



Smart Metering and Smarter Metering

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Imagine for a moment that we bought food in the way we currently buy electricity. We might order from a supply list with no prices marked and have whatever we fancied delivered to our door whenever we pleased. A single, un-itemized bill would arrive in the mail once every couple of months covering all the food ordered and delivered during the billing period. How would our food bills probably compare to what they are currently? How would we go about reducing our food bill in order to save money when we know nothing about the cost of each act of consumption? If the 'Ministry of Food Supply' were worried about the amount of food available, reliance on expensive imports or whether the delivery system might not be up to the task, what could they do to encourage a 'food conservation culture'?

What is missing from our hypothetical scenario is real-time price feedback, which would allow consumers to take responsibility for their own consumption. Its absence makes the task of trying to reduce demand much more difficult, both for consumers and for those trying to manage the supply. If we are ever to introduce a conservation culture, the tradition of passive consumption must first be challenged.

A Tradition of Passive Consumption

The traditional AC system has evolved as a natural responsibility of government for reasons of scale and because the stability of such a system requires central control in real time. Its history as a public service has led to political pressure to keep prices low overall and uniform, independent of the cost of supply despite the fact that the cost of supply may vary considerably at different times and in different locations. The resulting low tariffs - sometimes lower than the cost of production - and extensive cross-subsidies have muddied the waters and encouraged passive consumption.

Passive consumers do not give a second thought to the act of consumption, let alone the mammoth tasks of production and delivery. They take supply completely for granted. When supply is stable, prices are low, tariffs are fixed over long periods of time and billing is delayed, this attitude becomes entrenched. It is not surprising that developing a conservation culture under such circumstances is very difficult.

Price Increases as a Blunt Instrument

The more centralized and bureaucratic systems become, the further they are removed from real costs as so many factors are impenetrably bundled together. The price signals which finally feed through to the end user are inevitably weak and distorted, thereby providing little incentive for conservation and efficiency. Under these circumstances, raising prices in an effort to discourage consumption becomes a blunt instrument. It may make consumers angry, but does relatively little to alter their consumption patterns because they do not generally know what options are open to them and cannot make informed choices between them. If price signals can be sharpened, especially in combination with clear information on conservation and efficiency, then usage can be

What consumers require if they are to take responsibility for their own consumption is feedback in real-time. They also need to be able to connect each act of consumption with its immediate price consequence, as they do for food purchases. Payment in advance sharpens price signals and gives a direct incentive to conserve, while feedback gives consumers the information they need to prioritize their various uses of electricity and to target areas where they can cut back if necessary.

The Woodstock Hydro Case-Study

In 1989, [Woodstock Hydro](#) instituted a voluntary program intended to reduce bad debt. For a small fee per month, it installed a pre-payment meter in the home of each customer choosing the option. Customers were given a smart card, which they would use to purchase an electricity credit of whatever amount they chose from any one of a number of local retailers. A new meter with a remote display offered real-time feedback in a form comprehensible to all and in a convenient location where the customer could easily check the information as to how quickly the card was being depleted. There was no opportunity to accumulate bad debts, and therefore no need for customers to be disconnected and then reconnected - for a substantial fee - as is common practice under other utilities.

There is a button on the front of the display box, and by pressing it, you can get the [following information](#) on your energy usage:

- How much power remains
- Present rate of use (in dollars or kWh)
- Amount of power in dollars used yesterday
- Amount of power in dollars used in the last month
- Date and amount of the last transaction
- Current date and time
- Estimated number of days until card replenishment
- Much more

The utility soon noticed that consumption had fallen for those on the program by an average of 15%. This had not been anticipated as no conservation information had been provided. Indeed initially, the utility thought the reduction must be some sort of technical problem and attempted to solve it. Eventually they realized that the effect must be real and began to study it. The program was opened up to the whole customer base and has become so popular that there is a waiting list to be part of it. Customers typically save more per month from reduced consumption (15-20%) than they pay (as a small daily supplement to actual consumption) to be part of the program. Approximately a quarter of the customer base now participates in the pre-payment initiative.

"It's been a pretty well-kept secret," said Garry Roth, president of Woodstock Hydro in Woodstock, Ont., the only utility in Canada to use the system. "[But] customers love it."

What Woodstock Hydro had inadvertently discovered was that they had managed to design a program which tapped into customers' psychological drivers for conservation. With real-time feedback, consumers could immediately see the price consequences of any given act of consumption. By watching the display unit in their kitchen, they could see the balance on their card decrease at different rates depending on their own actions. As a result, [they quickly learned for themselves](#) how to keep that decrease as slow as possible. In short, they had been transformed from passive consumers into active consumers.

One lady noted that it helped her realize her fridge needed servicing, since she saw her consumption (electricity, not sandwiches) go up all of a sudden, and started turning off and unplugging things until all was left was the fridge. Another said she is quite well off, thank-you, and that she opted-in to show her teenage daughters the value of loads and loads of laundry, to prepare them for life in the real world. Another's child was in the habit of drying her mittens in the dryer during lunch, then going back out to play. Now Dad makes sure she has a second set of mitts by the door instead.

The effect is comparable to the feedback screen in a hybrid car, which shows the driver vividly how his driving habits affect his fuel consumption. The result in the case of hybrids is that drivers generally drive more slowly and much less aggressively because the feedback system acts as a fuel-economy tutor. In the case of electricity, active consumers turn off lights in unoccupied rooms, alter thermostats in a seasonally appropriate way, dry clothing outside on a clothesline and take other measures to reduce consumption. One might imagine that utility customers would have resented having to take these measures, but in fact Woodstock Hydro noticed that participants in the program complained much less frequently than did other customers. They had begun to treat buying electricity in the same way that they bought food or fuel for their vehicle - as their own responsibility. When their card balance was depleted, they put electricity on the shopping list.

"Woodstock Hydro estimates that if 25% of Ontario's 4.5 million homes went to a pay-as-you-go metering, with an in-home information display unit, the environmental impact would include the shutting down of two of the province's six coal-powered generation plants."

Pre-Payment Metering and Time-of-Use (TOU) Pricing

There is no reason a Woodstock-type metering system should not be combined with TOU pricing. If the original scheme resulted in savings of 15%, combining that with TOU pricing as well as an extensive education campaign should be able to achieve both additional conservation and load-shifting. If also combined with incentive programs to encourage the replacement of incandescent lighting and aging appliances, consumption could potentially be reduced by far more, and in a relatively short space of time.

When asked at the 2004 Electrical Power Symposium in Ottawa (IEE/IEEE EPS 2004 - Ontario's Tough Electricity Choices), Ken Quesnelle from Woodstock Hydro indicated that the current Woodstock meters could accommodate both TOU pricing and net metering. The current system would not, however, be able to integrate the two-way communication and critical call features required for smart meters under the current plan. As the Woodstock meters are considerably less expensive than the proposed smart meters, partially due to the lack of two-way communication capability, integrating TOU pricing into this existing platform would seem to be a far more cost-effective means of introducing smart-metering. It would not be possible to adjust the peak load periods remotely, but this could be done manually or, alternatively, a blend of summer and winter load periods could be used. Even if a means could be found to integrate two-way communication, it is unclear whether this additional feature would add real value, let alone whether it would do so cost effectively.

Metering and the Utilities

From the utility's point of view, pre-payment metering reduces costs considerably. If such a scheme were universal, there would no longer be a need to physically read meters, as each time a pre-payment customer purchased an electricity credit the supplier would be informed as to the amount of electricity consumed. There would be no need for personnel to disconnect and

These savings could, and should, be used to reduce the distribution cost element significantly. The effect would be to amplifying the effect of TOU commodity price differentials, thereby sharpening price signals without the need for overall price rises.

In contrast, the current smart-metering initiative would cause the cost and complexity of billing to escalate dramatically. Enormous amounts of data would have to be expensively transferred from each metered property to the utility - data which would have to be secured. That data would then have to be centrally processed in order to generate an amalgamated bill, typically based on two months consumption and delivered a month after the end of the billing period.

The cost of developing such a complex billing system would be out of all proportion to the anticipated benefits - benefits which would be minimized due to the lack of real-time feedback and billing delay. This would represent a extravagant waste of resources given that the viable alternative would eliminate the need for billing entirely.

Pre-Payment Metering and the Less Fortunate

[Part I](#) of this discussion addressed disproportionate impacts of price rises on the less fortunate, explaining how price rises in the absence of the tools needed to tackle demand can cause unnecessary hardship as well as providing only limited load-shifting and little real conservation. Conversely, under the scheme explored here, consumption typically falls without the need for price rises in absolute terms due to the fact that the effect of price signals has been amplified. Because consumers are equipped with feedback as a teaching tool, the conservation they come to practice is likely much less painful than would be the case if they had no real information as to how to reduce their bills. An additional information campaign, perhaps in combination with efficiency incentives, could be even more effective.

Under a pre-payment system, less fortunate individuals are protected from the accumulation of unpayable debt, which typically leads to disconnections and expensive reconnections. This cycle imposes an additional cost upon the poor that needlessly causes hardship, whereas empowering them to make good choices using pre-payment and feedback can help to avoid that additional burden.

An additional possibility, which could be instituted if this scheme were to be copied provincially, would be to provide means-tested electricity credits to the most vulnerable consumers via their smart cards. The impact of prices rises, which are likely to be necessary in the future in order to pay the debts of the old Ontario Hydro and to replace Ontario's aging generation plant, could therefore be muted for those least able to cover higher bills while still having a sufficient impact on over-consumption by the remainder of the population. Electricity pricing and social welfare could be disentangled in order to avoid political balancing acts which end up not satisfying any political objectives due to trying to reconcile mutually exclusive goals. The cost of the credit program would give public authorities - often the owners of the public housing in which the poorest consumers live - a direct incentive to invest in home improvements such as insulation on behalf of their tenants.

As there is good reason to believe that there may be many more people living in reduced circumstances in the future than there are presently (due to the impacts of bursting debt bubbles and peak oil among other factors), consideration of the less fortunate may have much more widespread applicability as time goes by.

Setting a New Gold Standard in Metering

Ontario has already decided to upgrade its existing metering system at considerable expense. This represents an opportunity to define a new Gold Standard in metering, but that opportunity

is not being employed to best advantage. A maximum conservation target of only 5% is far lower than could be readily achieved, and would be attained at a far higher cost than necessary if expensive and superfluous metering features are insisted upon. However, it is not too late to alter the technical details of the proposed program. Combining a Woodstock-style metering system based on pre-payment and real-time feedback with TOU pricing could set a new standard in metering technology. It would be smart from both human and technological perspectives and would provide both cost-effective conservation and load-shifting.



Ultimately, no metering initiative, however smart, can save the power system from the effects of exponential growth, but appropriate metering can reduce consumption significantly enough and quickly enough to buy Ontario the time it needs to bring other supply and demand initiatives on stream.



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