Exploring the factors affecting home energy retrofit adoption - a case study of the EcoENERGY retrofit program

Exploring the Factors Affecting Home Energy Retrofit Adoption – A Case Study of the EcoENERGY Retrofit Program

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Abstract:
In the wake of the global financial crisis, the Canadian government created the EcoENERGY Retrofit for Homes program with the stated goal of "Encouraging homes to become more energy-efficient, reduce emissions produced through energy use, and contribute to clean air, water, energy, and a healthy environment for Canadians." However, results varied considerably nationwide. An early review of this data suggests that retrofits were not adopted with spatial or temporal uniformity.

Population data on were obtained from the 2006 and 2011 censes and the National Household Survey; these were then matched with household pre- and post-retrofit data from the EcoENERGY Retrofit program. Multiple linear regression analysis of the retrofit adoption rate was conducted at the finest spatial resolution common to these datasets.

This preliminary analysis suggests that income, non-condominium properties, and high shelter costs (greater than 30% of household income) had a significant positive correlation with adoption of retrofit measures at a 99.9% confidence level. Meanwhile, renter-occupied units and participation in the workforce were negatively correlated. Seasonal variation was also observed, with the majority of retrofits occurring in winter months. Further, spatial variation at both the city and neighbourhood level suggests a greater degree of program customisation is required to ensure uniform building stock improvement.

The findings fit with an emerging pattern that grant programs can be effective at delivering high volumes of savings but have a limited market impact in the post-funding period; ~25% of energy advisors were laid off after the conclusion of the initial program end date of March 2011, tied to a sharp decline in the number of energy audits. This study reinforces the importance of the upfront cost barrier and consistent federal-level support. However, retrofit program design may need to provide different grants in different municipalities to address specific community needs.

Keywords:
Residential retrofit; energy efficiency; technology adoption; spatial/temporal considerations; retrofit grants

1. Introduction

In the wake of the global financial crisis, the Canadian government created the EcoENERGY Retrofit for Homes with the stated goal of: "Encouraging homes to become more energy-efficient, reduce emissions produced through energy use, and contribute to clean air, water, energy, and a healthy environment for Canadians."

The EcoENERGY program summary ran nationwide 2007-2012 in two stages (first stage concluded in March 2011). It offered over Can$1B in grants, up to Can$ 5,000 per household, for efficient heating appliances, insulation, windows, doors, air sealing, HVAC systems, and hot water heaters. The program required both pre- and post-retrofit audits in order to be eligible for a grant.

Energy advisors carried out home energy audits for over 600,000 single-family dwellings (SFD) or 7% of the Canadian stock, stimulating over Can$10B in economic activity.[1,2,3] Modelled estimates of energy performance of retrofitted homes suggest demand reductions of 20%, on average.[3]

However, results varied considerably nationwide. An early review of this data suggests that retrofits were not adopted with spatial or temporal uniformity. For example, the share of the existing single-family dwelling (SFD) stock that adopted retrofits differ substantially between cities (Figure 1).

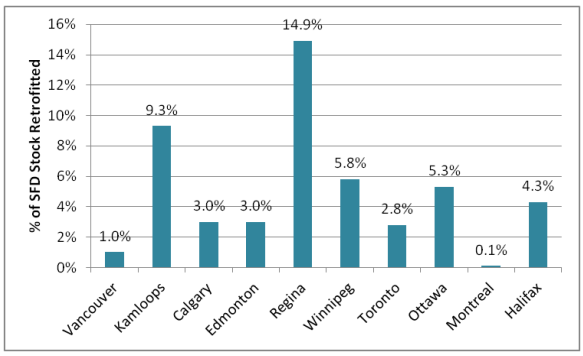

Figure 1: Percentage of SFD Stock Retrofitted during the ERfH Program

This study presents early results of spatially and temporally disaggregated information on retrofit adoption across Canada. This can be used to inform future retrofit programs, which are now being considered in a number of Canadian jurisdiction

2. Methods

In order for households to be eligible for EcoENERGY grants, pre- and post-retrofit audits were required. These audits were conducted by certified energy advisors who used energy demand modelling software (HOT2000) to determine the baseline and post-retrofit annual energy consumption. The modelling software considered house characteristics such as floor area, volume, local climate, in addition to energy-related installations. Location data (forward sortation areas, FSAs) were also provided by auditors.

The percentage of homes that completed a retrofit after the audit is termed the conversion rate, and serves as an indicator of the programs' ability to convert initial interest into energy efficiency retrofits. Studying conversion rate variation nationwide can reveal useful details to inform program design.

Population data on FSAs were obtained from the 2006 and 2011 censes and the National Household Survey[2,4,5]; these were then matched with household pre- and post-retrofit data. Statistical analyses at this stage have been limited to linear regression modelling, using R's native function.

3. Results and discussions

Variation in the conversion rate nationwide are plotted in Figure 2. At first glance, this suggests greater adoption (marked in green) in higher density areas, with lower density areas demonstrating lesser adoption (yellow to red). However, further examination of three major cities highlights non-uniform conversion within cities.

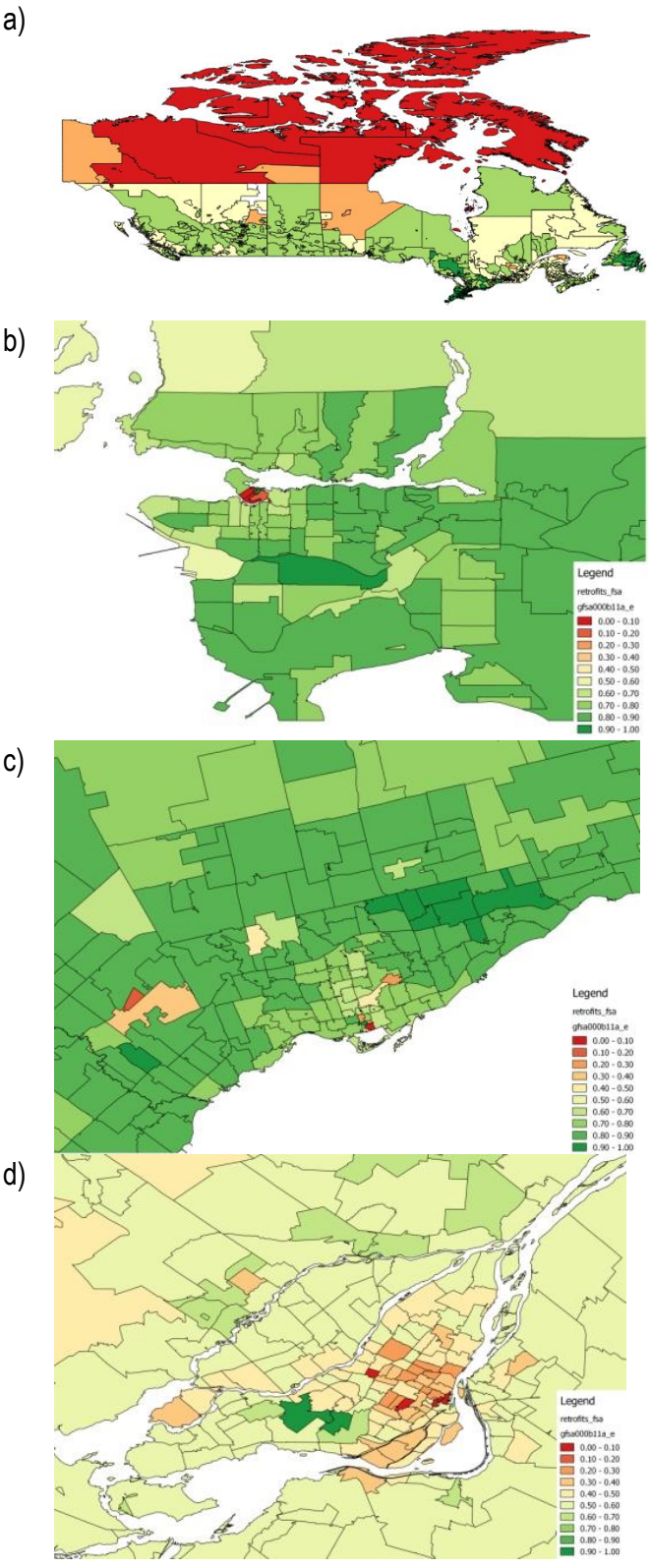

Figure 2: National and Selected Urban Conversion Rates for EcoENERGY Retrofit for Homes; a) Canada, b) Vancouver, c) Toronto, d) Montreal

An examination of temporal adoption patterns (shown in Figure 3) revealed that the majority of retrofits occurred during winter months, with the peak occurring in most jurisdictions at the end of the initial funding period.

Income, non-condo properties, and high shelter costs (greater than 30% of household income) had a significant positive correlation (99.9% confidence interval). Meanwhile, renter occupancy, property value and participation in the workforce were negatively correlated. Population density and post-secondary (even in STEM disciplines) were not significantly correlated.

Table 1: Multivariate Regression Results for Selected Variables Related to the Share of Single-Family Dwellings Retrofitted in all Canadian Forward Sortation Areas (n=1580; signif codes '***' = 0.001, '**' = 0.01, '*' = 0.05, '.' = 0.1, ' ' 1)

Variable	Pr(>|t|)	
Pop density	$1.94x10^{-1}$	
Income	$1.18x10^{-9}$	***
Post-Sec	$3.83x10^{-1}$	
Workforce	$3.47x10^{-15}$	***
Non-condo	$1.23x10^{-3}$	**
Housepoor	$7.24x10^{-4}$	***
Prop-value	$6.53x10^{-2}$	.
Rent-occ	$<2.0x10^{-16}$	***

The findings above fit with an emerging pattern that grant programs are simple and effective at delivering high volumes of savings but have a weak market impact in the post-funding period (~25% of energy advisors were laid off after the conclusion of the initial program end date of March 2011)[3].

There is a general movement away from this type of 'rebate only' program towards more comprehensive 'market transformation' retrofit programs. This program include elements of the latter approach (e.g., training for over 5000 energy advisors), but an internal evaluation states that ERfH would have been more cost effective if it had better engaged local partners.

4. Conclusions and outlook

This study reinforces the importance of the upfront cost barrier and consistent federal-level support. However, retrofit program design may need to provide different grants in different municipalities to address specific community needs. The next phase of this study is to use spatial and temporal disaggregation of selected technologies to help guide the next generation of Canadian retrofit programs.

Finally, the spike observed at the end of the retrofit resulted in a boom and bust cycle, which is symptomatic of grant programs.[3] This creates labour market volatility in the energy retrofit sector, rather than building a stable market from the ground up. Policies must select incentive levels to create demand growth that can be supported by the market, to avoid distorted price signals and encourage long-term plans for hiring energy assessors. Businesses and homeowners should be encouraged to develop continual improvement strategies for their energy efficiency retrofits, discouraging subsidy expectations.

Acknowledgements

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References

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