Electricity Prices, Technology, Consumer Response

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Introduction

- Information technology is changing rapidly:
  - metering, displays, Internet, appliance controls.
- How does changing technology affect:
  - consumption,
  - response to prices,
  - consumers' ability to cope with rising prices?
- What technology do we need to improve electrical system performance?
- Focus on residential consumers, Ontario.

Why do we Care?

- Peak loads cause inefficient capacity utilization.
- Environmental harm from generation.
- Cost of, and resistance to, new facilities (generation, transmission).
- Consumer unhappiness about rising prices.

Goals

- Shift peak consumption to off-peak to reduce high peak costs, environmental harm.
- Reduce consumption at all times, to reduce environmental harm of generation.
- Help consumers reduce costs by adapting their consumption to prices and their needs.

What we know: Price Response

- Consumer response to electricity price.
- Elasticity (% change Q)/(% change P):
  - Short run -0.3
    - 10% price increase → 3% consumption decrease
  - Long run -0.9
    - 10% price increase → 9% consumption decrease
- Condo sub-metering (zero price to real price)
  - Consumption drops ~20% very quickly.

What is the Price?

- Average price: monthly bill/consumption.
  - Include all charges, taxes, rebates.
- Marginal price: change in total cost for a change in consumption at a particular time.
  - Energy price only, from TOU table.
  - Energy price plus variable T & D & misc.
    - This is the true marginal cost for consumer.
- In Ontario, there are many ‘prices.’

Toronto Electricity Prices

($/kWh February 2014)

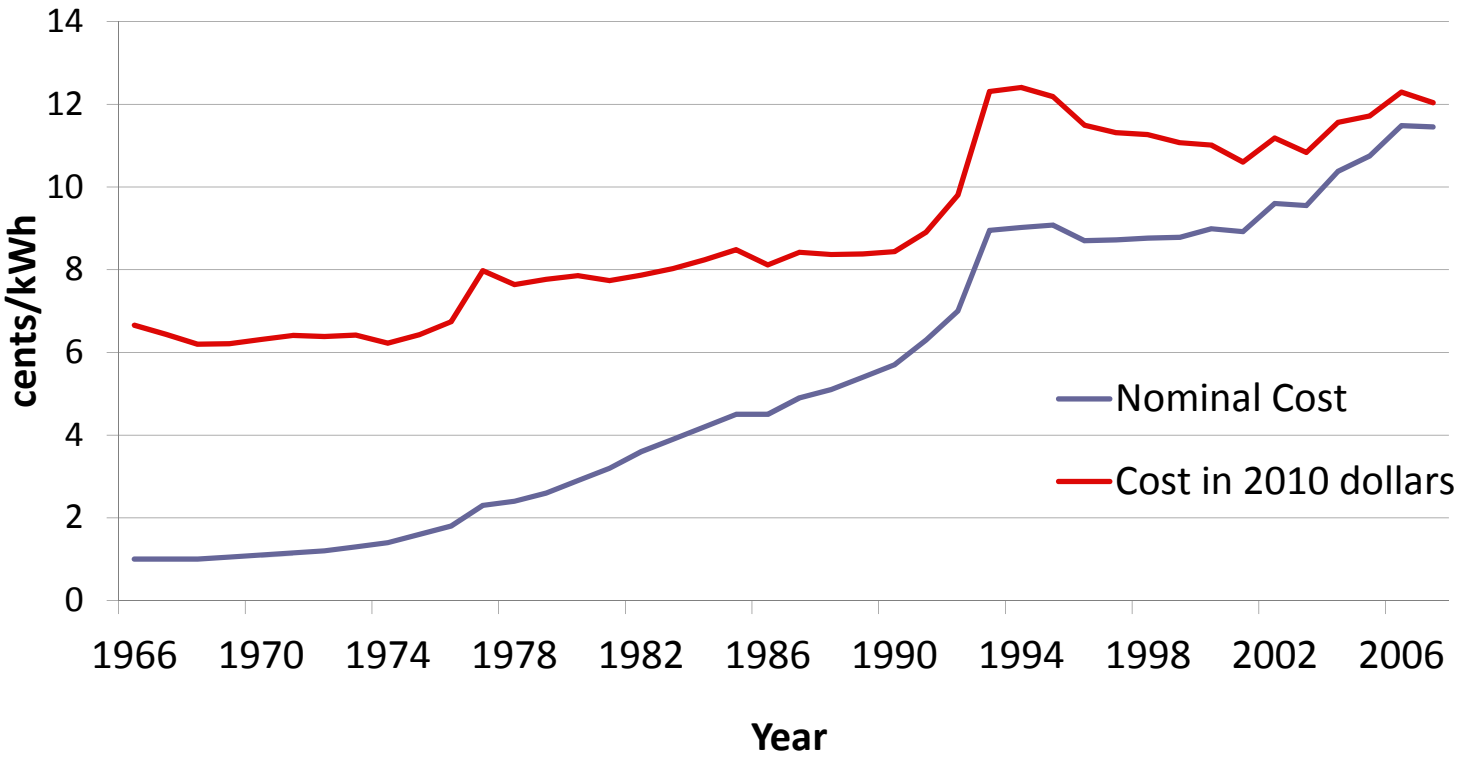
	Peak	Mid-peak	Off-peak	Average (wtd)	Peak/Off Ratio
Energy (TOU)	0.129	0.109	0.072	0.089	1.79
Other variable	0.042	0.042	0.042	0.042	
Total with tax & CEB	0.173	0.153	0.115	0.133	1.50

Average from bill: cost/kWh (DND Feb. bill/kWh) 0.174

(includes fixed charges)

HOEP January 0.066

Ontario Average Residential Price 1966-2006 (cents/kWh)



What we know: TOU, CPP

- TOU can cut peak demand 3%-6%.
  - Opt-in studies show up to 10% but these over-estimate opt-out or compulsory TOU effect.
  - Ontario/Brattle find 1.3% to 5.6% first year for OPA Peak Demand Period (June-August, 1-7 PM).
  - Ontario/Navigant find 3.3% June-Aug peak reduction.
    - Overall TOU effect on annual total consumption: -0.2%.
- TOU plus Critical Peak Pricing or CP Rebate **cuts peak demand 11%-22%** for opt-in cohort.
  - Opt-out study found **no significant reduction** from adding CPP/CPR to TOU.

What we know: Info & Control

- With no change in price:
  - in-home displays or web pages achieve little reduction (EPRI 2012);
  - mailed reports with normative comparisons reduce consumption 2% to 2.6%. (EPRI 2012);
- TOU plus real-time monitors in Ontario reduces consumption 6.5%.
- Adding utility control of appliances to TOU multiplies TOU peak reduction by 1.5 to 2.0.

What we know: Info & Control (2)

- EPRI 2013, Ohio Critical Peak Rebate ($0.40) summer with/without In-Home Display or Programmable Controllable Thermostats without/with utility control :
  - CPR with IHD, or PCT without IHD, reduces peak demand ~8-11%%. Consumers do not do much.
  - CPR with PCT **under utility control** reduces peak demand 28% to 30%.
  - Focus here on A/C control. Summer.

Conclusions: Info & Control (3)

- Looking at all residential consumers (not opt-in):
  - Providing information alone has reduced demand and/or peak demand by very little.
  - TOU pricing alone or with consumer information reduces peak demand by 3-6%.
  - CPP or CPR reduces peak demand more than TOU.
  - CPP or CPR with utility control (of A/C) substantially reduces peak demand - up to 30%.

Implications for Technology

- Consumers tend to be passive, so you need a high peak price **and** utility control to get big results.
- Consumers won't tolerate high bills, so Real-Time Pricing is out, leaving CPP/CPR to get the high peak price.
  - Is compulsory CPP/CPR politically feasible?
- Is compulsory utility control politically feasible?
  - Opt-out/override may help, does not reduce effect much.
- How can we use evolving technology to improve this response?

What Can Technology Do?

- Displays of individual appliance consumption:
  - Real-time, cumulative, share of total, kWh or cost.
  - Kitchen display, computer, remote by Internet, mobile device.
- Warnings that major loads are on:
  - Electric space heaters, snow/ice melters, etc.
- Real-time control of major loads:
  - In-home, computer, remote by Internet, mobile device.
  - Smart panel monitors, controls individual circuits.
- Automatic control of major loads:
  - By the consumer's devices.
  - By the utility/subject to consumer over-ride.
- Most of this is available today.

Technology Possibilities (2)

- Careful design of what information is displayed:
  - What information do consumers care about and respond to?
    - Cost/month, year?
    - Compare to own usual, to neighbours, to 'green' standard?
- Look at auto fuel consumption displays, internet usage displays, etc. as models.
  - Green leaves when economical, leaves turn brown, die, flutter to the ground when not economical . . .

Technology Possibilities (3)

- Careful design of automatic control of appliances.
  - Most people will not follow prices, information, incentives and control by themselves.
  - Provide default control systems acceptable to most consumers.
    - Remote control by utility based on real-time events.
    - Control by in-home device based on real-time events.
      - Include learning/adaptation like NEST thermostat.
    - Allow consumer to over-ride the control in real time, fully informed about the price.
    - Transparent status information to the consumer.

Consumer Choice of Technology

- How do consumers learn what a technology can do, what it will do for them?
  - The market is full of ads for devices that may not perform as promised.
  - Consumers don't want to be ripped off.
  - Consumers reluctant to cede control of appliances.
  - Whose information do they trust?
  - How can we gain trust at low cost?

What about Cost?

- Lots of wonderful technology.
- Some is too expensive to be worthwhile.
- Consumers are not helped by technology costing more than it saves.
  - Focus on major loads where substantial savings are likely (A/C, resistance heat, HWH, dryer).
  - Use cost-benefit analysis to choose cost-effective strategies.
    - Value of peak savings, environmental benefits.
- Don’t waste money.

Working with markets

- Markets are efficient only with competition, perfect information and homogeneous goods.
  - Information and control devices are not homogeneous, consumers not well informed.
- So, we can **not** rely on the free market to provide efficient conservation results.
- But governments are terrible at choosing technology, choosing winners.
- Rely on stakeholders and regulator to facilitate this market.

What can we expect?

- Ontario electricity prices will increase substantially.
- Cost of monitoring and controlling individual appliances is falling.
- Cost of understanding consumer's needs and patterns is falling.
- Technology capability is growing.
- Challenge: can we take advantage of this to help consumers and the hydro system?

What should we do?

- We need strong price signals to support conservation and peak reduction.
  - TOU not enough. Add CPP/CPR.
  - Build environmental costs into analysis of benefits.
- We need good information for consumers at the right time and form.
  - Find who can best provide it, what to provide.
- We need mandatory control programs, with opt-out and choices.
  - Decide who does it, how to max choice, flexibility.

Suggested Actions

- Add CPP or CPR to existing TOU.
- Develop information program(s) targeted to responsive consumers designed to max response, with choice.
  - Encourage in-home information and control technology.
- Add utility control program to CPP/CPR
  - Mandatory control program(s) targeted to responsive consumers, with some choice. Not small users.
  - Base program design on **facts**: costs, benefits and payback.
- Design the program to ensure that it will
  - avoid pure waste;
  - shift discretionary use to off-peak times;
  - save money for most consumers;
  - be based on analysis of facts.