6 are the average hourly prices paid by wholesale customers. (See Note 15.)

[15] The price is actually set in advance of the consumption. The Independent Electricity System Operator describes the setting of the HOEP (see Note 14) in this way: "Suppliers submit offers to sell electricity and wholesale buyers submit bids to buy electricity. The IESO then uses these offers and bids to match electricity supply with demand, and establishes the Hourly Ontario Energy Price, or HOEP." (From http://www.ieso.ca/imoweb/mktOverview/mktOverview.asp.)

[16] Box 7 is Figure 1.1.2 of the Ontario Power Authority's *Supply Mix Advice* (Volume 1, Part 1-1, Page 2, December 9, 2005). It is available at http://www.energy.gov.on.ca/english/pdf/electricity/Part%201-1%20Supply%20Mix%20Summary.pdf.

[17] Box 8 is Figure 1.2.19 of the Ontario Power Authority's *Supply Mix Advice* (Volume 1, Part 1-2, Page 46, December 9, 2005). It is available at http://www.powerauthority.on.ca/Storage/18/1339_Part_1-2_Supply_Mix_Advice_and_Recommendations.pdf.

[18] The 500-MW estimate is from Table 1.2.7 of the Ontario Power Authority's *Supply Mix Advice* (Volume 2, Part 1-2, Page 40, December 9, 2005). It is available at http://www.powerauthority.on.ca/Storage/18/1339_Part_1-2_Supply_Mix_Advice_and_Recommendations.pdf.

[19] Box 9 is Figure 2.6.7 of the Ontario Power Authority's *Supply Mix Advice* (Volume 2, Part 2-6, Page 155, December 9, 2005). It is available at http://www.powerauthority.on.ca/Storage/18/1350_Part_2-6_Methodologies_and_Assumptions_Adopted.pdf. This report notes that several projections of electricity consumption were reviewed. The projection used was that of ICF consulting based on work by the Independent Electricity System Operator, as modified by Ontario Power Authority. This projection, which is generally lower than the other reviewed projections, may be the most plausible even if only because it is the one that is the most consistent with consumption patterns since 1990. In particular, this projection suggests that residential consumption will *decline,* whereas the other projections suggest it will increase. OPA supports the argument for a decline in baseline residential consumption

[20] Box 10 is based on Figures 2.6.8 and 2.6.9 of the Ontario Power Authority's *Supply Mix Advice* (Volume 2, Part 2-6, Page 156, December 9, 2005). It is available at http://www.powerauthority.on.ca/Storage/18/1350_Part_2-6_Methodologies_and_Assumptions_Adopted.pdf.

[21] Box 11 is Figure 2.6.10 of the Ontario Power Authority's *Supply Mix Advice* (Volume 2, Part 2-6, Page 157, December 9, 2005). It is available at http://www.powerauthority.on.ca/Storage/18/1350_Part_2-6_Methodologies_and_Assumptions_Adopted.pdf.

[22] For peak demand from January 1984 to April 2002, see http://www.ieso.ca/imoweb/webdata/TransitionInformation/pd/pdMonthly20minpeak1984-present.pdf. For peak demand since May 2002, see http://www.ieso.ca/imoweb/pubs/marketReports/download/HourlyDemands_20060224.csv. For projections until 2015, see Table 4.4 on Page 27 of IESO's *10-year Demand Forecast* at http://www.ieso.ca/imoweb/pubs/marketReports/10Year_ODF_2005jul.pdf.

[23] Box 12 is based on data from Statistics Canada's *Survey of Household Spending 2003*. Information about the *Survey* is at http://www.statcan.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=3508&lang=en&db=IMDB&dbg=f&adm=8&dis=2. Note that 'after-tax income' here means 'income after personal taxes'.

[24] Box 13 is based on data from Statistics Canada's *Survey of Household Spending 2003*, detailed in Note 23.

[25] This estimate assumes a reduction in residential sector demand of 333 MW (i.e., two thirds of the total noted in Box 8) and a total residential demand potential of 7,500 MW (i.e., 20% of that noted in Box 8). 333 MW is 4.4% of 7,500 MW.

[26] The quote is from Page 26 of the source detailed in Note 4.

[27] The two-year time-of-use pricing experiment by the Pacific Gas & Electric Company showed an overall reduction in peak demand by volunteer participants of 21%. Midwest Power Systems of Iowa demonstrated a 13.6% reduction in peak demand in a similar program. Both concluded that volunteers have a greater-than-average ability to shift usage. Details of both programs are in a presentation by Schlumberger Electricity Inc. available at the Web site of the Ontario Energy Board at http://www.oeb.gov.on.ca/documents/directive_dsm_schlumberger.301003.pdf.

[28] Mountain DC, Lawson EL, Some initial evidence of Canadian responsiveness to time-of-use electricity rates: Detailed daily and monthly analysis. *Resources and Energy Economics*, 17, 189-212, 1995.

[29] The final report on the assessment of the California Statewide Pricing Pilot and appendix can be found at http://www.energy.ca.gov/demandresponse/documents/group3_final_reports/2005-03-24_SPP_FINAL_REP.PDF and at http://www.energy.ca.gov/demandresponse/documents/group3_final_reports/2005-03-24_SPP_APPENDICES.PDF.

[30] Box 14 is from Slide 17 of a presentation to a workshop conducted by the California Energy Commission in September 2004, at http://cacx.org//demandresponse/documents/2004-09-30_workshop/2004-09-30_SPP_OVERVIEW.PDF. A longer version of the same presentation is at http://www.nwcouncil.org/energy/dr/library/drrc_presentation.pdf

[31] This is because the relative increase in the RPP is higher than in the California TOU but not as high as in the CPP-F. On the other hand, electricity prices in California are generally higher than in Ontario, which may soften the impact of increases, and the high CPP-F rate came with a day’s notice.

[32] The smart meter does not literally have to be the interface point, which could be a nearby computer or processor that interacts with the meter.

[33] Box 16 is from a presentation used by the Ontario Ministry of Energy during consultation sessions held in November and December 2005 primarily for local distribution companies (LDCs) and vendors of advanced metering infrastructure. The presentation is available at http://www.energy.gov.on.ca/index.cfm?fuseaction=electricity.smartmeters_sessions.

[34] King C, Delurey D, Twins, siblings, or cousins? Analyzing the conservation effects of demand response programs, *Public Utilities Fortnightly*, 54-61, March 2005 (available at http://www.americanenergyinstitutes.org/research/ConservationEffects.pdf).

[35] Box 17 is taken from a document produced by Capgemini, *Smart Metering: The holy grail of demand-side energy management?*, available at http://www.capgemini.com/resources/thought_leadership/smart_metering_the_holy_grail_of_demand-side_energy_management/.

[36] The estimates and the quotation are from Page vi of the *Smart Meter Implementation Plan*, detailed in Note 3. The paragraph following the one in which the quotation appears suggests that the cost of the meters will be included in the distribution component of the charges for electricity. This component varies with use, but would not vary with time of use. Each local electricity

has its own distribution rate approved by the Ontario Energy Board. It is part of what is billed as the 'delivery charge'. Presently it varies between about 1.3 and 1.8 cents per kilowatt-hour. For a consumer billed for 1,000 kWh per month, the smart metering supplement coul add about 25% to the distribution rate.

37 The estimated amortized capital cost per month is $2.47; operating cost is $1.42; operating savings are $0.39. These matters are set out at the beginning of Appendix C to the *Smart Meter Implementation Plan*. The *Plan* itself is detailed in Note 4. The Appendix is available at http://www.oeb.gov.on.ca/documents/communications/pressreleases/2005/press_release_sm_appendices_260105.pdf.
Table 1 in the Appendix lists "smart metering benefits and their operating savings". The stated benefits are similar to those set out in Box 17.

38 According to the document detailed in Note 35, the information in Box 17 is based on "Interviews conducted by Capgemini with North American Utilities having deployed AMR pilot projects. Calculation based on the assumption that AMR is fully integrated and utilized".

39 Information about Toronto Hydro's peakSAVER program is at http://www.torontohydro.com/electricsystem/powerwise/peaksaver/faq/index.cfm#q14. Participating households are given $25 on signing up, and the chance to win prizes, but receive no other direct benefit.

40 An example of a stand-alone demand controller is described at http://www.brayden.com/demandcontroller.html.

41 An example of a computer-based home system—being tested by Enersource Hydro Mississauga—is at http://www.cleanair.web.ca/media/may904.html.

42 A Swedish study estimated that the cost per home of a demand-control system could be in the order of $1,500 per home (see Juozas Abaravičius, *Load Management in Residential Buildings*, thesis, Lund University, December 2004, at http://www.vok.lth.se/~eep/files/pdf/lic7024JA.pdf). If it is assumed that (i) typical on-peak use is 40% of the annual 10,000 kilowatt-hours, (ii) 10% of this is shifted to mid-peak and 10% to off-peak periods, and (iii) the OEB's Regulated Price Plan applies (see Section 2), annual savings would be $93. At 6% interest, the savings would cover the investment in 59 years, assuming no operating costs. If the installation cost were $750 rather than $1,500, the savings would cover the investment in 11 years.

43 A proper comparison of the costs of installing and managing load control and constructing and using peak generating capacity is beyond the scope of this paper. A preliminary comparison suggests that installing load control may be advantageous. Assuming (i) the $1,500 per home mentioned in Note 42, (ii) average peak demand of 15 kW, (iii) a reduction in the peak by 20% due to load control (i.e., 4.5 kW), and (iv) line and transmission losses of 10%, the cost per avoided megawatt is $300,000. Present estimates of the construction cost of a natural gas plant are about $600,000 per MW (e.g., see http://www.webpronews.com/business/topbusiness/wpn-54-20050413CalpineandMitsuiEnterCleanEnergySupplyContractWithOPA.html), so there is already an indication that the load control option could be favourable. However, there is no evident revenue from avoided demand, whereas there would be from a new generating station. A better would take into account the cost of peak generation, which can frequently be in excess of

$75/MWh (see Box 6). If the avoided megawatts are amortized over 20 years, at 6.0% the annual value is the equivalent of 350 megawatt-hours at $75/MWh, or about one such hour per day.

[44] Questions were also asked about providers' costs for electricity and other fuels, but many responses to these questions were found to have inconsistencies and the results were not further analyzed.

[45] Considerable caution should be exercised before relying on these comparisons, in part because of the small numbers of relevant responses in the *Survey of Household Spending 2003*. Of 1,944 usable Ontario records in this survey, only 116 were in respect of households in subsidized housing, 37 were in house-type units and 79 were in apartment-type units. According to Statistics Canada's weighting factors, these records represented, respectively, 268,091, 93,646, and 174,445 households. The total of 268,091 happens to be extraordinarily close (within 0.08%) to the total number of social housing units in Ontario—267,888 as reported by the Ontario Non-Profit Housing Association at http://www.onpha.on.ca/about_non_profit_housing/default.asp?load=important_statistics. However, this may be a coincidence because not all social housing units are subsidized, and not all households benefiting from a housing subsidy are in social housing.

[46] The *Regulated Price Plan* currently provides for a residential rate of 5.8 cents per kWh for the first 600 kWh and 6.7 ¢/kWh thereafter. A bulk-metered, residential building with 50 units would pay the lower rate for the first 30,000 kWh.

[47] For the OEB's adjournment notice, see http://www.oeb.gov.on.ca/documents/cases/EB-2005-0252/proceduralorder3_130605.pdf.

[48] That is, unless the customer has a contract with an independent electricity retailer. In Toronto, the most favourable five-year contract presently available from such a retailer would be for a flat rate of 8.99 cents per kilowatt-hour (see http://www.energyshop.com/es/prices/ON/eleON.cfm?ldc_id=293&). This would seem to be less advantageous than the Regulated Price Plan (see Section 2).

[49] The timing was possibly a coincidence. The LIEN report makes no mention of the OEB proceeding. It begins with the following: "The Government of Ontario is proposing to amend the *Tenant Protection Act* … to allow landlords, without the consent of the tenants, to install electrical sub-meters in existing multi-residential buildings and make electricity a separate charge in the rent.

[50] The LIEN report is *Zapping Tenants: A critical analysis of sub-metering in the residential rental sector*, May 2005, available at http://www.acto.ca/docs/ZappingTenant_FullReport.pdf.

[51] Anna Linden Fraser has conducted a detailed examination of this matter for the Social Housing Services Corporation in a June 2005 report entitled *Social Housing Tenants in Receipt of Social Assistance: Report on Disincentives for Energy Conservation*.

[52] Information about the AMO/LAS plan is in the document *Electrical Services and Procurement Program* at http://www.amo.on.ca/AM/Template.cfm?Section=About_Us1&TEMPLATE=/CM/ContentDisplay.cfm&CONTENTID=39372.