Transforming A Residential Lighting Market: Estimating the Impact of Ten Years of DSM Activities in British Columbia

Iris Sulyma & Ken Tiedemann

Research4Results and BC Hydro

Introduction

- In 2001, BC Hydro established a second ten year demand-side management plan aimed at reducing the growth in energy and peak demand
- A key component of the plan focussed on transforming the residential lighting market – initially by promoting CFLs and CFL torchiere fixtures and then later by promoting LEDs and LED fixtures
- Purpose of this study was to consolidate and reconcile ten years of residential lighting evaluations and identify key lessons on how to transform a residential lighting market
- Research design was a quasi-experiment with a comparison group in another jurisdiction used to inform detailed engineering algorithms

Outline

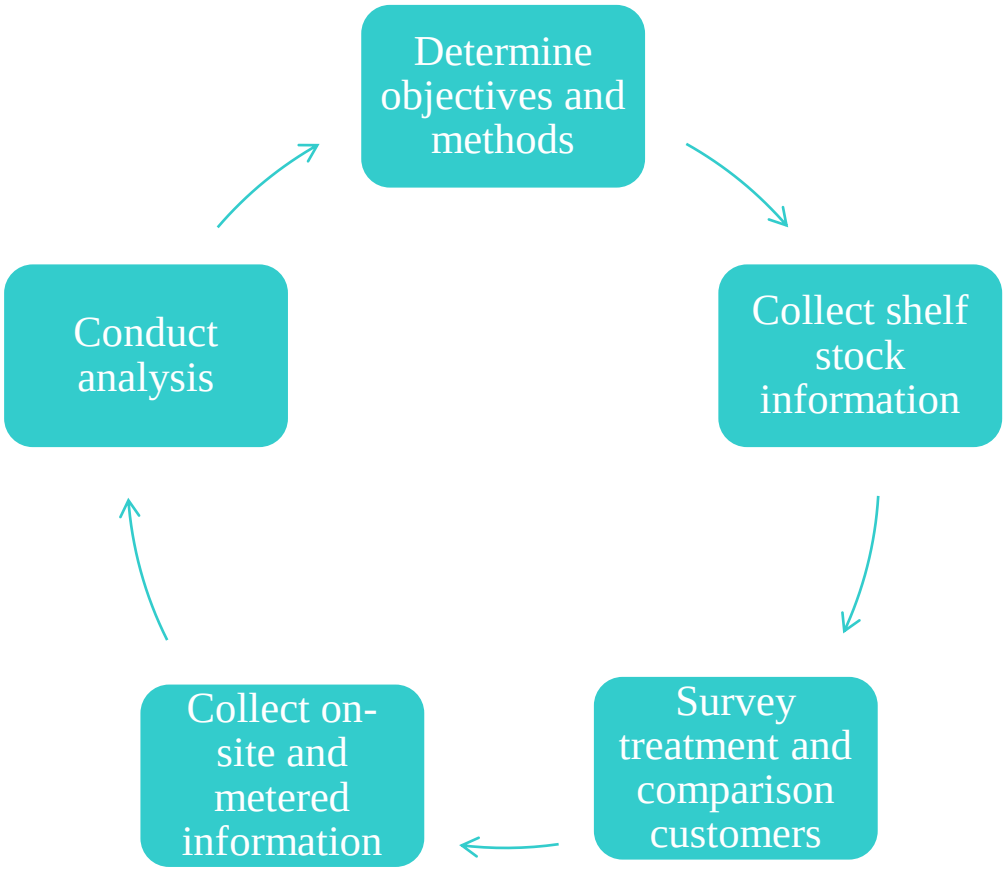
- BC electricity market
- Data and method
- Residential lighting market overview
- Phase 1: Re-launching the CFL (2002-2004)
- Phase 2: Transforming the CFL market (2005-2007)
- Phase 3: Broadening the market to LEDs (2008-2011)
- Market transformation assessment
- Conclusions and lessons learned

British Columbia

British Columbia Hydro

- 56,000 gigawatt hours of electricity annually
  - ►45% is purchased by residential households
  - ►4,776 GWh Power Smart annual savings
  - ►Average household uses 11,000 kWh annually
- 75,000 kilometers of transmission & distribution lines
- 95% of the province's population
  - ► 1.7 million customers

Evaluation Cycle



Direct Energy Savings Algorithm

- Incented units is the number of units receiving incentives, unit power savings is the average difference in watts between the base unit and the average incented unit, installation rate is the percentage of CFL purchases made that are installed and considered a new installation (i.e., did not replace an existing CFL), hours of use is the average hours of use based on customer survey/metering data, cross effects are the additional heating requirement related to lower lamp heat losses during the heating season (for electrically heated dwellings), net to gross is based on customer self-reports, and the summation is over the various lighting products supported by the program.

$$\text{Program } \Delta kWh = \Sigma_i \{\text{incented units}_i * \text{install rate}_i * \text{unit power save}_i * \text{hours of use}_i * \text{cross effects}_i * \text{net to gross}_i\} \quad (1)$$

Total and Market Effects Energy Savings Algorithms

- Incremental units are based on differences between BC Hydro installations and Saskatchewan installations for phases 1 and 2 and the difference between BC and North and South Dakota for the third phase
- This is a quasi-experimental design where the total program impact is estimated using (2), and then disaggregated into direct effects and market effects using (3)

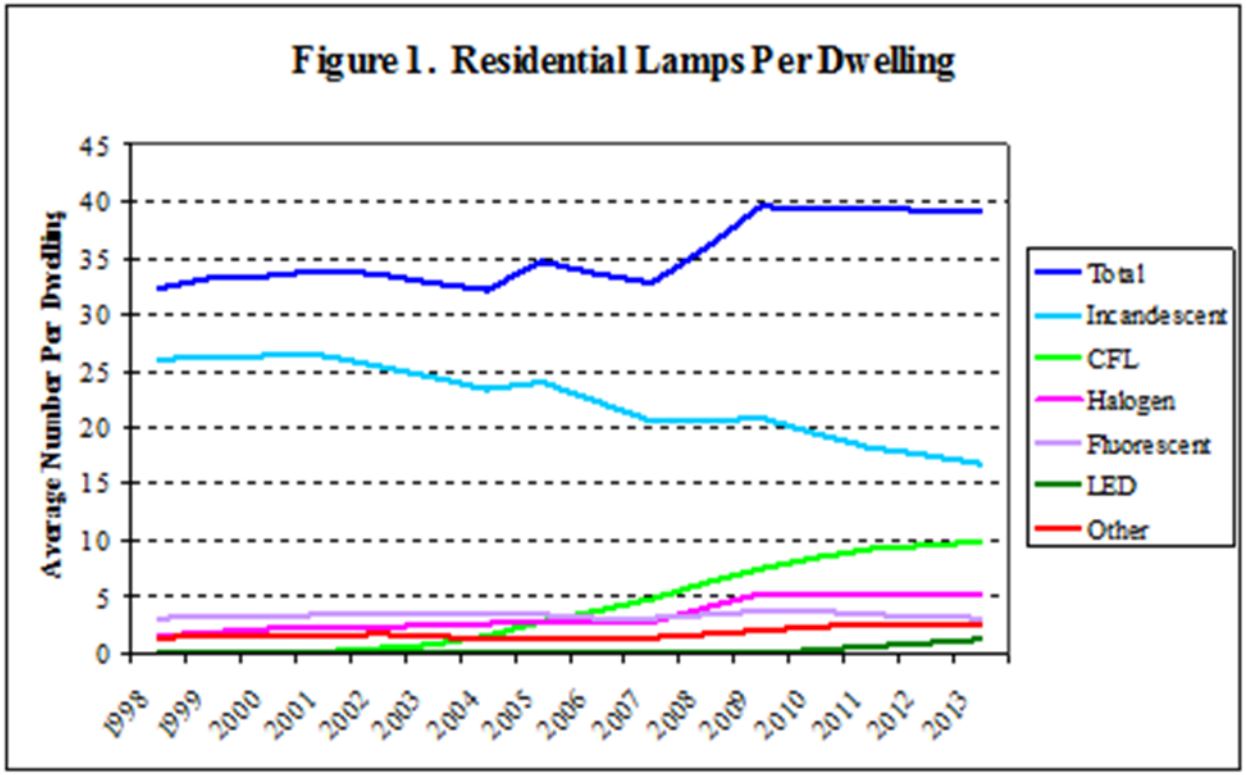
$$\text{Total } \Delta kWh = \Sigma_i \{\text{incremental units}_i * \text{unit power savings}_i * \text{hours of use}_i * \text{cross effects}_i * \text{net to gross}_i\} \quad (2)$$

$$\text{Market } \Delta kWh = \text{Total } \Delta kWh - \text{Program } \Delta kWh \quad (3)$$

Residential Lighting Market Overview

- Figure 1 presents information on the saturation of residential lamps per dwelling for the period 1998 through 2013 with typical survey has six to seven thousand completions which provide a maximum margin of error of ± 1.5%
- First, the total number of lamps per dwelling was fairly stable for ten years from 1998 through 2007, but it subsequently increased by about 20% through 2013 to 39.2 lamps per dwelling
- Second, the number of incandescent lamps decreased by about nine units per dwelling from 1998 (26.0) through 2013 (16.8), which was essentially offset by the increase of CFLs, which increased by about ten units per dwelling for the same period (from 0.1 to 9.9)
- Third, the number of halogen lamps increased by about four units per dwelling from 1998 (1.6) through 2013 (5.3), but changes in saturations for linear fluorescents, LEDs and other lamps were relatively small

Residential Lighting Market Overview



Re-launching the CFL: Phase 1 Summary

- Beginning in 2001, BC Hydro decided to re-launch its residential lighting program with a focus on both energy acquisition and market transformation beginning with a comprehensive CFL market characterization and baseline study
- Demand-side recommendations included: (1) implement a point-of-sale rebate coupon campaign; and (2) expand efforts to educate consumers about CFLs
- Supply-side recommendations included (1) expand efforts to work with supply side actors including large retailers, chains, grocery stores and up-stream actors; and (2) develop and distribute materials to retailers.

Re-launching the CFL: Program Activities

Dates	Key activities
2001-2002	Power Smart brand used to promote CFLs at 600 establishments using point of purchase materials to gain customer exposure and encourage reatiler stocking of CFLs
2001-2002	The h.e.l.p campaign used advertising and in-store promotional materials, 25,000 CFL give aways and 2.8 million CFL rebate coupons
2001-2004	Energy efficient fluorescent lighting included in 8,000 new homes
Spring 2002	Some 42,000 vouchers for free and discounted CFLs provided in Courtney, Comox Valley and Quesnel give away
Spring 2003	Torchiere pilot provided incentive coupons to encourage CFL rather than halogen torchieres
2003	Voucher program expanded to the rest of Vancouver Island to help constrain load growth because of distribution constraints

Transforming the CFL Market: Phase 2 Summary

- In 2005, BC Hydro launched a second phase of its residential lighting program
- New market analysis indicated that although British Columbia had the highest penetration of CFLs in Canada, there were still considerable opportunities for cost effective market transformation to reinforce and support traditional CFL giveaways and deep price discounts
- Market effects were defined as incremental sales for energy efficient lighting products due to BC Hydro's efforts to reduce supply-side and demand side barriers which limit availability, accessibility, affordability, awareness and acceptance of energy efficient lighting

Transforming the CFL Market: Program Summary

Dates	Key activities
Spring 2004	Voucher program for free CFLs expanded to the Lower Mainland to increase customer awareness, exposure and interest
Fall 2004	Campaign featured CFLs, CFL torchieres and seasonal LEDs with mail-in coupons
Fall 2005	Campaign included in-store discount coupons for variety of energy efficient lighting products
Jan 2006	Two-tier campaign rewarded high involvement retailers with grater rewards

Broadening the Market to LEDs: Phase 3 Summary

- In 2008, the CFL component of the residential lighting program began a transition from spirals to specialty bulbs
- CFL coupons were replaced by instant in-store discounts and manufacture buy-downs, with increased focus on non-incentive promotional activities including advertising and in-store events
- In 2009 and 2010, increased focus was placed on promotion of specialty CFLs, LEDs, Energy Star fixtures and LED fixtures
- Provincial minimum energy performance standards for 75W-100W General Service A type lamps came into force in January 2011, and, due to Federal government delays, this is three years in advance of parallel federal legislation

Broadening the Market to LEDs

Dates	Key activities
Fall 2007	CFL program began transitioning from standard CFLs to specialty CFLs
Fall 2008	Program expanded sue of mid-stream incentives to leverage scarce program resources for incentives
Fall 2009	Increased focus on LEDs and LED fixtures
Fall 2010	Energy Star fixtures added to the prodcut mix

Energy Savings (GWh/year)

	Direct	Market	Total
Phase 1: 2002-2004	121.2	51.6	172.8
Phase 2: 2004-2007	34.6	196.7	231.3
Phase 3: 2008-2011	23.2	115.3	138.7

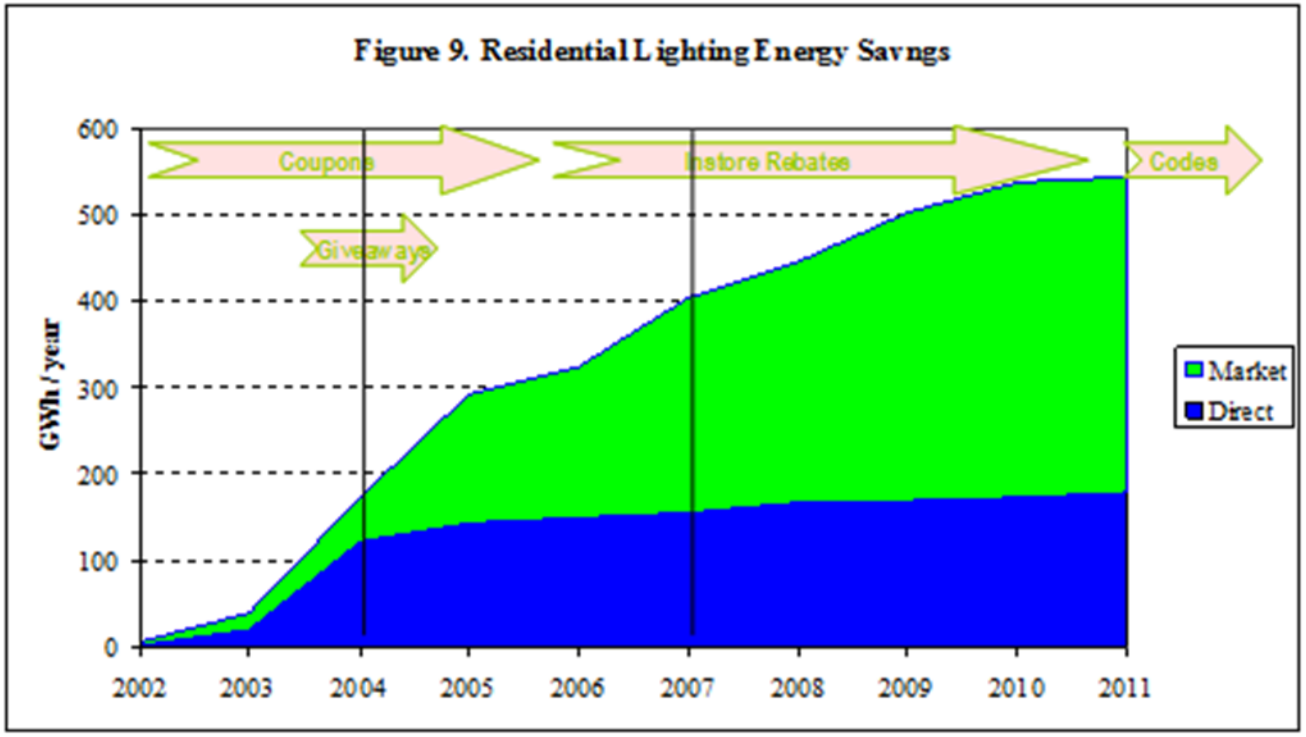
Market Transformation Assessment

- At the time of program launch, five barriers to residential lighting market transformation were identified. These were defined as follows
- **Availability** - availability refers to the quantity and variety of energy efficient lighting products available in the market
- **Accessibility** - accessibility refers to the relative share of lighting shelf space devoted to energy efficient lighting, as well as stocking behaviour and display characteristics
- **Affordability** - affordability refers to regular purchase prices, price discounts, and life cycle costs for energy efficient compared to other lighting products
- **Awareness** - awareness refers to customer and trade ally awareness of the characteristics, quality, costs and benefits of energy efficient lighting
- **Acceptance** – acceptance refers to customer and trade ally satisfaction and installation penetration of energy efficient lighting products

Market Transformation Assessment

Barrier	2002	2011
Availability	About 90 unique CFL models available for sale	Increase but an accurate estimate difficult because of very similar CFLs with different SKUs
Accessibility	CFLs made up about 6% of shelf space	CFLS made up about 24% of shelf space with additional 3% for LEDs
Affordability	Typical CFL price was $20.00 compared to typical incandescent price of $1.50	Typical CFL price was $4.50 compared to typical incandescent price of $1.00
Awareness	74% of survey customers aware of CFLs	95% of surveyed customers aware of CFLs
Acceptance	25% of customers had purchased at least one CFL	80% of customers had purchased at least one CFL

Market Transformation Assessment



Conclusions

- By the end of ten years, BC Hydro's residential lighting energy savings were more than 540 GWh per year
- For the first three years of the program, energy savings were primarily due to the direct impacts of incentives, but by the fourth program year, market impacts due to advertising and market transformation were dominant
- The number of CFLs increased from 0.4 per household in 2002 to 9.3 per household in 2011
- Evidence suggests that all five market barriers have been successfully addressed: availability has increased; accessibility has improved; prices have fallen; awareness has increased; and acceptance has increased.

Lessons Learned

- Evaluation practice in most areas of social science emphasizes the use of randomized controlled trails or experiments or where that is not feasible the use of quasi-experiments with a treatment group and a comparison chosen to be as similar to the treatment group as feasible
- Energy program evaluation is unusual in that gross are first estimated using engineering methods and then adjusted with a net to gross ration usually based on self-report surveys
- Psychological methods research suggests that self-report surveys can be subject to significant biases, which reduces the credibility of studies based on a self-report approach
- It is feasible to use a quasi-experimental approach to evaluate at least some DSM programs

Lessons Learned

- Using a quasi-experimental design requires considerable care in research design and implementation, since the comparison group should be as close as possible to the treatment group in terms of the relevant drivers of measure installation and use, but it should be subjected to a minimum and preferably to no similar program activities
- Commitment to the use of a quasi-experimental design involves a significant use of resources as costs for customer surveys and other related data collection efforts can easily be doubled compared to the use of the customer self-report method of assessing the net to gross ratio

Questions

isulyma@gmail.com

ken.tiedemann@bchydro.com