Recognizing Success:

Energy Efficiency, Energy Use and Greenhouse Gas Emission Performance in Canadian Homes: 1990–2010

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Canadian
Home Builders'
Association

A Note on Data Sources for this Report

This report draws on two primary data sources:

- The *National Inventory Report, Greenhouse Gas Sources and Sinks in Canada, 1990–2010*, was published by Environment Canada in 2012 under the terms of the U.N. Framework Convention on Climate Change.

- The *Comprehensive Energy Use Database* (CEUD) is compiled and maintained by Natural Resources Canada. The current version of the CEUD includes detailed data through 2009.

The two data sets have different end dates: aggregate national data through 2010 is available from the *National Inventory Report*, while the more detailed data in the CEUD covers the period ending 2009. Reflecting this, readers should note that variation in the dates cited in the report simply reflect these differences in the data sets.

In addition, the data presented in the section addressing energy performance in new homes was produced using HOT2000 V10.51 and housing specifications drawn from the EnerGuide Rating System database, as well as historic new home specifications drawn from Canadian Home Builders' Association (CHBA) and Canadian government archives.

Background

As a resource-rich and industrialized nation with a growing economy and population, Canada has been challenged to achieve meaningful reductions in the level of its greenhouse gas (GHG) emissions. According to Canadian government data, over 80% of our total GHG emissions are linked to energy use. As a result, achieving an actual reduction in emissions requires improvements in the efficiency of energy use at a rate greater than our economic growth.

To date, most of Canada's economic sectors, including transportation and commercial buildings, have not achieved such significant energy efficiency improvements[1]. However, the residential sector–comprising the homes that Canadians live in–has established itself as a leader in both energy efficiency and constraint of GHG emissions.

Energy Efficiency Trends in Housing

Between 1990 and 2010, greenhouse gas emissions from Canada's homes fell by 4.7%, while total Canadian emissions from all sources rose by 17.5%.

Over the same period, the number of homes in Canada grew by more than 3.6 million, or 35.6%. And the total area of Canadian homes increased by 48%.

Even with 35.6% <u>more</u> homes, the residential sector produced 4.7% <u>less</u> total GHG emissions than 20 years earlier–by any measure, an impressive accomplishment, and good news for the environment.

So how did this remarkable performance come about?

The residential sector's success in energy efficiency and GHG emissions since 1990 results from broad-based energy efficiency improvements in both existing homes and the new homes built each year. It reflects the efforts of new home builders and renovators to deliver better homes to their customers. And it has been supported, significantly, by government R&D efforts and energy efficiency programs.

This report tells the story of how this has happened.

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[1] See Chart Six, page 12 for specific comparative results

So How Much Have New Homes Changed?

Everyone knows that a new home built today is more energy efficient than one built in the past. But exactly how much more efficient?

In order to answer this question, a typical Ottawa-area home design from the mid-1970s was analyzed using the latest version of Natural Resources Canada's HOT2000 simulation software[2].

This archetype home, represented in Figure One, was very common in the region at that time. Often referred to as a "four-square", it provides about 2,100 square feet of above-ground floor area on two storeys. Original construction specifications for the home were obtained from the CHBA's archives.

Analysis determined that the home, as originally built in 1975, would consume 343.2 GJ of energy per year, for all uses.

The same home was then analyzed based on current Ontario Building Code requirements[3], with specifications to the building envelope, and mechanical equipment (i.e., furnace, water heater and ventilation) changed to reflect performance requirements in the current Ontario Building Code, but not beyond.

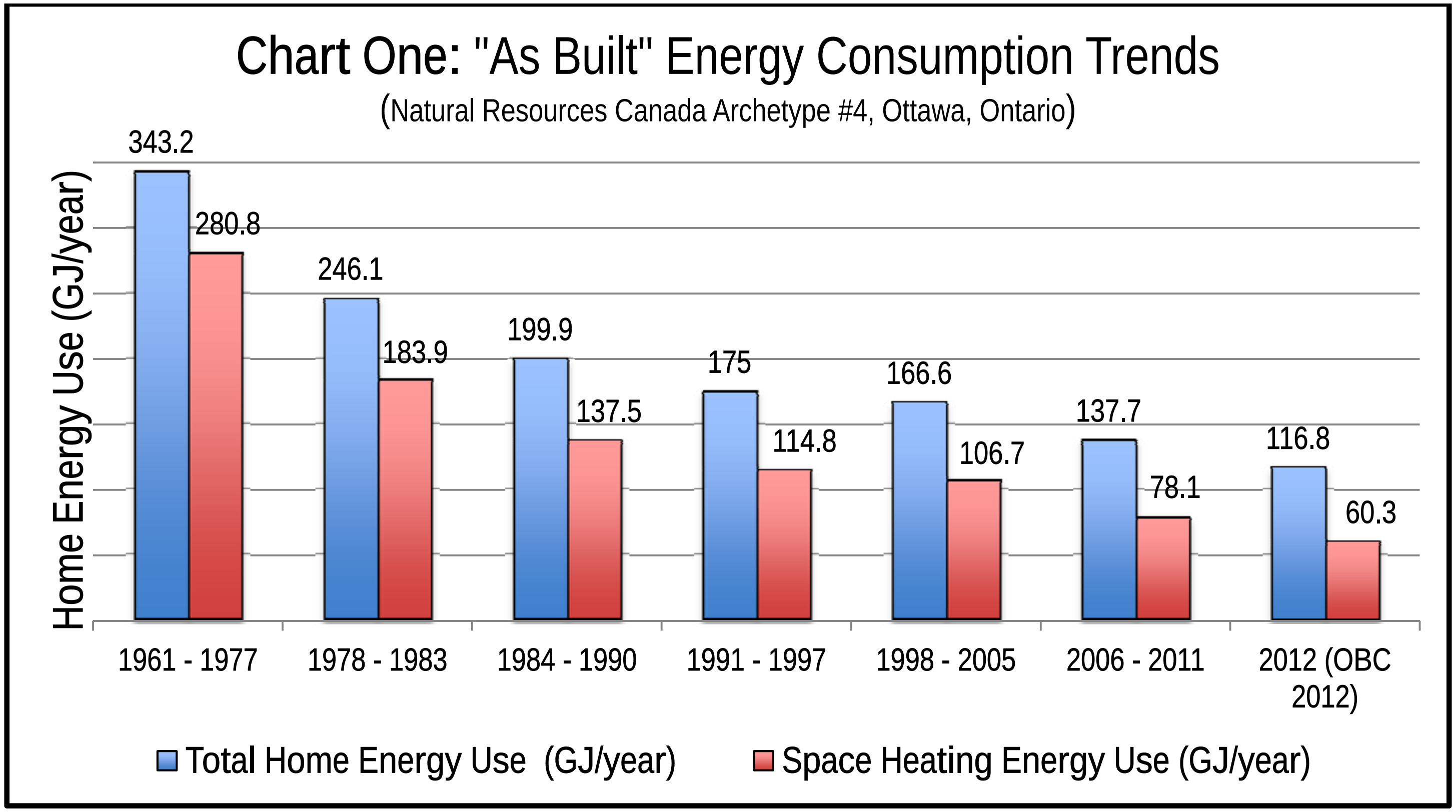
Figure One: Archetype house in Ottawa

[2] HOT2000 v10.51

[3] Ontario Building Code, 2012

The “2012 version” of the home would require just 116.8 GJ of energy per year–66% less than in the original home, as built in the mid-1970s. Energy required for space heating alone fell even more–by 78%.

Chart One illustrates how the energy performance of the archetype home evolved between the mid-1970s and 2012, based on common construction practices at different times.



Source: CanmetENERGY, Natural Resources Canada, 2012

The bottom line on this “apples to apples” comparison? In the case of the Ottawa analysis, an identical home built today would use only one-third as much energy as one built less than 40 years ago.

That’s how much new homes have changed.

The energy efficiency improvements in the residential sector reflect change both in the efficiency of the house envelope itself, and in the various energy-consuming devices used by Canadians everyday.

The process of continuous improvement resulted from the efforts of builders to provide their customers with high-quality, comfortable homes. It was made possible through the ongoing collaboration of the home building industry with key government researchers, particularly with Natural Resources Canada, Canada Mortgage and Housing Corporation, and the National Research Council of Canada. And it was supported through evolving equipment performance standards, particularly related to natural gas furnace efficiency.

Significantly, energy performance requirements in building codes have tended to lag behind actual performance improvements in new homes, rather than to cause these improvements.

Through the 1990-2000 period, government-supported R&D, technology demonstration projects and specific programs aimed at homeowners and home buyers have helped transform the marketplace and make Canadian housing a world leader in energy performance.

In addition to improvements in new home performance, a parallel process of continuous performance improvement within the existing housing stock–through renovation and retrofitting of equipment–is also well-established and significant.

Other Relevant "Apples to Apples" Comparisons

To put the energy efficiency improvements achieved in new homes into context, it is useful to compare them with automobile fuel efficiency gains over a similar time period.

In relation to cars, such "apples to apples" comparisons are more challenging, as few specific car models have been in continuous production over this period, and data from the mid-1970s is either unavailable, or unreliable. To provide some sense of the comparative picture, USEPA fuel efficiency ratings from 1985 and 2012 were assessed[4], and comparable ratings for a number of common cars are presented in Table One.

Table One: Changes in Specific Car Model Fuel Efficiency: 1985 - 2012

Manufacturer/ Model	1985 US EPA Combined Fuel Efficiency	2012 US EPA Combined Fuel Efficiency	Percentage Improvement 1985 - 2012
Chevrolet/Impala	19 MPG	22 MPG	15.8%
Ford/Mustang	20 MPG	23 MPG	15%
Honda/Accord	26 MPG	27 MPG	3.8%
Toyota/Corolla	27 MPG	29 MPG	7.4%

Source: United States Environmental Protection Agency (USEPA), 2012

As the EPA data make clear, the "apples to apple" improvement in automobile fuel efficiency has been significantly less than the energy efficiency achieved in new homes, where a 66% improvement was calculated.

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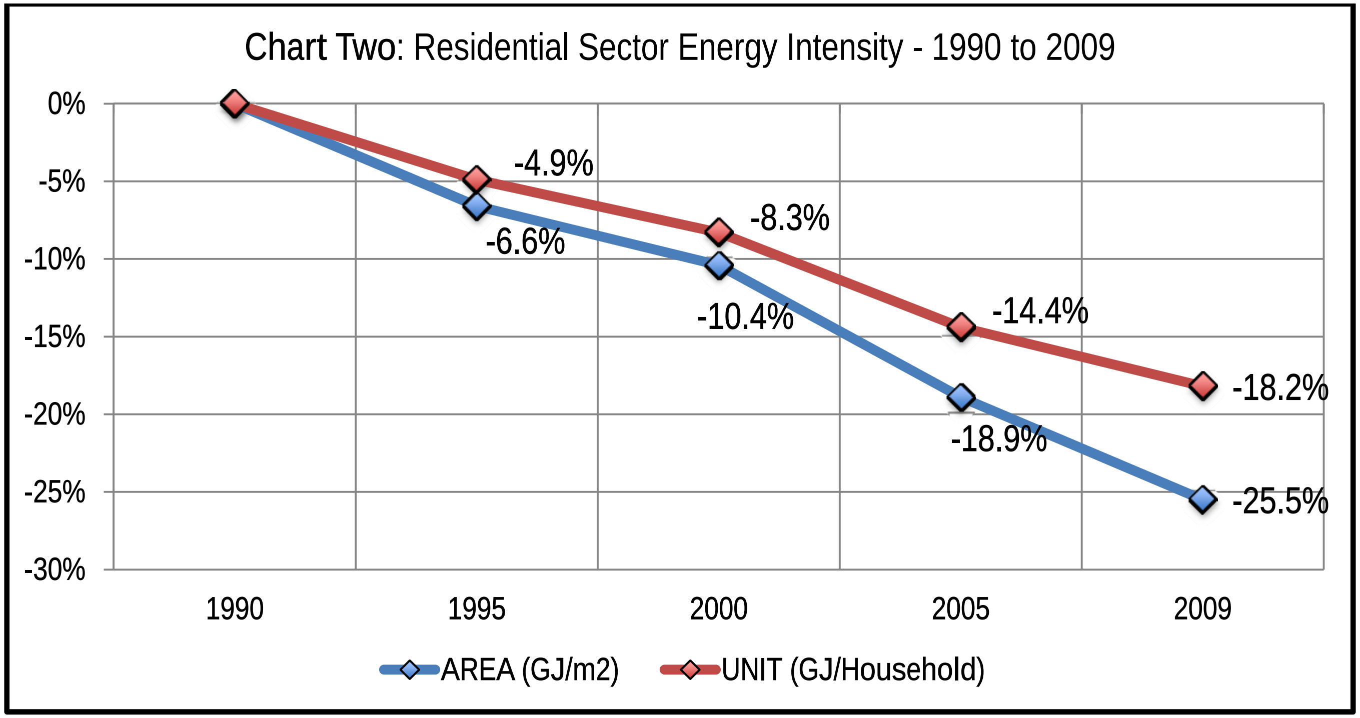
[4] U.S. EPA mileage data can be found at http://www.fueleconomy.gov/
For the car models listed in our comparison, similar 'base model' specifications were selected. These were as follows:

- Chevrolet Impala: 1985 model – 6 cylinder/4.3 litre engine, 4-speed automatic transmission. 2012 model – 6 cylinder/3.6 litre engine, 6-speed automatic transmission.
- Ford Mustang: 1985 model – 4 cylinder/2.3 litre engine, 3-speed automatic transmission. 2012 model – 6 cylinder 3.7 litre engine, 6 speed manual transmission.
- Honda Accord: 1985 model – 4 cylinder/1.8 litre engine, 3-speed automatic transmission. 2012 model – 4 cylinder/2.4 litre engine, 4-speed automatic transmission.
- Toyota Corolla: 1985 model – 4 cylinder/1.6 litre engine, 4-speed automatic transmission. 2012 model: 4 cylinder/1.8 litre engine, 4-speed automatic transmission.

Overall Residential Sector Energy Efficiency Performance

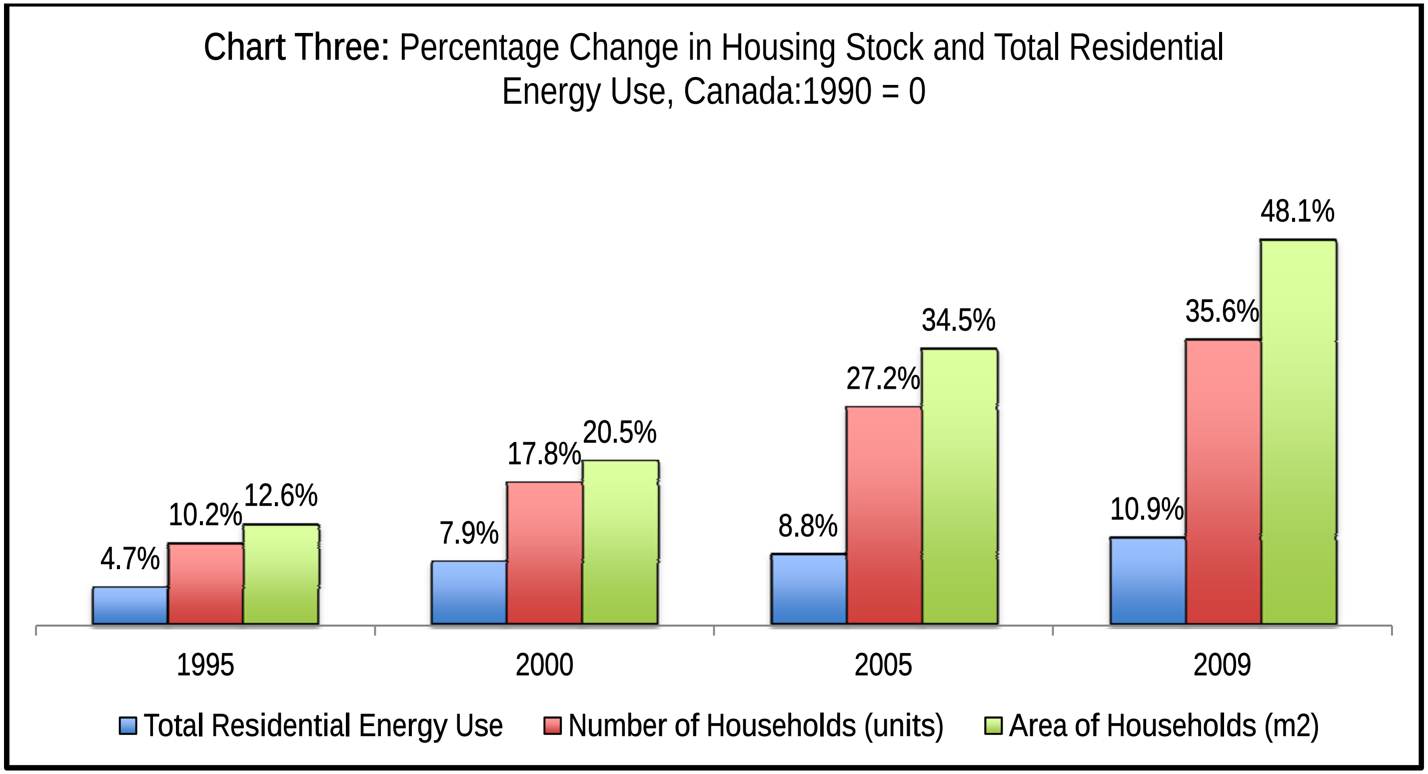
Chart Two tracks changes in the energy intensity of Canada's residential sector from 1990 to 2009, and includes all homes in residential use in a given year. Energy intensity (the inverse value of efficiency) is illustrated on both an area and unit basis to reflect the evolution in the average size of homes over the period.



Source: *CEUD*, Natural Resources Canada, 2012

As shown, on a per-unit basis, Canadian homes were some 18.2% more energy efficient in 2009 than in 1990. On an area basis, energy efficiency gains were 25.5%.

Chart Three shows changes in both the stock characteristics and total energy use of Canada's homes at five-year intervals over the 1990-2009 period.



Source: *CEUD*, Natural Resources Canada, 2012

As Chart Three illustrates, gains in energy efficiency have meant that the growth in the number and total area of Canadian homes has significantly outpaced growth in the amount of energy used by the residential sector. By 2009, the total area of Canadian homes had grown by 48.1%, while total energy use grew by just 10.9%.

It is important to bear in mind that these results represent the "fleet average" of Canada's housing stock–the performance of <u>all</u> homes, both existing homes and the new homes added to the stock each year. Improvements in the energy performance of new homes, as discussed previously, have been much greater.

Unlike most other energy-consuming products, the energy efficiency of a home is not fixed at the time of construction– subsequent improvements to the building envelope, systems and equipment within the home can alter its energy efficiency characteristics significantly.

As a result, the 18.2% improvement in the energy performance of the average home has come about due to a number of factors:

- Many older home envelopes have been upgraded with the addition of insulation and the replacement of older windows with newer, more efficient ones.
- New homes are constructed to be far more energy efficient than in the past, resulting in smaller increments of energy demand per unit of new housing.
- Space heating systems have become far more efficient, particularly the natural gas-fired systems that are used in the majority of Canadian homes. As older heating systems are replaced, space heating efficiency increases. Space cooling systems have also seen significant energy efficiency improvements.
- Most white goods (refrigerators, washers, dryers and other appliances) have seen very significant improvements in their energy efficiency over the last decade or more. As these major appliances reach the end of their useful lives and are replaced, home energy performance improves.

Table Two: Evolving Energy Performance in Older Existing Homes in Canada

Vintage	“As Built”	“As Found”	Post ecoEnergy Grant
1961 - 1977	ERS 41	ERS 63 (+28.7%)	ERS 72 (+44.5%)
1978 - 1983	ERS 57	ERS 66 (+20.8%)	ERS 74 (+38.9%)
1984 - 1990	ERS 65	ERS 69 (+11.5%)	ERS 75 (+28.2%)

Source: CanmetENERGY, Natural Resources Canada, 2012

To provide further insight into how the energy performance of older homes has evolved, data generated by Natural Resources Canada’s EnerGuide Rating System (ERS) was analyzed for the Ottawa-area “Archetype Four” home cited previously. This data provides three energy performance values for different construction periods. The first value, “As Built”, represents the archetype house energy performance when constructed. The second value, “As Found”, represents the energy performance as measured by ERS evaluation prior to energy retrofitting under the ecoENERGY Home Retrofit Program. The third value represents the energy performance achieved following ecoENERGY grant improvements.

What these data make evident is the magnitude of efficiency improvements that occur on a home over time. In Table Two, performance measures are presented in the form of the home’s ERS rating and as the percentage improvements from its original construction performance.

Residential Sector Greenhouse Gas Emissions

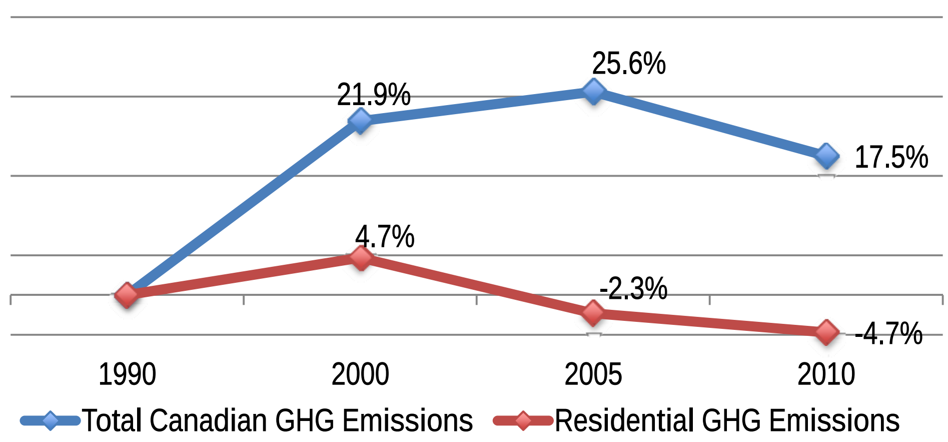
Over the last decade, Canada has participated in two international agreements aimed at addressing climate change by cutting the greenhouse gas emissions linked to this problem.

The first of these, the *Kyoto Protocol*, committed Canada to reducing its greenhouse gas emissions to the level produced in 1990, between 2008 and 2012. As indicated in Chart Four, our nation was unsuccessful in this effort, and Canada has since withdrawn from the *Kyoto Protocol*.

However, success in constraining GHG emissions varied considerably among various economic sectors in Canada.

The performance of the residential sector was particularly noteworthy: by 2010, GHG emissions from Canadian homes had fallen by 4.7%, close to the original Kyoto target. This was achieved in spite of more than 35% growth in the total number of homes in Canada.

Chart Four: Percentage Change in GHG Emissions Since 1990 (1990 = 0)



Source: *National Inventory Report, Greenhouse Gas Sources and Sinks in Canada, 1990 – 2010*, Environment Canada, 2012

In contrast, during this same period, Canada's total GHG emissions rose considerably.

In 2010, Canada became a signatory to the *Copenhagen Accord*, with a new GHG reduction target of 17% below 2005 levels by 2020.

Based on Canada's government-reported total GHG emissions in 2005, this new target is 14.6% above the previous Kyoto goal, and will be met 8 years later.

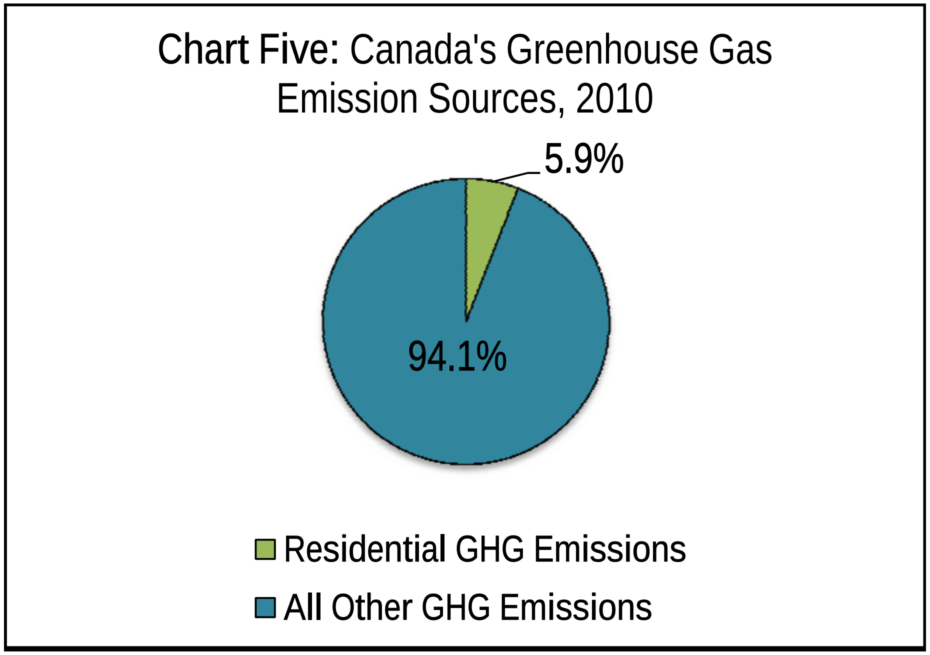
Between 1990 and 2010, the residential sector's share of Canada's total GHG emissions fell steadily, from 7.3% of the total in 1990, to 5.9% in 2010.

This improvement came about through energy efficiency gains in both new and existing homes, and was largely the result of consumer choices made in a competitive marketplace.

This was a voluntary process driven both by Canadians' desire to live in more comfortable homes and have lower monthly operating costs, and the home building industry's drive to deliver such benefits.

Ongoing incremental improvement in the energy performance of homes, generated by innovation, can be expected to deliver additional GHG reductions in the coming years.

However, given that total GHG emissions for Canada's more than 13 million homes accounted for less than 6% of our nation's greenhouse gas emissions by 2010, these reductions can make only a modest contribution to meeting Canada's overall GHG reduction obligations.



Source: *National Inventory Report, Greenhouse Gas Sources and Sinks in Canada, 1990 – 2010*, Environment Canada, 2012

Other economic sectors, particularly those that have so far failed to contain growth in their energy use and GHG emissions, will need to follow the example set by Canadian homeowners and the home building industry.

Greenhouse Gas Emission Results, 1990-2009

As of the end of 2009, the residential sector continued to be a leader in terms of constraining greenhouse gas emissions.

Over the 19-year period since 1990, residential GHG emissions fell by 5.4%. With the exception of emissions from the agricultural sector, this represents the only net decrease in emissions by any economic sector.

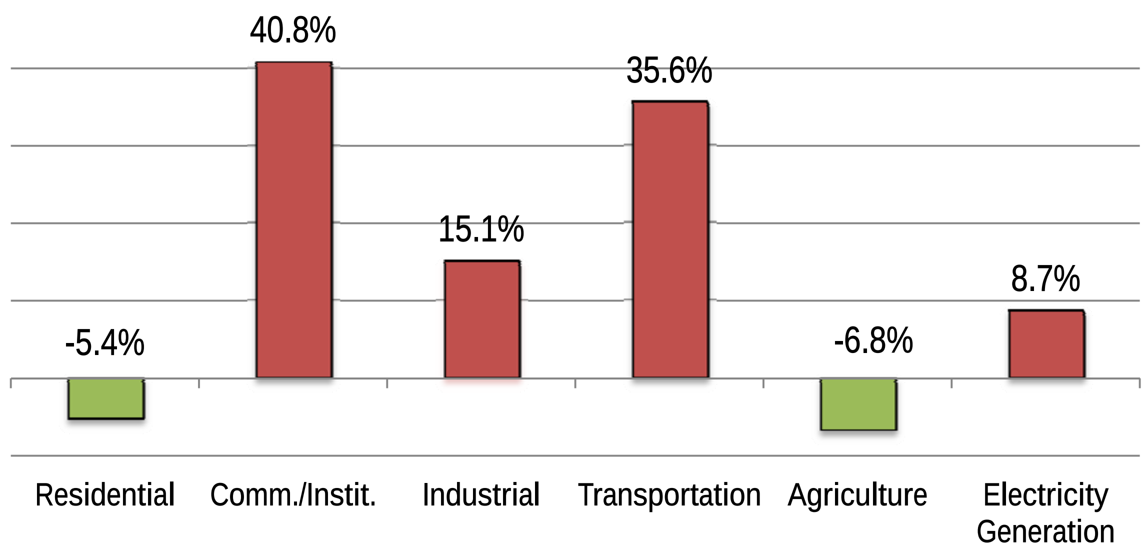
Of particular note is the contrast between the performance of residential and commercial/institutional buildings sectors.

As of 2009, Commercial/institutional buildings had seen GHG emissions grow by 40%.

In contrast, residential emissions had decreased by over 5%.

These results cannot be explained through differences in growth over the period–quite the opposite:

Chart Six: Percentage Changes in Greenhouse Gas Emissions, by Sector, 1990 - 2009



Source: *CEUD*, Natural Resources Canada, 2012

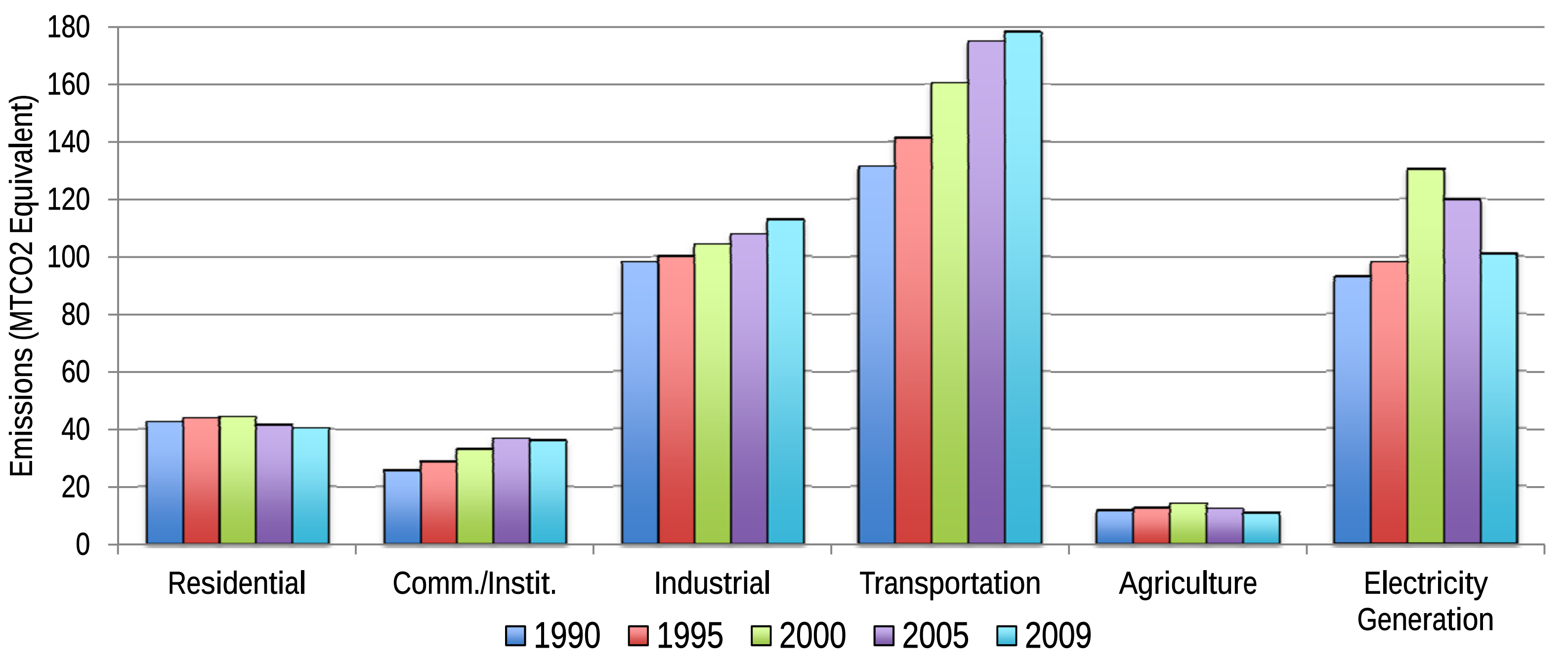
- From 1990-2010, growth in total area of all homes outpaced growth in the commercial/institutional sector. The total area of all homes increased by 48% while commercial/institutional buildings saw a total increase in floor area of only 39%.

- This performance difference resulted from a sharp 25% improvement in the energy efficiency of Canada's residential housing stock (on an area basis), in contrast with a mere 1% increase in the energy efficiency of commercial/institutional buildings.

Chart Seven presents GHG emission trends for all of Canada's economic sectors. This provides insight into both the comparative performance of each sector, and the overall magnitude of their emissions.

In relation to buildings, the residential and commercial/institutional sectors had roughly similar total emissions in 2009, however the residential sector accounted for some 1,789 million m^2 of floor area, while commercial/institutional buildings accounted for only 709.5 million m^2 of area–60% less.

Chart Seven: Trends in GHG Emission, by Sector, 1990 - 2009



Source: *CEUD*, Natural Resources Canada, 2012