Walter G Booth School of Engineering Practice

Inquiry into

Policies for driving reduced Green House Gas (GHG) emissions behaviour in individuals

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Abstract

Despite the severe threat of climate change, and a high awareness of the issue, the Canadian public is not engaged in reducing their greenhouse gas (GHG) emissions. This is an inquiry into effective ways of driving individual behaviour to reduce GHG emissions based on insights from readings in behavior economics and environmental economics, review of numerous surveys on the topic, best practices in other countries, and interviews with professionals in behavior change and sustainable energy.

Personal transport, home heating and home electrical use were selected as examples, with existing policies and technologies evaluated to see where the barriers to changing behavior exist. It is concluded that in order to drive significant behavior change in reducing personal GHG emissions, some technology innovations and revisions to supporting regulations and other government policies are needed. Several policy revisions are drafted with plans to submit to the appropriate authorities.

An electricity conservation group in a Hamilton neighborhood will be a real-life experiment in identifying barriers to conservation behavior, proposing solutions and potentially providing a blue-print for scaling-up behavior change to a broader audience. Together this should provide a plan for instigating greater personal behavior change to reduce GHG emissions.

Keywords: behavior, climate change, policy, transportation, energy, electricity

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Contents

1 Introduction

Despite the severe threat of climate change, and a high awareness of the issue, the Canadian public is not engaged in reducing their greenhouse gas[1] (GHG) emissions. It appears that even people affected by extreme climate events such as hurricanes, wildfires or flooding do not take action (Whitmarsh & O'Neill 2011). Technological innovations such as renewable energy and electric vehicles are not solving the problem because people have yet to change their behaviors and adopt these new technologies in large numbers. There are many government programs for industry that are having success[2], perhaps because businesses make rational economic decisions (Gowdy 2008). Meanwhile, success in reducing personally controlled emissions is lagging. A key question is: Is this an individual problem or a problem for the state to fix? I suggest that government has a major role to encourage behavior change through effective policy.

In many developed nations such as Canada, over one-third of the CO_2 emissions come from private travel and domestic energy use (Whitmarsh & O'Neill 2011), so individuals and communities in these countries have a significant role to play. It is valid, therefore, for energy conservation policies to address individuals. Policies often use economic tools such as rebates for purchase of energy efficient products including vehicles, but these policies have not effectively instigated long-lasting, durable behavior changes. Trends show emissions from transportation and individual household electrical use are increasing, and Canada is not close to achieving its Copenhagen targets in emissions reductions (Environment Canada 2012); Canada's emissions are predicted to be 720 million tonnes (MT) in 2020 compared to the 607 MT target.

[1] In this paper the GHG gas focused on is carbon dioxide (CO_2).
[2] (Trottier nd) contains strategies for industry to reduce energy use by 80% by 2050.

It is postulated that policies for changing behavior in the environmental realm could benefit from research in behavior economics and environmental economics for effective drivers and techniques. The potential for behavior change is limited, however, if there are barriers created by current infrastructure and existing policy. Barriers exist where residential communities are designed to cater to automobiles, and subsidies to oil and gas companies keep gasoline prices low, and do not reflect the externalities of fossil fuel use. How drivers and techniques for changing behavior can be exploited is illustrated with examples from individual transport and energy consumption. An initiative to explore behavior changes using a small group in a real world application and bring these changes and lessons into the broader public realm is presented.

The total CO_2 emissions including industry, business and personal emissions from thirteen developed countries plus the European Union (EU) are shown in Table 1, based on National Inventory Reports (NIR) to the International Panel on Climate Change (IPCC) (UNFCCC 2012). To estimate the per capita CO_2 emissions, the country reported emissions value was divided by the population, then by 3, to estimate personal emissions[3] (Appendix A). Canada's annual CO_2 e emissions are about 700MTe (Env Can 2012a, b), assuming 30% (230MT) from personal emissions, this is 7T per capita, which places Canadians personal GHG emissions second highest on this list.

Other developed countries have had varying degrees of success in reducing GHG emissions (Talbot 2012, Nakagami 2008). One explanation for the range of 1.2-8.5T may be the source of energy and driving habits. For example France, with a large percentage of nuclear power (WNA 2013) has a low individual footprint of 2.5T despite high heating and electricity

[3] Assume 1/3 commercial, 1/3 industry, 1/3 personal

use, and Japan with fewer kilometers per capita is at 3.1T. Sweden makes extensive use of district heating and heat from waste (SEA), and the market share of renewable power in Germany is 10% (Frendel 2005). The UK has implemented a Climate Change Act with carbon budgets set in law (Ref). Canadian emissions reduction policies could learn from successes in other countries.

Table 1: Global Emissions Profiles per Year [4]

country	Total - E	Individual footprint[5], E/P/3	Transport[6]		Home electrical use[7]	Home Energy per household [8]
	MTs	T	km/person	T/person	kWh/cap	GJ
US	5747	6.06	14,853	5.1	13,394	101
EU	4409	1.99	n/a	n/a	n/a	n/a
Russia	1555	3.62	369	0.85	6,430	n/a
Japan	1184	3.11	7,193	1.7	8,394	41
Germany	953	3.97	11,347	1.7	7,215	74
Canada	763	7.27	15,266	3.9	15,137	106[9]
UK	590	3.12	12,090	2.0	5,733	23[10]/
Australia	581	8.42	13,357	3.2	10,286	53
France	496	2.50	12,190	2.0	7,728	74
Spain	327	2.30	8,969	2.2	6,155	n/a
Sweden	32	1.19	11,803	2.3	14,939	14.420[11]
S. Korea	n/a	n/a	4,217	1.7	9,744	59
China	n/a	n/a	n/a	n/a	2,943	18
Italy	445	2.43	14,688	2.0	5,384	n/a

The Kyoto Protocol Implementation (KPI) Act was passed in 2007 and repealed in June 2012. Although Canada withdrew from the Kyoto Protocol in 2012, Canada remains a signatory of the United Nations Framework Convention on Climate Change (UNFCCC) and is required to

[4] http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/6598.php
[5] assuming 1/3 personal, 1/3 industry and 1/3 business
[6] IEA Transport 2009 data and trends, Ch 5 ITF Reducing Transport GHG Emissions, pp 205-271
[7] Electric Power from UNFCCC Individual Country reports
8 From individual country reports, and Nakagami Fig 5
[9] 7,000 kWh
[10] Reference 6294 kWh
11 Reference 35.8 TWh for 9 million people

report annually on GHG emissions (UN FCCC 2012). The federal government developed "A Climate Change Plan for the Purposes of the Kyoto Protocol Implementation Act"(Env Can nd d) with 20 federal government initiatives, most of which ran from 2007 to 2011; some, such as automobile fuel efficiency standards are ongoing and others such as rebates, continue on at the provincial level. Canada is "associated with" the Copenhagen Accord with emission targets of 17% below 2005 levels by 2020[12].

Government entities involved in reducing GHG emissions worldwide are shown in Appendix F, led by the UN FCCC. In Canada, Natural Resources Canada (NRCan) is responsible for electricity conservation programs in the Climate Change Action Plan. Statistics Canada obtains data on energy use and Environment Canada monitors, trends and reports emissions. Many environmental groups and think tanks contribute to GHG emissions policy.

2 Methodology

The literature on changing environmental behavior was reviewed. Numerous surveys that have been conducted in these areas include: Transport Canada's compendium of surveys on sustainable transportation (Tables B2, B3, B4 Appendix B), NRCan's REAT survey (Parekh & Wang 2012) on electricity use in 700 homes, Ontario Power Authority (OPA 2009, 2012 a,b,c, nd a) surveys on consumer attitudes and behaviors towards energy conservation, and other surveys from across Canada (Wolf 2011). Foreign electricity use surveys include: the UK (Defra 2011) and Forsa in Germany (Frendel 2007). With many relevant surveys available, additional surveys were not considered necessary for this inquiry.

Some studies interviewed members of grassroots environmental groups such as Carbon Reduction Action Groups (CRAGs), to identify factors preventing behavior changes and ways to

[12] http://www.climatechange.gc.ca/default.asp?lang=En&n=4D57AF05-1

encourage change (Todhunter 2011 Davidson 2011). Researchers studying these groups sought to learn about the group experiences, if they have successfully made behavior changes, get opinions on their motivation and see what role, if any, being part of a group plays ().

Interviews were held on the subjects of changing behavior (D. Campbell), sustainable living and economics (E. Jelinski) and District Energy Systems (F. Carou).

3 Changing Behavior

To achieve behavior change, drivers, techniques, policy tools and barriers[13] need to be identified. Changing habitual behavior is acknowledged to be very difficult (Verplanken 2011). Some success has been achieved with interventions directed at times of change when habits are more amenable to modification. Traditional drivers are: knowledge, information or awareness, financial incentives, sense of duty or guilt, or negative comparisons (Rabinowich et al 2011). These drivers have been tried on environmental related behavior but with limited effect, as people do not always make rational economic choices (Gowdy 2008, Shogren 2008), and resist changes in behavior that are counter to mainstream behavior or that reduce comfort or convenience.

One of the primary drivers for changing behavior is awareness. Surveys show (TC 2009) that a majority of Canadians are aware of climate change, are concerned, and know they need to modify their behavior. Most have taken some action to reduce the GHG emissions for which they are personally responsible, and agree that there is more that they could do. This high state of awareness has not, however, translated into effective action, as indicated by increasing emissions from transportation and residential electricity use (Env Can 2012b).

[13] EU Technical Report EEA No 5/2013

Another important driver is engagement. Many people have 'picked the low hanging fruit' but the next level of change requires modifying habitual behavior, such as reducing driving, or involves additional time, effort or cost, such as installing home insulation, and requires a higher level of engagement (Hoppner 2011, Wolff 2011).

Financial drivers are not effective in changing environmental behavior unless they are significant, and "monetizing" environmental behavior can be demotivating (Gowdy 2008). Financial incentives may promote self-interest, and discourage behavior in the public interest (Rabinowich et al 2011). Assuming that individuals will choose the most economic option is a fallacy. If green behavior will increase wealth, people may not chose it (Venkatchalam 2008) if the choice involves extra effort (status quo bias[14]), detracts from current comfort or convenience (endowment effect[15]), or deviates from social norms of behavior. Conversely, if green behavior will decrease wealth, people may choose it anyway if it complies with social norms, provides positive emotional feedback or is perceived as mandatory and effective. Rebound effect[16]

Using negative comparisons with others to create a sense of guilt is ineffective as a driver to change environmental behavior. People will change more readily if they already see themselves in a positive light, as environmentally responsible (Rabinovich et al 2011). Feeling guilty may lead to internal conflict in which they understand what they should do, but do not act.

People are driven to conform to social norms and will adopt behavior that is perceived as mainstream even if it is costly or inconvenient. So if they are involved with a group or

[14] Status quo bias is related to loss aversion as individuals want to remain at the status quo, because they see disadvantages of leaving it.

[15] In behavioral economics, the endowment effect is the hypothesis that a person's willingness to accept (WTA) compensation for a good is greater than their willingness to pay (WTP). This is due to the fact that once you own the item, forgoing it feels like a loss, and humans are loss-averse.

[16] The Rebound effect in conservation and energy economics refers to the behavior response to new technologies with higher efficiency and cost of use. For example, the direct rebound effect is operating when a person increases consumption of a good such as driving more or leaving lights on because of the lower cost of use of fuel efficient cars and energy efficient lights.

community where green behavior is the accepted social norm, they more readily adopt it (Rabinowich et al 2011). Social media can be effective in making green behavior mainstream, particularly if used by high profile organizations[17]. Advertising can make green behavior the new social norm. In these cases, people voluntarily change their behavior in order to 'fit in', not to 'save the environment' (Allcott & Mullainathan 2010).

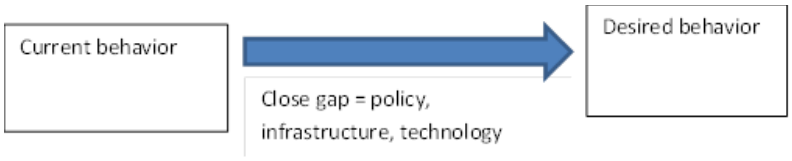

Figure 1

Techniques to change behavior are: informational, positive motivational or coercive motivational. Informational techniques are: telling people why and how they should change, self-discovery or value change, or direct experience (deYoung 1993). Self-discovery and direct experience could entail participating in experiments such as metering, or do-it-yourself projects, and have been shown to lead to deeper and longer lasting behavior change and to enhance the creativity of solutions and increase engagement (deYoung 1993).

Positive motivational changes may be extrinsic, involving money or social status, or intrinsic. Intrinsic motivation also leads to more innovative solutions and longer lasting change (deYoung 1993). Coercive techniques such as regulation constrain the behavior choices and mandate participation, and can involve monetary disincentives such as taxes, social disincentives such as peer pressure, or physical barriers such as High Occupancy Vehicle (HOV) lanes or banning certain products. However coercion can create anger, which may be more paralyzing than motivating (deYoung 1993).

[17] such as the David Suzuki Foundation, or the World Wildlife Fund

Third Sector Organizations are non-government, non-business organizations such as civil society, and they can be effective in raising awareness, encouraging collective action and developing new social norms (Buchs 2012). Collective action can be more effective than individual action in tackling barriers such as policy and infrastructure. Difficulties arise, however, when trying to translate small group changes to the broader public (Davidson 2011).

Green behavior is a shared responsibility between the public, government and industry and is not just the responsibility of the individual (Paterson & Stripple 2010); it requires enabling infrastructure and technology to be successful. Environmental problems have been created by the state through infrastructure such as cities and suburbs designed for the car, a dependence on fossil fuels and a goal of increasing Gross Domestic Product (Davidson 2011). People are locked into the structure of the life they have built that determines their patterns of behaviors, for example living in suburban neighborhoods far from places of work or shopping. Policy has a major role to play in removing these barriers to allow behavioral change.

There are four types of policy tools: economic, information, behavioral and regulatory (EuC 2012). Economic policy tools are market based instruments such as taxes and subsidies; these are not very effective in influencing environment related behavior, as people tend not to make rational decisions[18] according to neoclassical economic theory when making environmental related decisions (Gowdy 2008). "In reality, environmental decisions are made with too little time, too much choice, or procrastination, and are based on mental shortcuts or heuristics using anchoring, loss aversion, and the status quo bias" (EuC 2012). In fact this is what is wrong with much current policy; it assumes that individuals make rational decisions and does not recognize the strong influence of social and personal norms, and effects such as the

[18] "Rational decisions involve rational preferences, maximizing outcomes, and acting independently on the basis of full information and conscious deliberate thought" (Gowdy 2008).

status quo bias. Policy assumes that if a subsidy or coupon is provided, people will purchase the technology or service although they may not have the time or inclination to use it.

Policy that provides information may be somewhat effective in changing behavior (Paterson & Stripple 2010, Wolf 2011). Some recent initiatives that raise awareness are carbon "footprints" and carbon "diets". A carbon footprint can be measured using one of many available calculators and compared to others; some tools also provide advice, ideas and services (Paterson & Stripple 2010). Knowing their carbon footprint may make people reflect on their carbon emissions and realize the changes that small behavior adjustments can make. Technology such as fuel efficiency gauges, smart meters, monitors and displays will help with behavioral change to reduce ones carbon footprint, as people respond to feedback such as mile markers in race, or position numbers in a queue if the number currently being served is displayed (Fischer 2008). The type of information that might be most effective is: direct and continuous feedback on current GHG emissions, how changing behavior can have a significant impact, what alternative technologies are available, and skills to implement some energy saving changes

Policy designed to change behavior includes 'influence tools' or 'nudges'. Small group initiatives such as CRAGs make the green practices of others visible (Paterson & Stripple 2010). Car free days can make other modes of transport the 'social norm', at least for a day, a "nudge" (Lawton 2013).

Regulatory policies are limits or bans on behavior or products, efficiency standards, or price regulation, and work best if there is a tangible benefit for the regulated[19] (Oye & Maxwell 1994) and when there are alternatives. Regulations can make green behavior the default.

[19] Olsonian costs from a few, benefits to many; Stiglerian - costs from many, benefits to a few.

4 Results

Three examples in the areas of personal transport, home heating and home energy use are discussed to illustrate the above concepts on changing environmental related behavior.

4.1 Example 1 - Personal Transport Behavior

The average Canadian driver travels 17,000 km/year which is among the highest in the world, Table 1. Fuel is almost entirely carbon based petroleum, so the average Canadian car emits 4T CO_2[20] (Appendix B). Emissions from Canada's 14,000,000 personal cars are about 56MT or 45% of Canada's overall transportation emissions (Bromley 2005).

The desired behavior change is for people to drive less by using carpools, car sharing, taking transit, using non-motorized transport such as cycling or walking, or adopting telework or alternative work arrangements. These behaviors are not widely embraced in Canada for various reasons. Carpools or car shares lack flexibility. Public transit is limited, especially in rural areas. Bus transport is seen as a sign of low income, so if gas prices increase, the affluent tend to cycle before they take the bus (TC 2009). There is a perceived lack of safety and risk of theft in bicycling, Canada's climate makes it is difficult to cycle year round, and urban design favours use of the automobile over cycling or walking. Finally drivers are often trapped into certain behavior by the lack of viable alternatives.

To reduce excessive emissions per vehicle, inefficient driving habits such as idling, driving older or less fuel efficient cars, and driving at congested times should be minimized (TC 2009). These behavior changes are constrained by lack of knowledge (e.g. idling), technology

[20] CO2e A metric measure used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP). Carbon dioxide equivalents are commonly expressed as "million metric tons of carbon dioxide equivalents (MMTCO2Eq)." The carbon dioxide equivalent for a gas is derived by multiplying the tons of the gas by the associated GWP. MMTCO2Eq = (million metric tons of a gas) * (GWP of the gas)

and infrastructure. Although fuel efficiency standards in Canada[21] will follow the US[22] and increase by 50% by 2025, these standards still lag those in the EU[23] and Japan[24] (Appendix A). Increasing automobile fuel efficiency alone may encourage more driving, as a result of the rebound effect. Electric Vehicles (EVs) and hybrids still have a small market share due to high initial cost and limited availability.

Much driving behavior is habitual and change is difficult because of the 'endowment effect, where people are reluctant to forego something such as driving that they have done in the past, and the 'status quo bias' which is a preference for the current state of affairs or continuing to living their life as they have been. Transport is an area where there can be 'free-riders' (Gowdy 2008), driving fuel inefficient cars and taking discretionary single occupant trips. Social norms need to be changed so people modify their behavior without thinking that they are sacrificing their lifestyle, and free riders are punished.

Economic drivers are seemingly not powerful enough to instigate behavior change in Canadian driving habits, and many driving decisions are not made according to neoclassical economic theory. For example when gas prices rise, few drivers adjust their behavior (Turrentine 2007): "People had to drive as much as they did to lead the lives they had constructed for themselves." Economics may cause people to purchase fuel efficient cars but not to reduce driving, because driving is the social norm. Turrentine's (2007) research into knowledge, beliefs, and behavior with respect to purchase and use of fuel efficient cars showed that people generally did not know the fuel efficiency of their cars, and purchase hybrids for

[21] 32 mpg,
[22] similar to Australia and China
[23] 44.5 mpg
[24] 48 mpg

ideological reasons not economics. Hybrids make up their extra cost[25][26] in fuel savings over about 6 years. There may, however, be a price point where people will purchase these cars or drive less as in Europe (Table 1) where there are substantial fuel taxes, congestion charges, and automobile licensing fees.

Turrentine (2007) found that driving behavior is changed for social reasons; purchasing a hybrid means a commitment to a new set of values or a symbolic message sent to car manufacturers. Aspects of fuel efficient vehicles that motivate drivers, such as emotions or social awareness, need to be understood and exploited in order for drivers to choose to purchase these vehicles. Successes are occurring around the world (C40 Cities nd).

4.1.1 Technology Issues

Behavior changes to reduce GHG emissions from car use are hindered by technology. Electric Vehicles (EVs) in some provinces receive their electricity from coal or gas plants that emit significant quantities of GHG. There are alternative fuels such as natural gas, ethanol, and biodiesel available, used by 70 million of the over 1 billion vehicles worldwide, but vehicle conversion to natural gas is a lesser known option in Canada. Regulations are for 5 % renewable fuel in Canada; in Sweden it is widely available and not taxed (SEA 2012).

To make fuel efficient driving more difficult, older cars do not have effective fuel efficiency gauges, and those in newer cars may only track short term efficiency. To have an instantaneous readout of fuel efficiency, it has to be calculated over a time period using fuel usage per unit of distance. These gauges are available in EVs and hybrids with digital screens.

[25] http://automobiles.honda.com/alternative-fuel-vehicles/ accessed 18 Sept 2013

[26] $5,600 extra cost ($25.1k for Civic hybrid sedan vs $19.5k for Civic coupe) , $2,000/y fuel; assuming 50% fuel savings yields a 5-6 years pay off

Because of differences in gas prices and small differences in fuel economy between cars, the feedback may be that driving behavior or fuel efficient cars makes little difference to cost.

Some areas for innovation in transportation that could facilitate reducing GHG emissions are hydrogen fuel cells, long lasting batteries to extend the range of EVs, and alternative vehicles that address barriers such as adverse climate, including human powered vehicles such as velomobiles or bicycle-cars, solar powered cars (ELF $5,000) or BlueVelo cab cars ($10,000) [27].

Infrastructure needed to support GHG reductions from transport includes more charging stations, safer separated or coloured bike lanes, public bike storage, or subsidized bike racks.

Hybrids and EVs are expensive with a long payback. The $8,500 rebate available through ecoAuto (Government of Ontario) does not cover the cost difference between conventional cars and EVs as shown by the following examples: a Smart for Two[28] EV coupe is $26,900 compared to $14,400 for conventional, $29,900 for an EV cabriolet compared to $20,500 for the conventional automobile. The slightly larger Nissan Leaf is $31,000-$38,000[29] and only 60,000 Nissan Leafs have been sold world-wide in the 3-years since its introduction[30].

4.1.2 Current Policy

Federal, provincial and municipal policies for reducing transportation GHG emissions are reviewed in Appendix B, such as ecoAuto, ecoMobility, and emissions regulations. Despite these programs, Canada lags other countries in effective sustainable transportation. This may be because perverse subsidies for gasoline fuel encourage driving by keeping fuel prices unrealistically low, and discourage alternative fuels and the innovation needed to break our

[27] http://www-nrd.nhtsa.dot.gov/pdf/esv/esv22/22ESV-000108.pdf
[28] http://www.thesmart.ca, accessed 17 Sept 2013
[29] http://nissan.ca/buying/configurator/en/modelChooser.html?group=LEAF, accessed 17 Sept 2013
[30] http://www.newswire.ca/en/story/1181797/nissan-announces-canadian-price-reduction-and-faster-charging-time-for-2013-nissan-leaf

reliance on fossil fuels. Some of the Clean Air Agenda initiatives in the Canadian KPI Act 2011 encourage the purchase of more fuel efficient vehicles (GHG Emissions Regs 2011) and more fuel efficient driving (ecoEnergy), using policy tools such as regulations, economics (ecoAuto rebate, Green Levy, Retire Your Ride) and information (ecoMobility) but these policies have not been effective in capturing people's attention. The lack of success is evident as Canada's emissions from personal transportation grew between 2009-2011 (EC 2012a). The question remains: What policy modifications can further progress in switching to alternative fuel or alternative modes of transportation in Canada?

Municipalities have Transportation Master Plans (TMP) and Active Transportation (AT) Plans. Municipal planning departments are changing urban design so that new neighborhoods are denser and less car-friendly. Mixed zoning is more prevalent and new development or changes to existing land use are incorporating new urbanism, discouraging automobile use, encouraging cycling, walking, and transit[31] but this is difficult to apply to existing neighborhoods. Transportation plans include the use of transportation hubs and streamlining mobility mode shifts such as from train to subway or buses.

Many policies are directed at times of change, such as financial subsidies when purchasing a new car, walkable neighborhoods when moving house or transit use when changing jobs. Financial incentives may also draw attention to a desired behavior, such as purchasing hybrid cars or retiring old ones.

How cost effective are these policies? The federal ecoAuto Rebate provided a $2k rebate for hybrid automobiles, received over 182,300 applications and issued 169,800 rebates totalling

[31] In Ontario this is Places to Grow, The Big Move

$191.2 million[32]. This is about 1% uptake of the 14 million cars on the road. Assuming a 50% reduction of CO_2e per vehicle (2T), the program reduced CO_2 e emissions by 360,000 tonnes at about $530 per tonne CO_2.

The Environment Canada ``Retire your ride" program offered $300 cash to 'scrap' cars and trucks manufactured before 1996, which emit significantly more GHG than newer cars[33]. It was estimated that this would affect about 5 million cars. The 2011 evaluation report shows a cost of $92 million, indicating an uptake of about 300,000 vehicles. At an estimated savings of 2T CO_2e per car, assuming each of these cars was replaced by a more fuel efficient one; this is $92 million for 600,000T CO_2, or $160/T.

4.2 Example - Energy Use Behavior in Home Heating

Another example of where behavior change is needed to reduce GHG emissions is energy use for home heating. Many studies combine electricity and heating as 'home energy' use. This study will consider them separately as it is focused on GHG emissions, which differ depending on the fuel used to generate the electricity or the home heat. The size of the carbon footprint from household energy use is evaluated and behavioral barriers to reducing it are identified. Existing policies are critiqued with respect to how behavioral change is or is not addressed. Energy will be discussed in terms of Joules (J) and electricity in terms of Watts[34] (W).

Canada has some of the highest energy use for household heating in the world (Table 1), 1,369,000 TJ[35] for space and water heating with a population of 35 million, or 106 GJ[36] for the average household (range 80-120 GJ) compared to 23 GJ in the UK and 14 GJ in Sweden. The

[32] 2011 Evaluation report of ecoAuto rebate program http://www.hrsdc.gc.ca/eng/publications/evaluations/service_canada/2011/june.shtml
[33] http://www.ec.gc.ca/doc/ae-ve/2011-2012/1447/ec-com1447-en-s2.htm
[34] 1 kWh = 3.6E6 J
[35] TJ = tera joules 10^{12} J
[36] GJ = giga jules 10^{9} J

energy needed for heating is a function of dwelling type, age, and size, house area/ person and degree days (Parekh and Wang 2012). Canada has relatively few people per home, large home area and a cold climate.

The average household energy for home heating use has significant regional variation across Canada (Table 2); this variation is due to factors such type of fuel used for heating, and higher energy use in areas (Stats Can 2007). In Canada the fuel for home heating varies by province, so some regions use higher carbon intensity fuel sources than others (Appendix C).

Table 2: Canada Emissions Trends (Env Can 2012a)

	Total		**Individual responsibility**						
	Total, MT	**Per capita, T**	**Personal transport[37]**		**Electricity T/household[38]**		**Home heating**		**Total**
			MT	%	MT	%	MT	%	MT
Canada	692	20.3	122	37	121	36	85	26	328
			T	%	T	%	T	%	
Avg. /cap			4	31	5	38	4	31	13
Alberta	237	63.7	2.9	21	5.3	38	5.8	41	14
BC & territories	69	12.4	2.7	24	5.5	49	2.1	19	11.3
Manitoba	20	16.3	2.8	26	5.7	54	2.1	20	10.6
Atlantic	49	24.5-14	3.1	29	3.9	36	3.7	35	10.7
Ontario	172	13.0	4.2	39	2.9	27	3.7	34	10.8
Quebec	81.8	10.4	3.3	36	4.6	51	1.2	13	9.1
Sask.	72.7	69.8	4.0	30	4.8	36	4.7	35	13.5
Territories	2	18.8			5.5	65	2.9	34	8.4

This information was used to estimate the carbon footprint due to home heating: Canadian average 4T per household, highest in Alberta (5.8T) and Saskatchewan (4.7T); and lowest in Ontario (2.9T). Electric heat can be low carbon intensity in provinces such as Quebec which has extensive hydroelectric resources. There may not be much discretion in a given region to change the fuel and existing furnaces are a barrier to changing fuel sources.

[37] Use 2,4 kg CO2e/liter
[38] 1 kWh = 3.6 E6 J

Are there 'best practices' that could be transferred here from other countries? Sweden, with a similarly cold climate, emits significantly less GHG for heating than Canada. Use of alternative fuels such as biofuels and waste is common, district energy systems (DES) have been used in Sweden for years, energy audits are mandatory and there are strict energy requirements in the building code.

In Canada subsidies for oil and natural gas are barriers to adoption of unconventional fuels, which are used in less than 1% of the households (Stats Can 2007). With gas heating, homeowners receive feedback for energy use only through bi-monthly bills, unlike fuel such as wood and oil, where immediate feedback is provided as the user can see how much has been used and how much is left. Existing infrastructure such as buildings and roads hinder District Energy Systems (DES). Energy audits are available (ecoEnergy) but expensive, invasive and often not followed through. Retrofits are difficult and costly in existing homes, and people may not have the skills needed to update home insulation, or the money for energy efficiency services. There may be a reluctance to reduce the temperature of the home if people feel that they are sacrificing their comfort while there are many "free-riders".

4.2.1 Technology Issues

Canadian standards for home construction can be found in the Model National Energy Code for Building (MNECB 1997[39]). The Ontario and BC Building Codes have incorporated suggested energy efficiency requirements but do not mandate the latest in green technologies. For example, there are issues with retrofitting older homes to current insulation standards; many older homes are R13 or R16 but the latest R24 insulation does not fit the stud spacing. To show what is possible for existing homes, the Residential Energy Efficiency Project (REEP) house in

[39] http://www.retscreen.net/ang/templates_model_national_energy_code_for_buildings.php

Kitchener retrofitted a century house and reduced energy use by about 90% using tank less water heaters, drain water heat recovery, high efficiency boilers and radiant heating, ground source heat pumps, energy recovery ventilators (CMHC nd).

Cost is a barrier to significant energy use reductions in existing houses. The cost of achieving the leading edge energy efficiency in the REEP house was $50,000, and for $30,000 a similar house achieved a 50% energy reduction. A typical solar hot water system in Canada costs between $4,000 and $9,000 installed. The energy production varies according to the size of the device, but a large device can provide up to 60% of the hot water heating needs for a family of four people (12-18 GJ/y and up to 300 L/d). Assuming $100/month, saving 60% or $60/month gives solar hot water a payback period of about 12 years.

A geothermal or ground source heat pump (GSHP) system that costs up to $30,000k can provide 27 MJ/h or 236 GJ/y. For a typical house using 107 GJ/y, this would more than meet the heating requirements. If annual heating costs were $1,794/y, the payback would be 15 years (Canadian GeoExchange Coalition).

4.2.2 Current Policy

NRCan is the federal department responsible for energy conservation, and can initiate revisions to the national energy code MNECB. NRCan subsidies for geothermal systems ($4000) were available a few years ago but have been discontinued. With uptake by 250,000 homes, the cost of the program was $1billion. By saving 4T/household/y over 25 years, the cost of each tonne CO_2 saved was about $40/T.

Current provincial policies to reduce home energy use include energy audits. In Ontario, the Green Energy Act (GEA) originally mandated an energy audit on sale of a home, but this has not been enforced. Audits involve significant cost even with rebates, and are available for

income -qualified residents through the Ontario Energy Board OEB (Horizon Utilities meeting), or may be funded by municipalities by property taxes or Local Improvement Charges (LIC) such as in the City of Toronto[40].

Municipal policies to modify home energy use behavior focus primarily on conservation. Some energy suppliers identify problem areas using billing data or energy mapping, which correlates energy use with geospatial location (Horizon Energy Mapping). Data is also used for historical and group comparison and prioritizing areas for district energy systems (DES). DES costs are in the millions of $s, so smaller scale neighborhood or block programs (microD) could be cost-effective, and are being considered in Community Energy Plans such as Toronto, Burlington[41] and Guelph.

4.3 Example - Home Electrical Use Behavior

Comparing household electricity consumption in several countries shows Canada's 15,000 kWh/year/capita (Table 1) to be amongst the highest (Nakagami et al 2008). The CO_2 emissions caused by electrical use vary across Canada depending on the fuel used to generate the electricity: 5.3 T in Alberta where coal power generation predominates, 5.7 T in Manitoba and 2.7 T in Ontario where nuclear and hydro-electric supply a large percentage of the demand (Table 2)[42]. The Canadian average is about 5T CO_2 per household.

Local Distribution Companies (LDCs) have attempted to change electricity use behavior in Ontario with Time of Use (TOU) rates, charging higher rates for peak power. This should encourage use of power "off-peak", but requires people to change habitual behavior such as when they do laundry or run their dishwashers, and overcome the 'status quo' bias. However,

[40] http://www.toronto.ca/taf/cleanair.htm accessed 17 Sept 2013
[41] http://cms.burlington.ca/Page7938.aspx accessed 17 Sept 2013
[42] Fuel intensity Nyboer 2013

current TOU rates do not provide a significant financial incentive to 'load shift', or use power at off-peak times. Some demographics (e.g. pensioners, families with pre-school children, home-based businesses) do not increase their load during peak times and should not be penalized for using base power during peak times[43]. LDCs do not provide sufficiently differentiated information; paying an electricity bill is like paying for a shopping cart full of items without knowing individual prices. Homeowners may lack the knowledge of how to effectively use less electricity, as they may not be aware of the electricity use of individual appliance (plug load), and may change their behavior without having an impact.

Major appliances such as fridges, clothes dryers, ranges, freezers, and dishwashers consume 40% (2700 kWh) of the annual household electricity use in Canada, Appendix D (EC 2012b). Federal standards for energy efficiency of major appliances are being tightened so this load is dropping gradually as 'existing stock' is replaced, but these are long-lived products. Loads for lighting, typically 1100 kWh (15%), are also dropping due to increasing use of energy efficient light bulbs. However, home entertainment uses about 1500 kWh (17%) and is rising due to the proliferation of new electronic devices, so total home electricity use is trending upwards (Parekh and Wang 2012).

Undesired behavior includes habitual or "status quo" bias behavior such as leaving lights on, leaving electronic devices on (phantom load), not air drying clothes, using dishwashers and other energy intensive appliances during peak hours, slow adoption of new technologies for electricity conservation such as smart meters reading $/hour, and lack of demand management. People do things that way because they always have. Behavior change to reduce electricity use is hindered by ineffective feedback, ineffective labelling and excessive cost of energy efficient

[43] use in other provinces?

products. Ineffective labelling results in consumers purchasing inefficient products. Devices and services that are not purchased because of high cost are energy efficient bulbs, home energy audits, and conversions to renewable power.

4.3.1 Technology Issues

The shift to the desired electricity use behavior is hindered by technological barriers, such as lack of technology to easily monitor individual appliance loads. The electricity usage per year of the appliance in kWh can be determined from the energy rating (W) and the hours of use determined through audits and surveys. Some high power items that are seldom used may use less total electricity than small devices that are continuously on, such as home entertainment, office and communication devices; many people are not aware of this or of the additional issue of standby power (up to 10%). Computer based or Smart Technology such as 'Smart Bars' to shut off electronics and eliminate phantom loads are available, Smart Meters for immediate feedback on appliances are being developed[44].

Another technological issue is that although efficiency standards for many products have increased (Appendix D, Table D5), there is still room for improvement particularly related to "phantom" loads. In Japan energy efficiency increased due to high standards and clear energy efficiency labelling of all products, making information obvious to users and driving sales of energy efficient products[45].

Widespread use of DES technology for cooling could reduce electricity used for air conditioning. Technology for solar power generation on individual household roofs[46] is not yet

[44] Conversation with Ministry of Energy staff at Sept 3 LTEP Open House in Burlington
[45] http://www.powerint.com/green-room/regulations-agency/energy-saving-labeling-program-japan-eccj
[46] microFit in Ontario

economical without the high prices provided by subsidies (GEA). Feed In Tarriff (FIT) and microFIT programs are currently suspended in Ontario, but Small FIT is still available.

Direct and continuous feedback on electricity use may help change behavior. Fischer (2008) reviewed numerous global surveys to determine characteristics of feedback that are most effective in changing behavior, such as the immediacy provided by smart meters. Feedback may also help to shift discretionary electricity use to off-peak times. Feedback enables hands-on experiential learning that can bring engagement and more creative solutions.

Further innovation (Talbot 2012) is needed in electricity storage systems: larger and less expensive batteries, pumped storage, phase-change storage devices. With effective electricity storage, excess solar power on a sunny day could be stored, or electricity generated at night could be stored in a phase change storage system for use the following day. Other innovative technologies are home gas boilers that generate both electricity and heat.

Many light bulb styles are only recently available in compact fluorescent (CFC) or Light Emitting Diode (LED), and these products are more expensive than the less energy efficient alternative. Manufacturers charge high prices, knowing the long lifetime of the bulbs will preclude replacement.

In the "rent your roof" program for a solar photo voltaic (PV) installation, the solar company receives 54.9 c/kWh and pays the homeowner 50% of that or about $800/year A 1 kW rooftop solar installation can produce 1200 kWh annually[47], at a cost of $5K. Typical roof areas[48] can support a 3 kW system, and the 3600kWh generated annually would meet over half the needs of a typical household in Canada. However, going completely "off-grid" may not be feasible as a 5 kW system (6000 kWh) would require a much larger roof area and still not meet a

47 for Canada's 400 ft^2 solar intensity of 3-5 kWh/m2/d
[48] 400 ft^2

typical home's electrical needs (7000 kWh). From this example, going off-grid would cost over $25k and even with an electricity savings of $1200/year would have a 20 year payback time. It could however reduce 4T $CO_{2\,/}$ y for 25 years at a cost of $250/T.

4.3.2 Current Policy

In Canada there are several policies that focus on emissions from household electricity use (Appendix D). Currently the Ontario Building Code (OBC) does not mandate particular technologies, but innovation for energy efficiency is encouraged.

5 Policy Recommendations

Governments should show leadership (Davidson 2011) in reducing energy use by making policy changes to address barriers in technology, infrastructure and cost. Governments should use electric fleets, create walkable government areas, and not light-up public buildings unnecessarily. Municipal buildings are becoming more energy efficient through the Green Municipal Fund (GMF); provincial and federal governments need to as well. Perverse subsidies for fossil fuels should be eliminated.

There are four areas proposed for policy change based on the above examples related to personal transportation, home energy use and home electricity use.

5.1 LTEP

To address electricity use and conservation, there is currently an opportunity for public input to Ontario's Long Term Energy Plan (LTEP), which includes energy conservation, so the following will be submitted through the Environment Registry (Appendix G). The Ontario Energy Board (OEB) should identify ways of reducing the high cost of an energy audit and increasing uptake; for example, the low-income program could include a sliding scale of income qualification. In order to aggressively retrofit existing homes; funding options for energy

efficiency should be explored such as using LIC initiatives for home energy retrofits (TAF 2013). There should be support neighborhood conservation initiatives, such as doing audits on a representative sample of homes in a typical neighborhood and bulk purchasing services and materials for retrofits. Encourage implementation of the audit recommendations by addressing barriers such as cost, lack of skill, procrastination, by means of training or financial incentives for reducing energy use, and provide additional feedback such as continuous display of gas use per billing period.

There are Conservation Demand Management (CDM) incentive programs for industry and small businesses (Horizon) with CDM key account managers. To appeal to a sense of community, energy conservation programs could be adapted for community groups to reduce cost.

Changes to TOU rates by pricing electricity closer to its production cost are supported. LDCs should set targets for maximum variation between base and peak to minimize the need for peaking plants.

5.2 Municipal Planning Departments

Municipal planning departments can modify policies to encourage changing behavior in personal transportation (Appendix G). Perceived lack of safety is the biggest barrier to cycling; providing bicycle/traffic physical separation would increase safety and also encourage innovative transportation modes. The Ontario Ministry of Transportation has prepared Ontario Traffic Manual Book 18 Bicycle Facilities, draft May 2013 as a guide to municipal planners. Regions such as Halton (2011) and municipalities such as Oakville (2012) have Transportation Master Plans (TMPs) that contain Active Transportation (AT) sections but these do not yet contain requirements for bicycle/traffic separation. Guidelines from Book 18 should be incorporated in

the town and region master plans. These master plans budget for AT and Book 18 contains a section on implementation, which involves coordination with planned roadwork to minimize costs. Share the Road Cycling Coalition's 2013 Bike Summit attended by municipal and provincial politicians reported successes such as the city of Chicago which has plans for 100 miles of protected buffered lanes by 2015 and has increased cycling up to 30%. Municipalities should be encouraged to schedule 'Car-less' days that make *not* driving the socially accepted behavior, particularly in affluent areas where cycling is preferred to transit.

5.3 Ministry of Transportation and Infrastructure

Municipal policies are influenced by the Planning Act from the Department of Transport & Infrastructure, and have a significant role to play in changing transportation related behavior. Planning departments are applying mixed zoning and new urbanism concepts[49] such as 10 minute neighborhoods[50] to new developments, but suburbs remain bastions of the automobile. Plans to apply these concepts to existing neighborhoods are needed. Road design should be improved to eliminate congestion by using traffic circles and synchronized traffic lights. Surveys indicate people are willing to move to sustainable neighborhoods (TC 2009).

Some cities in Ontario are preparing Community Energy Plans that encourage more use of DES from solar and geothermal for home heating, and funding strategies such as property taxes or LICs for pilot district energy or conservation initiatives. More municipalities should actively promote DES or Combined Heat and Power (CHP) in areas of high energy intensity as shown by energy mapping (CUI). New developments should be required to submit energy plans.

[49] Charter of the New Urbanism, Congress for the New Urbanism cnu.org
[50] e.g. Portland

Subsidies for solar hot water should be initiated, and subsidies for geothermal which were very cost effective should be restored. The cost of installing geothermal systems should be reviewed and perhaps controlled as this is an effective but expensive program.

Provincial building codes should be revised on 3 year cycles and mandate more energy efficient technology such as solar panels and green or "cool" roofs for new homes (City of Toronto[51]), Leadership in Energy and Environmental Design (LEED), and the various technologies used in the REEP house (CMHC nd). Advantages of regulations are that builders or architects may be reluctant to deviate from standard plans unless driven by an environmentally aware homeowner, so developing 'canned' non-standard high efficiency plans will reduce cost.

Ministry of Transportation and Infrastructure policies can also encourage adoption of EVs. Hybrids and EVs are not yet economical, so they are purchased for emotional reasons; provincial subsidies for EVs and home charging stations (ecoAuto) should be increased, and preferred parking and use of HOV lanes should be offered to EVs and hybrids. Driving efficiency should be included as part of driver education, and effective fuel efficiency gauges should be installed in all cars**.**

5.4 NRCan

To change behavior in favor of energy efficient product purchases, NRCan policies should tighten regulations. One of the findings with respect to changing habitual behavior is that people do not make environmental decisions based on economics, so regulations may be more effective than financial incentives. NRCan should adopt stricter automobile fuel efficiency regulations, and targets for percentage EVs and hybrids until a tipping point is reached these

[51] http://www.toronto.ca/legdocs/municode/1184_492.pdf, accessed 19 Aug 2013

vehicles become the social norm. Renewable fuel regulations of 5% should be raised. These fuels should be widely available, and they should be exempt from taxes.

NRCan should mandate increased energy labeling of products. The excessive cost for energy efficient products and services such as CFC, LEDs, and energy audits is a barrier, so NRCan should subsidise or limit prices of energy efficient products and ban inefficient ones to encourage market transformation (SEA 2012), so the default option is green.

6 Discussion

On the basis of the above inquiry, the answer to the question: "Can behavior change alone be expected to accomplish significant GHG emission reductions?" is "No". There is significant change needed from the population, but there is a lack of leadership in government environmental policy, and many barriers to personal GHG emission reductions. Suggestions to address some of these barriers will be sent to the various policy makers (Appendix G).

To further explore the findings from studies of environmental behavior that show groups can be more effective than individuals in making radical cuts in personal CO_2 emissions, a neighborhood in Hamilton was approached about forming an Electricity Conservation Group. This would be similar to the CRAG concept but with a focus on electricity and cost savings; it would be impact oriented rather than intent oriented (Wolf 2011) reducing environmental impact although that would not be its primary intention. The proposed terms of reference are to: meet every two months for an information session and to provide the opportunity for feedback and discussion of good practices. Hydro bills will be analyzed and used to trend electricity usage. The results may show ways to translate small group change to the broader public and scale up change, with enabling legislation, infrastructure changes, grants, and toolkits prepared from group experiences.

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Appendix A – Energy Use and Emissions Data

Table A-1

	IPCCC		IEA	UNFCCC		
country	Country emissions E[53]	Country population P	Transport[54]	Home electrical use, annual[55]		Home Energy per household [56]
	MTe	M	km/person	kWh/cap	gm CO2 /kWh	GJ
US	5747	316	14,853	13,394	528	101
EU	4409	739	n/a	n/a	359	n/a
Russia	1555	143	369	6,430	n/a	n/a
Japan	1184	127	7,193	8,394	424	41
Germany	953	80	11,347	7,215	468	74
Canada	763	35	15,266	15,137/household	186	106 GJ
UK	590	63	12,090	5,733	470	23 GJ
Australia	581	23	13,357	10,286	847	53
France	495	66	12,190	7,728	77	74
Spain	324	47	8,969	6,155	287	n/a
Sweden	32	9	11,803	14,939	22	14.4 GJ
South Korea	n/a	n/a	4,217	9,744	515	59
China	n/a	n/a	n/a	2,943	n/a	18
Italy	445	n/a	14,688	5,384	423	n/a
OECD EU	n/a	n/a	12,000	n/a	n/a	n/a

Table A-2 Statistics Canada

	# households	Total CO2	End use		Light
	K		Space heat	Water	
Atlantic	963	3.5	2.8	0.6	3.7
Quebec	3,332	4	3.5	0.5	2.9
Ontario	4,962	18.4	13.9	4.4	5.7
Manitoba	466	1			4.8
Saskatchewan	407	1.9			5.3
Alberta	1,417	8.2			5.1
BC	1,793	3.1			5.5
Territories	34.6	0.1			

[53] http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/6598.php
[54] IEA Transport 2009 data and trends
[55] Electric Power from UNFCCC Individual Country reports
56 From individual country reports, and Nakagami Fig 5

Appendix B - GHG Emissions from Personal Transport

The average Canadian drives 15,000 km/year, among the highest in the world, and the average car on the road has a fuel efficiency of 8-9L/100km (low when compared to Europe[57]), giving the average emission per driver of 4T CO_2e. This ranges from a high of 4.2T in Ontario to a low of 2.7T in BC, a significant regional variation. Fuel is almost entirely carbon based petroleum with natural gas and electricity making up <1% [58]. By comparison, Europeans drive less, have more fuel efficient cars, and use a higher percentage of alternative fuels.

Current policies of the federal, provincial and municipal governments that attempt to limit GHG emissions from personal transport are identified below. The Clean Air Agenda initiatives in the Canadian Kyoto Protocol Implementation Act 2011 related to transportation emissions are shown in Table B1. These federal policies[59] attempted to change behavior by encouraging the purchase of more fuel efficient vehicles and more fuel efficient driving. They used policy tools such as regulations, economic tools, information tools and behavioral tools.

Table B1 shows two regulations, the Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations (2011) and the Renewable Fuels Regulations. The first regulation establishes progressively stringent GHG emissions standards for new vehicles for model years 2011-2016, based on fleet averages and aligned with U.S. standards (CAFÉ). This regulation applies to companies that either manufacture cars or import them into Canada. New standards will be developed for model years 2017 - 2025 (Notice of Intent October 2010), in coordination with the U.S. Environmental Protection Agency (EPA). Fleet average is to be reduced by 5%/year from 2017-2025. The Renewable Fuels Regulation requires an average renewable fuel content of at least 5%, as of December 2010. (In Sweden pumps at over 60% of the stations provide renewable fuel, and renewable fuel is not taxed; this has led to a 6% use of renewable fuel, (SEA 2012).

[57] http://ec.europa.eu/environment/air/transport/road.htm
[58] http://www.nrcan.gc.ca/plans-performance-reports/strategic-outcome-and-program/2013-14/132
[59] Most expired in 2009-2011

There are three economic tools In Table B1, ecoAuto Rebate, ``Retire your ride", and the Green Levy. The first two policies use positive motivation. The ecoAuto Rebate provided a $2k rebate for hybrid automobiles[60] , but ended March 31, 2009, after receiving over 182,300 applications and issuing 169,800 rebates totalling $191.2 million[61].

The Environment Canada ``Retire your ride" program (NVSP) offered $300 cash to 'scrap' cars and trucks manufactured before 1996. It was estimated that about 5 million of the 20 million cars on the road in Canada were older cars, which emit significantly more GHG than newer cars; the 2011 evaluation report[62] of the NVSP shows a cost of $92 million between 2009 and 2011. The Green Levy program was a tax on inefficient vehicles, which is a monetary disincentive.

There are two policy tools in Table B1 classed as informational. The ecoEnergy for personal vehicles program produced a fuel consumption guide which also contains efficient driving tips. The ecoTECHNOLOGY for Vehicles Program conducts in-depth safety, environmental and performance testing on a range of new and emerging advanced vehicle technologies for passenger cars and heavy-duty trucks.

One policy tool in Table B1 addresses behavior, the eco Mobility program (2008-2010). This program produced toolkits to assist communities in transportation demand management (TDM): (a) TDM for Canadian Communities, (b) Planning and Delivering TDM Programs, (c) Active Transportation in Canada: A Resource Planning Guide, and (d) Changing Transportation Behavior: A Social Marketing Planning Guide. It also produced the 'Compendium of Canadian Survey Research on Consumer Attitudes and Behavioral Influences Affecting Sustainable Transportation Options' referred to in this study.

Looking at provincial policies, the Government of Ontario introduced the Electric Vehicle (EV) Program Incentives of $8.5 k for an EV purchase (battery > 17kWh) and $5k for plug in hybrids (4kWh battery). Ontario also has a Natural Gas Vehicle (NGV) program. Similar policies in other provinces are

[60] Toyota Prius ($26k) Globe and Mail July 27, Honda Civic Hybrid, Ford Escape Hybrid, Saturn VUE Hybrid, Toyota Camry Hybrid

[61] http://www.hrsdc.gc.ca/eng/publications/evaluations/service_canada/2011/june.shtml

[62] http://www.ec.gc.ca/doc/ae-ve/2011-2012/1447/ec-com1447-en-es.htm

shown in Appendix E; for example British Columbia has a "scrappage" program, and a NGV program. A carbon tax on gasoline fuel has been implemented in Quebec and BC[63].

The Federation of Canadian Municipalities (FCM) has TDM guidelines. The Association of Ontario Municipalities assists the 444 towns and cities it represents with policy development, creates cost savings opportunities and tracks programs receiving funding from the Gas Tax fund. Many municipalities have developed policies and TDM programs that attempt to change the behavior of their residents: drive less, take transit, cycle, and walk, often based on the Eco Mobility documents (Transport Canada) such as the TDM toolkit. For example, the town of Kelowna has an "Eco Pass" which provides free parking in the downtown area for hybrids and EVs, bicycle lockers can be rented for $2/day, and bike racks installed by business are subsidized. There are cycling advocacy groups such as the Share the Road Cycling Coalition. Community events are implementing "bicycle valet parking" to encourage attendance by bicycle. Car Free days are promoted in thousands of cities around the world, including several in Canada. Globally this is popular as in Bagota where the car free day was institutionalized by public referendum, and in Jakarta, where every Sunday is car-free. Many cities have a Transportation Master Plan (Town of Oakville Switching Gears) and an Environmental Strategic Plan (Oakville Lets Go Green).

Bicycling is more widely adapted where separated or coloured bike lanes provide additional safety, such as Denmark, Vancouver, Portland, France, Netherlands, Tucson, Madison, and Philadelphia (although much of this cycling may be for recreation). There is a Cycling in Cities research Program at UBC and Bicycle Pedestrian Guidelines have been developed. Hundreds of kilometers of bicycle lanes are being added. Towns are purchasing hybrid buses or implementing Bus Rapid Transit, fuel efficient town fleets and EV charging station infrastructure.

Canadian standards for fuel efficiency (CAFÉ standards) significantly lag those in Europe and Japan (An 2004), for example 24 mpg in the US, 32 mpg in Canada, 44-51 mpg in EU, 48 mpg in Japan, 34 mpg in Australia, and 34 mpg in China. In California hybrids and EVs can use HOV lanes. Other

[63] (According to Pandora's Promise, trying to reduce fossil fuel use by raising the price of carbon fuel does not work).

countries have introduced policies such as such as toll roads, and congestion charges. The Institute for Transportation and Development Policy awards best practices among global cities.

Table B1: Federal Policies to encourage fuel efficient vehicles

Reducing GHG emissions from new cars and light trucks – new regulations (The Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations 2011)
Regulating renewable fuels content – new policy
ecoAuto rebate program – ended 2009 – provincial programs
Green Levy on fuel inefficient vehicles > 13L/100km
ecoEnergy for personal vehicles program
ecoMobility 2008-2010, compendium of survey results, and several guideline reports
national vehicle scrappage program (NVSP) 2009-2011
ecoTechnology for vehicles program
Promoting sustainable urban transit – reports containing guidelines for municipalities

Table B2

Transport Canada Compendium is based on the following 10 surveys

1. Ontario Walkability Study, May 2001
2. L'état du vélo au Québec en 2005, June 2006
3. Major Benefits to Health and Environment, 1998
4. Cycling in Cities Opinion Survey, 2006
5. Rapport sur les habitudes et les attitudes de déplacement domicile-travail du personnel du Centre hospitalier
6. Canadian Perceptions Toward the "New Realities of High Gas Prices": Implications for Public Transit and Environmental
7. 2008 Commuter Attitudes Survey Report, June 27, 2008
8. Greater Toronto Transportation Authority Foundational Research, Phase I, November 2007
9. Interest in Viable Transportation Options Among Private Vehicle Drivers, July 2004
10. Bike Lanes, On-Street Parking and Business: A Study of Bloor Street in Toronto's Annex Neighbourhood, February 2009

Table B3: Behaviors to Reduce Car Use

B1 Drive less or switch to a more sustainable mode
B2 Combine multiple driving trips or eliminate single occupant vehicle trips
B9 Use ride matching services (internal or external)
B10 Use HOV lanes and carpool parking
B11 Join a car share program
C1 Take public transit to/from work/school
C2 Take public transit for other destinations
C3 Use discounted transit passes or other transit programs offered by employer or school
C4 Use charter buses offered by employer
C5 Use kiss & ride/park & ride lots
D1 Commuter cycling (e.g., cycle to/from work/school)
D2 Commuter cycling combined with transit (e.g., rack & roll type programs)
D3 Other cycling trips (e.g., cycle to/from other destinations)
D4 Other cycling trips combined with transit
D5 Use cycling facilities offered by employer/school
D6 Organize a cycling school bus
D7 Take locally available cycling courses (safety, skills, repair, anti-theft, etc.)
D8 Join a cycling club or co-op

Table B4: Improve Driving Efficiency

B3 Turn off motor when parked for longer than 1-3 minutes
B4 Drive the vehicle to warm it up
B5 Use fuel-efficient driving techniques (e.g., drive the speed limit/constant speed, correct tire pressure, reduce weight in trunk, reduce drag by using air conditioning instead of opening windows, etc.)
B6 Perform regular car maintenance (tune ups, oil checks, tire rotation, etc.)
B7 Use ethanol blended gasoline
B8 Purchase a hybrid or more fuel-efficient model

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Federation of Canadian Municipalities. (2008). Improving Travel Options with Transportation Demand Management http://www.fcm.ca/Documents/tools/GMF/Improving_Travel_Options_with_Transportation_Demand_Management_EN.pdf, accessed 19 Aug 2013

Government of Canada. (nd c). A Climate Change Plan for the Purposes of the Kyoto Protocol Implementation Act 2011 http://www.ec.gc.ca/Publications/98673EA5-AD03-4D6A-93B4-1CDF2088BF43%5CKPIA-Plan-2012---April-25-_E_02.pdf

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Town of Oakville. (2011). Environmental Strategic Plan http://www.oakville.ca/townhall/environmental-strategic-plan.html accessed on 20 Aug 2013

Appendix C GHG Emissions from Home Energy Use

Emissions depend on the fuel used for heating, which can be electricity or direct combustion of fossil fuels such as oil, natural gas or wood. As shown in Table C1, 43% of Canadian homes are heated by natural gas, 38% by electricity, 6% by oil, 13% by wood or wood pellets and 1% by propane (Stats Canada 2007). There is regional variation with the Maritimes using oil and wood, 79% of households in Quebec using electricity and 7% using light fuel oil, Ontario, Manitoba, Saskatchewan, Alberta and BC using a majority of natural gas with significant amounts of electricity.

Table C1 Households and Environment Energy Use (Stats Canada 2007 Catalog 11-526-S)

Units, TJ	Electricity – add fuel mix		Natural gas		Oil		Wood/ wood pellets		Propane		All fuel types
		%		%		%		%		%	
Canada	520250	38	587183	43	76773	6	176107	13	8642	1	1,368,955
Newfoundland and Labrador	12,518	54	F	F	4,680	20	5,746	25	273	1	23,216
PEI	1,667	25	F	F	3,064	45	1,890	28	134	2	6,777
Nova Scotia	14,822	33	F	F	15,613	35	12,864	29	354	1	44,369
New Brunswick	18,240	53	F	F	4,343	13	10,729	31	291	1	34,273
Quebec	189,948	61	10,805	3	21,899	7	84,996	27	1,619	1	309,266
Ontario	154,995	30	298,893	58	21,722	4	35,411	7	4,146	1	515,166
Manitoba	20,215	42	23,671	49	F	F	3,370	7	F	F	48,093
Saskatchewan	11,699	24	33,956	70	F	F	F	F	F	F	48,482
Alberta	33,704	20	130,037	77	F	F	5,738E	3 E	F	F	169,800
BC	62,442	37	88,415	52	3,678	2	13,750	8	F	F	169,511

The CO_2 produced for each major conventional fuel source[64] (excluding electricity) per kWh is natural gas (0.4 lb[65]), oil (0.5 lb), propane (0.7 lb), coal/wood 0.75 lb (NRCan a,b,c?). Most provinces have a GHG emissions reduction action plans with regional data (Appendix E). Some governments will financially support the switch to lower emissions fuel, for example in Quebec's Action Plan (Govt. of Quebec nd), natural gas use was stated as a reason for increased emissions in home heating, and the

[64] http://oee.nrcan.gc.ca/equipment/heating/2371
[65] 1 lb = 0.454 kg

Quebec government supports converting from fossil fuel heating to geothermal, hydroelectric, wind or solar power (Rénoclimat program).

Emissions from electrically generated heating depend on the source of fuel for electricity. The CO_2 intensity of electricity by province is 0.82 T/MWh (NS), 0.74T/MWh (Alta), 0.1T/MWh (Ontario, Quebec and PEI), ref, so a household heating entirely with electricity would emit 24T CO_2 in Nova Scotia and 2.9T CO_2 in Ontario. Electric heat can be low emissions in provinces like Quebec which has extensive hydroelectric resources.

As would be expected, there is an inverse relationship between heating demand and average winter temperature in Western countries. There is a higher household heating demand in Montreal (65 GJ) with an average winter temperature of -10C than in Florida where the average is 20C (5 GJ), (Nakagami.et al 2008). Fuel used around the world for home heating is shown in Table C2 (Nakagami et al 2008); natural gas and electricity are the fuels of choice in developed countries. Good practices from several countries are discussed in more detail below.

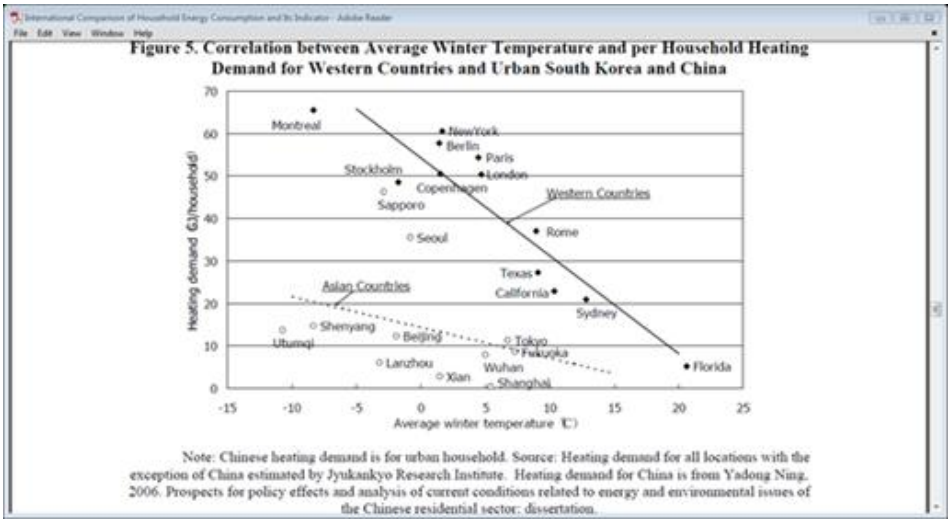

Figure C-1 From Nakagami et al 2008

Comparing Canada to countries with similar development and climate is useful. In Sweden, energy for home heating (space heating and water) usage is 30% electricity, 30% solid biofuels, 15% district heating and 5% oil. Sweden uses significantly more biofuel, heat pumps and district energy systems than Canada: heat pumps are used in 45% of the one- and two-dwelling buildings, and electricity

is used for floor heating and fan heaters. In Germany the use of renewables for home heating is small but significant: solar 4.9%, heat pumps 1.8%, PV 2.4%, and wood pellets 2.2% (Frendel 2005), compared to being almost negligible in Canada.

Table C2: Fuel Sources for home heating in 7 countries (Nakagami)

USA	Natural gas (30%), electricity (70%)
UK	Natural gas
Australia	Electricity
Germany	Relatively high kerosene consumption
France	High consumption of wood
South Korea	More city gas and kerosene than Japan, and less electricity
China	High per household consumption, 80% of this is wood or agricultural waste

Some of the unconventional fuels are wood pellets, ground source heat pumps (GSHP), district heating, and solar hot water. The use of wood pellets is increasing around the world[66]. Sweden uses 1,400,000 T annually to lead Europe, but there is also substantial usage in Italy, Germany, Austria and Denmark. Canada produces a large amount from forest products but exports them rather than using them as a source of heat, as they are believed to be a greater source of air pollution than natural gas (ref).

Ground Source Heat Pumps (GSHPs) provide space heating and air conditioning by transferring heat from the ground to the application. GSHPs can have deep vertical shafts for small spaces or shallower horizontal ground loops.

District heating or district energy systems (DES) take heat generated in a centralized location and distribute it for residential and commercial heating requirements. DES can pump water up to several kilometers[67] but additional pumping power required for the larger line size, so it is more effectively used in areas of high density. The heat can be obtained from a cogeneration plant burning fossil fuels or biomass, heat-only boiler stations, geothermal heating, central solar heating, other industrial waste heat or nuclear power. District heating plants can provide higher efficiencies and better pollution control than localized boilers. District heating use is growing in Canadian cities, with many new systems built in the

[66] Wood Pellet Association of Canada http://www.pellet.org/pellets-page-news/renewable-and-sustainable-energy-really-can-grow-on-trees
[67] 5-7 km

last ten years. Canadian cities currently use steam district heating systems (Toronto, Montreal, Ottawa and Vancouver), hot water district heating (Lebreton Flats in Ottawa, Charlottetown, PEI) or biomass as the fuel source and hot water as the energy transfer medium[68] (Ouje-Bougoumou). Combined Heat and Power District Heating (CHPDH) is being developed in Denmark as a store for renewable energy, particularly wind electric, that exceeds instantaneous grid demand via the use of heat pumps and thermal stores.[69]

Solar thermal and solar hot water are widely used in many countries (Australia, Austria, China, Cyprus, Greece, India, Israel, Japan and Turkey[70]).To increase use of this in Canada, retrofitting is needed to install roof top solar collectors and storage tanks, on the roof for thermosyphoning or on the ground requiring a pump. In winter there may not be sufficient solar heat gain to deliver the necessary hot water, so a gas or electric booster may be needed. The NRCan rebates have ended, but LiveSmart BC offers a $500 rebate.

According to Environmental Building News[71], new buildings can be built with half the fossil fuel use of existing buildings. The Pew Centre for Global Climate change 2005 report[72] says it is possible to improve existing buildings to reduce energy by one-half to two-thirds.

The most effective retrofits for reducing home heating needs are improvements to the building envelope: foundation, walls, windows, and roof. In cold climates this involves air sealing, insulation, and replacing windows with high efficiency ones. In warm climates, solar control and air sealing are the most effective retrofits. There are Canadian guidelines for home retrofits for increased energy efficiency (CMHC nd).

As part of the KPI Act 2011, several programs for home heating were introduced: ecoEnergy for renewable heat (2008-2010), ecoEnergy for renewable buildings and houses, ecoEnergy retrofit

[68] http://www.ouje.ca/content/our-story/energy.php
[69] http://en.wikipedia.org/wiki/District_heating
[70] http://en.wikipedia.org/wiki/Solar_water_heating
[71] the American Institute of Architects and the US Green Building Council challenge to have all buildings be carbon neutral by 2030
[72] http://www.pewtrusts.org/our_work_detail.aspx?id=327744

initiatives, including Energuide for homes. These programs have ended federally but continue on in some provinces, such as Ontario and BC (LiveSmart BC). The Green Building council advocates and educates for increased sustainability of residential buildings such as LEED. Provincial governments have their own building codes, e.g. Government of Ontario Building Code (OBC). Provincial governments have also developed policies, Appendix E, such as LiveSmart BC (Government of BC). Many provincial policies include home energy audits, which focus on reducing energy loss through better insulation and eliminating heat or air leakage.

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Appendix D GHG Emissions from Home Electrical Use

The REAT survey (Parekh and Wang 2012) estimated the average base load electricity usage in Canada at about 6920 kWh per year, or about 19.0 kWh per day (Appendix A). This is responsible for an average of 15,000 kWh/y per household or 5 T CO_2 per capita annually, but these emissions vary considerably across the country depending on the fuel used to generate the electricity, 5.3 MT in Alberta where coal power generation predominates to 2.7MT in Ontario where nuclear and hydro-electric supply a large percentage of the demand. Some provinces are rich in emission free hydro power, and other provinces have low emission nuclear power. GHG emissions are higher in provinces where coal or oil is the primary source of electricity generation such as Alberta. CO_2 intensity by province for electricity generation ranges from 0.82 T/MWh in Nova Scotia, 0.74 T/MWh in Alberta to 0.1 T/MWh in Ontario and 0 t/MWh in Quebec and PEI (Nyboer 2013).

Emissions also vary with time of use; for example some provinces have sufficient hydro or nuclear to meet base load but use coal or gas for peaking. As noted above, hydro and nuclear are almost GHG emissions free, while coal emits the most CO_2 of all fuel sources and natural gas emits about 50% of the CO_2 as coal.

Various surveys are available which estimate appliance energy use (Stats Canada 2007), some providing usage by appliance (OPA, Smart Grid, Horizon). Parath and Wang (2012) have found that base load electricity consumption attributed to lighting and appliances account for about 18% of the total residential energy usage. Home electricity use is trending upwards, despite improvements in efficiency of major appliances, due to the proliferation of new electronic devices (Parekh and Wang 2012). Table D2 indicates appliances are on average consuming 2700 kWh of the annual 7000 kWh (40%), home entertainment 1500 kWh and lights 1100 kWh. The appliances that use the most electricity are: refrigerators, clothes dryers, ranges and freezers (Table D3). Annual lighting energy usage averaged about 771 kWh for indoor applications and 317 kWh for outdoor applications for a total of 1088 kWh.

Europe has the EU 2008 Sustainable Production and Consumption and Sustainable Industrial policy action plan[74], reviewed in 2012 and EU policies – Eco design directive, EU Ecolabel, resource efficiency Europe 2020 strategy[75].

As part of the federal Clean Air Regulatory Agenda[76], Energy Efficiency Standards (Govt of Can nd b) encourage the use of energy efficient products by regulation, as dictated by the Energy Efficiency Act (1995). Stricter regulations should lead to inefficient products disappearing from the market. The Act originally applied to a few products but there have been 14 amendments adding new products or strengthening the requirements for products already on the list.

ENERGY STAR labelling complements the standards by highlighting the best performing equipment. A recent survey[77] found that 84% of Canadian consumers who bought or who were planning to buy home electronics were influenced by ENERGY STAR-qualified products. Widespread labelling of energy use has helped Japan become one of the top 10 countries for energy efficiency (Zumbrun 2008).

The four-year ecoENERGY for Renewable Power (ecoRP) program was launched in April 2007 and ended on March 31, 2011. ecoRP (for small businesses) provided incentives to increase Canada's supply of clean electricity from renewable sources such as wind, biomass, low-impact hydro, geothermal, solar photovoltaic, and ocean energy. The program provided an incentive of 1 cent/kWh[78] for up to ten years to qualifying projects. Payments to recipients will end in fiscal year 2020-21. In 2007, at the time of program design, it was estimated that the program would encourage about 14.3 terawatt-hours of electricity annually, or about 4,000 megawatts (MW) of renewable power capacity.

Many provincial policies are focused on conservation behavior as opposed to the federal government's efficiency standards and clean electricity generation. For example, the Government of Ontario has given responsibility for electricity conservation to Ontario Power Authority (OPA). The

[74] http://ec.europa.eu/environment/eussd/escp_en.htm
[75] http://ec.europa.eu/environment/resource_efficiency/about/roadmap/index_en.htm
[76] http://www.ec.gc.ca/default.asp?lang=En&n=56D4043B-1&news=295B1964-9737-4F80-B064-B3088D9910BE
[77] OPA 2011 shows 58% in Ontario, http://oee.nrcan.gc.ca/residential/7901
[78] Fit pays 50 c/kWh?

Ontario Energy Board gives the Local Distribution Company (LDC) targets for conservation as part of their license. Programs for residents include: the peakSaver program to reduce air conditioning load, programs for metering, and fridge and freezer pickups. Other programs are available for small businesses.

Provincial governments periodically revise Building Codes (latest revision 2012, 6 year cycle in Ontario) including the sections relevant to electricity. Some municipalities (City of Toronto 2005) have recommended that the Ontario Building Code (OBC) be changed to improve energy efficiency of new construction. It also recommended use of latest ASHRAE code and 3 year updates to the building code. The 2012 Building code revision only partially addressed these items. Examples of cutting edge green technologies found in other countries that could be incorporated in Canadian Building Codes are windows with solar radiation providing 50% of the heating in winter, lights with activity sensors, a computerized control panel that shows how much energy and hot water the house is producing, roof pitched at 35° to optimize solar power (5500 kWh/y), and solar hot water and solar heat pumps to provide under floor heating.

Other provincial policies for reducing home electricity use are shown in Appendix E. Ontario has the Green Energy Act and time of use (TOU) rates, Quebec has programs for electronic thermostats for baseboard heaters, geothermal, and recycling fridges. Saskatchewan has refrigerator recycling programs. BC and its agency BC Hydro have fridge buyback programs, net metering, clothes washer rebate assistance, and electric baseboard heaters programs. The Territories have programs for alternative energy, small renewable, and energy efficiency. The Yukon has refrigerator and freezer programs as well as wind prospecting. According to the Green Energy Act 2001, (Govt of Ont nd), municipalities in Ontario must have plans to reduce energy in the buildings under their control.

Various municipal policies attempt to reduce electricity household use or change the source of electricity to increased renewables. These policies may be run by the Local Distribution Company (LDC) such as Horizon or Hydro One, or the municipal government. In the US, Sierra Club Sustainable Cities (Regelsen 2005) describes some successful municipal programs such as rebates for resident sited solar,

green buildings, income qualified programs, green roofs, etc. In Canadian cities, bylaws to allow clothes lines in urban areas are now widespread; canopy cover guidelines from the Federation of Canadian Municipalities (FCM) promote planting trees for reduced use of air conditioning in summer. Toronto is the first city in North America to have a bylaw to require and govern the construction of green roofs on new commercial development; an "eco-roof" may be either a "green roof" that supports vegetation or a "cool roof" that reflects the sun's thermal energy.

Policies for renewable or low emission power sources to feed into the grid are FIT and microFIT in Ontario. Some examples of community renewable power are solar (Ontario Sustainable Energy Association OSEA)[79], methane from landfills, geothermal, and Hamilton renewable power HRP[80] with its 1.6 MW cogeneration facility infrastructure are examples.

Time-of-use rates are designed to shift use off peak and use hydro/nuclear and some companies are in the business of demand management (Bull Frog[81]).

Table D1: Electrical device Use In Canadian Households

	Average Number of Devices by End-Use Area (count)								
No of Houses Sampled	Lamps	fridge	Freezer	Dish washer	Home entertainment	Office & communication	Other common	Supplemental space conditioning	Other misc & seasonal
720	56.4	1.39	0.61	0.68	9.4	9.7	11.4	2.1	0.6

Table D2: End Use

	Average Annual Electricity Usage by End Use Area (kWh/house)								
No of Houses Sampled	Lights	Major Appl.	Home Ent't & Office	Other Common Loads	Suppl. Space Cond.	Other Misc & Seasonal	Pumps, Pools & Spas	**Total Base Load**	Standby Power
720	1088	2674	1547	704	230	184	492	**6919**	602

Table D3: Breakdown of Major Appliance Use (2674 kWh)

Appliance	W/device (typical range)	Use per house	Use per device kWh
Refrigerator	188-725	884 kWh	638
Clothes dryers	1800-5000	580	614

[79] http://www.ontario-sea.org/
[80] http://www.ec.gc.ca/p2/default.asp?lang=En&n=AC4DF9C1-1
[81] http://www.bullfrogpower.com/

Appliance	W/device (typical range)	Use per house	Use per device kWh
Ranges/ovens	1000/2300	579	579
Freezers	273	446 kWh	491
Wine cellars		375	410
Dishwashers	1200-2400	175	263
Microwaves	750-1100	117	111
Clothes washers	350-500	52	52
Window fan	200		
PC and monitor	270		
Laptop	50		
Ceiling fan 65-175			
Furnace fan	750		
TV	100-170		
Water heater	4500-5500		
Electric furnace	17,321		
Central air	5000		
Space heater	1500		
Video game player	195		

Table D43: Breakdown of Other electronic devices

	kWh per household	notes
Home entertainment devices	909.	341 standby
Office and communication devices	639	142 standby
Small kitchen appliance (coffee makers, toasters, toaster-ovens, slow-cookers, rice-cookers, blenders), cleaning appliances (vacuums, power heads), grooming appliances (clothes irons, hair dryers, styling iron), and other items such as AC-powered clocks, CO detectors and smoke detectors, garage-door openers, intercoms, home security systems, water softeners.	704	Average 11.4 other-common devices per household

Table D5: NRC Can Improving Energy Efficiency

	Devices included (residential only)
	Residential appliances, Lamps – fluorescent/incandescent, PAR lamps, clothes washers, domestic hot water, A/C
	Ceiling fan lighting, torchiere lamps, residential wine chillers, residential dishwashers, residential dehumidifiers, residential gas furnaces
	Residential boilers, large air conditioners and heat pumps, room air conditioners, digital television adaptors, residential general service incandescent reflector lamps
Amendment 9	Air conditioners, heat pumps, refrigerators, freezers, lighting.
Amendment 10:	Dehumidifiers, dishwashers, gas furnaces, speciality lighting.
Amendment 11	Residential gas boilers, Residential oil boilers, Large air conditioners and heat pumps, General service incandescent reflector lamps, Standby for electronic products, Compact audio products, Television (TV) and TV combination units, Video products, External power supplies, Electric boilers, Single package vertical air conditioners and heat pumps,
Amendment 12	100 and 75 watt light bulbs/60 and 40 watt light bulbs,
Amendment 13	Residential gas water heaters, General service incandescent reflector lamps, General service fluorescent lamps, Residential oil-fired water heaters, Packaged terminal air-conditioners and heat pumps, and Room air-conditioners.
Amendment 14	Residential refrigerators, Residential freezers, Residential dishwashers,

	Devices included (residential only)
	Residential and commercial clothes washers, Residential clothes dryers, Central air-conditioners and heat pumps, Oil furnaces, and Fluorescent lamp ballasts. Metal halide ballasts, pre-rinse spray valves, tankless gas water heaters, Battery charging systems

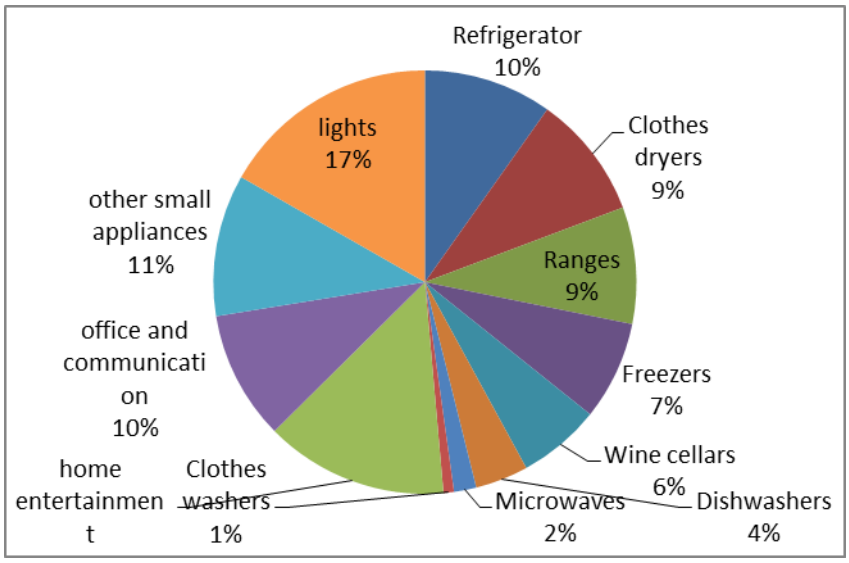

Figure D 1

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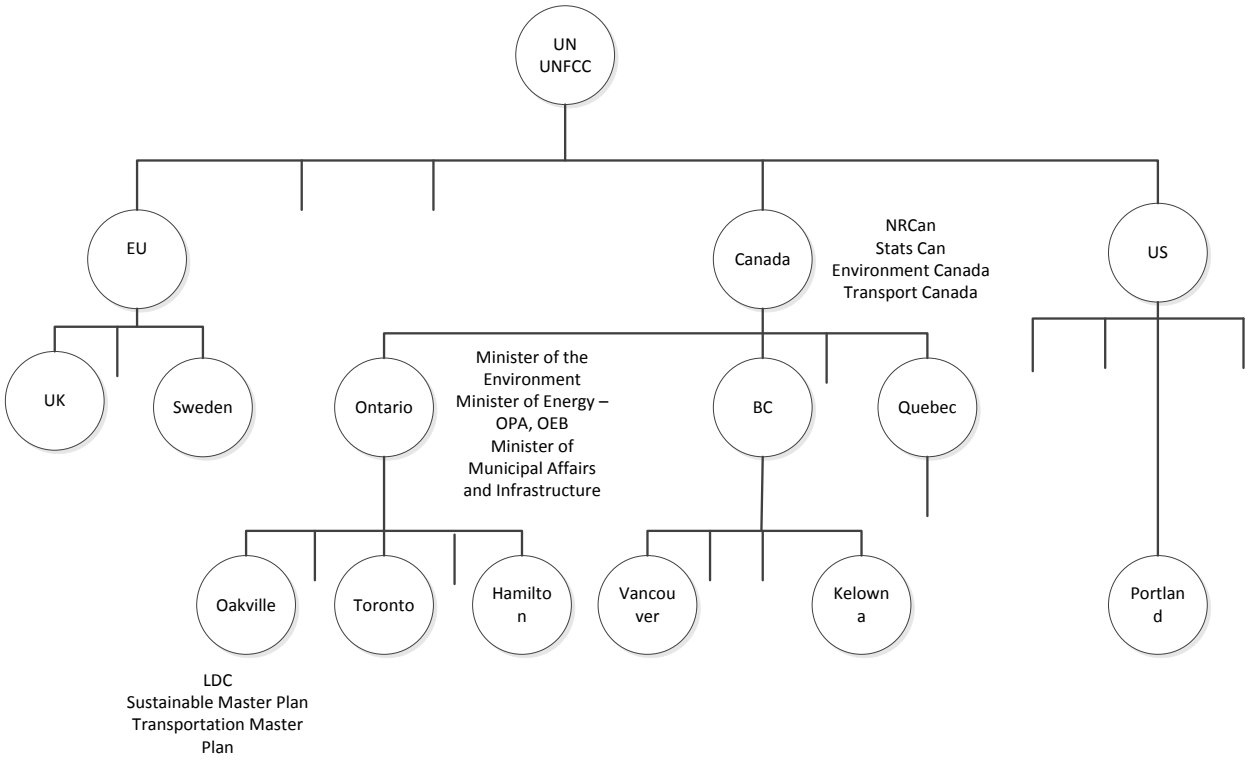
Appendix E Existing Provincial Policies

Province	Personal Transport	Home Heating	Electricity Use
Newfoundland		TakeCHARGE ENERGY STAR® Window Rebate Program, TakeCHARGE Insulation Rebate Program, TakeCHARGE Thermostat Rebate Program	
New Brunswick		Residential Energy Efficiency Program: Apartments,: Existing Buildings,: Newly Constructed Apartments,: Newly Constructed Homes	
Nova Scotia		Efficiency Nova Scotia: Home Energy Assessment Program, Low Income Homeowners Program, PerformancePlus Program, Residential Solar Air Heating and Water Heating Rebate Program, Nova Scotia - Your Energy Rebate	
Quebec		Rebate on Energy Star Windows, Condensing boiler, condensing water heaters, Programmable electronic thermostat, drain water heat recovery unit, financial aid for renovations –cooperative housing and not for profit community groups, high efficiency boiler, Novoclimat, Renoclimat, EnergyWise Home Diagnostic,	Electronic thermostats for baseboard heaters, Geothermal systems, Recyc Frigo
Ontario	NGV	New home construction initiative, Retrofit Program, Heating and Cooling program , Humidifier rebate program (Peel)	Net Metering, Horizon PeakSaver Plus, SaveON Energy PeakSaver plus (Ottawa), High Performance New construction (apartments), Fridge and Freezer pickup
Manitoba		Lower income energy efficiency program, Power Smart home insulation program, Power Smart Pay as You Save Financing, Power Smart Residential loan, Residential Propane and Oil Furnace/Boiler Replacement Program, Solar Water Heating Program	
Saskatchewan		Energy Efficient Rebate for New Homes, SaskEnergy Network Financing Program, EnerGuide for Houses Program, Geothermal and Self-Generated Renewable Power Loan Program, Refrigerator Recycling Program,	
Alberta		CO2RE (Carbon Dioxide Reduction Edmonton) – City of Edmonton, SunRidge BuiltGreen Homeowner Rebate Lethbridge, AB, HAT Smart - A City of Medicine Hat Environmental Initiative,	
BC	City of Kelowna ECO-PASS, Natural Gas Vehicle Grants, BC Scrap-It Program, Energy Efficient Buildings Strategy	Windows Rebate Program, New Home Program, Residential Energy Conservation Assistance Program, City Green Solutions, Air Source Heat Pump (ASHP) Rebate or Loan, ENERGY STAR ® Water Heater Program, Ground Source Heat Pump (GSHP) Rebate or Loan, Home Improvement Program, New Home Program, Solar Hot Water Systems, Switch 'n' Shrink Program (heating to natural gas), LiveSmart BC Efficiency Incentive Program, EcoSave Energy Retrofits Program - City	Fridge Buy Back Program, Net Metering, Residential Energy Saving Kit Offer, ENERGY STAR ® Clothes Washer Rebate Program, Energy Conservation Assistance Program (ECAP)

Province	Personal Transport	Home Heating	Electricity Use
		of Nelson, British Columbia	
Territories		The Residential Advisory Service,	Alternative Energy Technologies Program - Small Renewable Energy Fund, Energy Efficiency Incentive Program (EEIP)
Yukon			Refrigerator and Freezer Retirement Program, Wind Prospecting Service Program
Federal	Fuel efficiency regs Renewable fuel		NRCan efficiency standards

Appendix F Government Organizations in Emissions Reduction



Appendix G Letters

16 September 2013

To: Ontario's Environmental Registry

Subject: Comments on the Long Term Energy Plan (LTEP)

I would like to submit input and suggestions to sections of the LTEP regarding energy conservation. As a student in Engineering and Public Policy at McMaster University, I have been involved with an electricity conservation initiative in a 'code-red' neighborhood in Hamilton that has high energy intensity as revealed by energy mapping, but which also shows a wonderful community spirit as evidenced by purchase of a surplus school that has been converted to a well-used community centre. This real world experience has provided indications of some shortcomings in current energy conservation programs. These people have adopted the standard energy conservation measures such as CFC light bulbs, off-peak use of appliances, motion sensors, and even some very original measures such as using dishwashers every two weeks and cooking only on weekends, then freezing meals. Nevertheless these people are spending too much on electricity, and they cannot afford to.

Energy Audits

A few suggestions have come out of this study related to energy audits and having the recommendations implemented.

1. To increase uptake of the low-income energy audit program, a sliding income qualification scale for home audit eligibility would be an improvement. The people in this neighborhood do not like to think of themselves as low income, and a sliding scale would mean that the audit program could be applied to all, but to varying degrees.
2. Support neighborhood conservation initiatives, such as doing audits on a representative sample of homes in a typical neighborhood and bulk purchasing services and materials.
3. In order to aggressively retrofit existing homes; funding options for energy efficiency should be explored by the OPA such as municipalities using Local Improvement Charges (LIC) initiatives for home energy retrofits (e.g. Toronto Atmospheric Fund is an example).
4. Recommendations from energy audits are often not implemented; to encourage implementation of the recommendations, barriers such as cost, lack of skill, financial reward should be addressed, perhaps by programs run by the Local Distribution Company (LDCs).
5. The requirement to perform an energy audit on the sale of a home should be enforced.

Adopt Small Business Programs to Neighborhood Groups

1. Small businesses enjoy some attractive conservation programs such as the Retrofit program which pays for kWh demand saved. The LTEP should extend these programs for neighborhood or community groups, of a certain size and authenticity.
2. There is scientific rationale for approaching energy conservation programs from a neighborhood or group perspective, much from the UK experience with Carbon Reduction Action Groups (CRAGs). Groups offer sharing and learning opportunities, a sense of empowerment, a sense that green behavior is the social norm rather than the exception, reduce 'free-riders' and focus on

developing conservation knowledge and skills. Cost of conservation materials and services can potentially be addressed by the group.

Provide Better Feedback on Energy Use

1. Smart meters provide feedback on electrical use, and this has been shown in the literature to be an effective means of changing conservation behavior (Fischer[82]). These meters should be developed to provide information on individual appliance loads, be mandatory, and installed by the LDCs.
2. Feedback could be continuous display of electricity use per billing period, or financial incentives for reducing energy use**.**

Municipal Energy Plans

1. I support the requirement for municipal energy plans (including consideration of District Energy Systems (DES), in 'at-risk' neighborhoods.

Time of Use rates

1. I support the OSPE recommendations for changes to TOU rates. In this neighborhood there were many people who were using little electricity but being penalized at peak times. The recommendation to charge base rates for base usage and peak rates for usage OVER this amount during peak periods would make a difference to seniors, stay-at-home mums, home-business owners etc.
2. I also agree with pricing electricity closer to its production cost, so that off-peak rates would be lower and peak rates higher.
3. In addition to TOU rates, reducing the peak usage of electricity could be encouraged by setting targets for the maximum variation between base and peak to minimize the need for peaking plants.

Renewable Energy

1. Subsidies for solar PV should be available so these units become economical to install for the homeowners or neighborhoods own use without having to sell the power into the grid under small or microFIT.
2. Innovation into developing technology for local energy storage options would enable better use of solar PV systems for individual use.
3. Subsidies for solar hot water should be initiated. Subsidies for geothermal were effective and should be restored. The cost of installing geothermal systems should be reviewed and perhaps controlled as this is an effective but expensive program

These suggestions may be part of your existing portfolio, but I would like to emphasize that my studies indicate these can be particularly effective at encouraging conservation behavior.

Regards

Pauline C. Watson, P. Eng.

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September 18, 2013

Sustainable Transportation Program Co-ordinator

Engineering and Construction Department

Subject: Bicycle Facilities - Transportation Master Plan

I am writing out of concern for the poor uptake of bicycling for commuting/shopping (not sports activities) in Oakville. Despite many roads now sporting painted white 'bike lanes' these are underused.

Having read the Active Transportation section in the Transportation Master Plan (TMP) – Switching Gears (2012). I commend you on the scope of the document and the foresight in improving transit in the region.

I have been researching techniques to change public behavior in greenhouse gas (GHG) reducing activities such as personal transportation and have come across some recent information that I would encourage you to consider in applying in the Active Transportation (AT) sections of this Oakville plan and the Halton Region Master Plan (2011).

Perceived lack of safety is the biggest barrier to cycling (Transport Canada Compendium[83]); providing bicycle/traffic physical separation would increase safety and also encourage more active transportation including cycling and other innovative modes. I recall seeing safety as a common theme in the public input for the TMP.

You are likely aware that the Ontario Ministry of Transportation has prepared Ontario Traffic Manual Book 18 Bicycle Facilities, draft May 2013 as a guide to municipal planners. I suggest that this document has many good ideas on bicycle/car separation that could enhance Oakville's cycle routes, and which were not available at the time of Oakville's Transportation Master Plan (TMP).

The guidelines in Book 18 for separated bicycle facilities should be incorporated in the next revisions of the TMP if not sooner. Book 18 contains Section 6 on Implementation, which involves coordination with planned roadwork to minimize costs, and I would hope that at least some of these guidelines could be funded in the 2014 budget.

An example of successful application of these principles is found in Chicago as presented in last May's Share the Road Cycling Coalition's 2013 Bike Summit in Toronto attended by municipal and provincial politicians. Chicago has plans for 100 miles of *protected buffered* bicycle lanes by 2015 and has increased

[83] Transport Canada. (2009). Compendium of Canadian Survey Research on Consumer Attitudes and Behavioural Influences Affecting Sustainable Transportation Optionshttp://www.fcm.ca/Documents/tools/GMF/Transport_Canada/CompendiumResearchSustainableTranspo_EN.pdf accessed 18 Sept 2013

cycling up to 30%. Other cities where buffered bike lanes have been effective include Portland, Copenhagen[84], Rotterdam and the Netherlands[85] (Amsterdam).

Another driver of behavior change is conforming to social norms. I would suggest that Oakville consider more active transportation promotions such as a 'Car-less' days. These are enjoyed in thousands of cities around the world and are a "nudge" to encourage sustainable transportation behavior by make *not* driving the socially accepted behavior for a day, which may have lasting effects.

Regards

Pauline Watson, P. Eng.

[84] Elevating the conversation: Raised bike lanes are coming to Chicago, April 2013 http://chi.streetsblog.org/2013/04/08/elevating-the-conversation-raised-bike-lanes-are-coming-to-chicago/, accessed 18 September 2013

[85] Why is cycling so popular in the Netherlands? BBC News Magazine http://www.bbc.co.uk/news/magazine-23587916 accessed 18 Sept 2013

September 18, 2013

Office of Energy Efficiency

NRCan

Energy Efficiency Standards

I am currently conducting research into changing behavior to reduce greenhouse gas (GHG) emissions. One of my findings is that with respect to changing habitual behavior such as driving or shopping, people do not always make decisions based on economics, and regulations may be more effective than financial incentives, to make the default behavior "green"

I believe that additional or revised regulations are needed to effectively reduce GHG emissions from the personal transportation sector.

- The federal government should adopt stricter fuel efficiency regulations exceeding those of the US (CAFÉ) and being closer to those in Europe
- Renewable fuel regulations of 5% should be increased and alternative fuels made more widely available, as in Sweden. Renewable fuels should not be taxed.
- targets should be set for percentage electric vehicles (EVs) and hybrids
- A carbon tax on gasoline fuel to make hybrids/EVs economical compared to conventional automobiles.

Shoppers often purchase products based on habit: To increase the sale of energy efficient products, it has been found that proper pricing to reflect carbon externalities, and energy efficiency prominently displayed through labeling (as in Japan) are effective. The excessive cost for energy efficient products such as compact fluorescents (CFC) or Light Emitting Diode (LEDs) light bulbs is a barrier to their adoption**.** There should be an investigation into this excessive cost and perhaps a price control or subsidy so that these products are purchased over less energy efficient ones.

Regulations should considered to ban inefficient products (e.g. plasma TVs, incandescent bulbs) so the default option is green; a precedent for this is banning leaded gasoline.

Thank-you for considering my input.

Regards

Pauline C. Watson, P. Eng

September 18, 2013

Ministry of Municipal Affairs and Housing

Subject: Municipal Planning Guidelines Revisions to Support GHG Reductions

I have been studying techniques to change public behavior in greenhouse gas (GHG) emissions reductions. One of my findings is that current municipal infrastructure is a barrier to personal behavior change, and that municipal policies can have a significant impact on energy conservation behavior.

New urbanism is being applied in many new developments (Brampton, Oakville), with 'complete streets' , roads designed to eliminate congestion by using traffic circles and synchronized traffic lights. Surveys indicate the population is willing to move to and live-in sustainable neighborhoods (Transport Canada 2009[86]).

However suburbs remain bastions of the automobile. Planning departments should be encouraged to apply mixed zoning and new urbanism concepts to existing developments; techniques for doing this have been demonstrated 10 minute neighborhoods[87].

District Energy should be part of new urban infrastructure. Municipalities should actively promote DES using solar hot water, geothermal or CHP in areas of high energy intensity, and require new developments to prepare energy plans. Funding solutions such as local improvement charges or proportion of property taxes are needed for pilot district energy or conservation initiatives To encourage more use of solar and geothermal for individual home heating, a supportive policy framework is needed.

Finally, building codes play a key role in energy efficient housing. The next revisions of the provincial building codes should mandate more energy efficient technology such as solar panels and green or "cool" roofs for new homes (City of Toronto bylaw), LEED, and the various technologies used in the REEP house (CMHC). Building code changes may encourage builders and architects deviate from standard plans, without needing to be driven by an environmentally aware homeowner. Developing 'canned' non-standard high efficiency plans will reduce cost.

Thank-you for considering my input.

Regards,

Pauline C. Watson, P. Eng.

Engineering and Sustainable Policy, Inc.

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[86] Transport Canada. (2009). Compendium of Canadian Survey Research on Consumer Attitudes and Behavioural Influences Affecting Sustainable Transportation Options http://www.fcm.ca/Documents/tools/GMF/Transport_Canada/CompendiumResearchSustainableTranspo_EN.pdf accessed 18 Sept 2013

[87] Portland http://www.livablecities.org/blog/10-minute-neighborhoods-will-take-little-more-time accessed 18 September 2013

September 18, 2013

Ministry of Transportation and Infrastructure

Subject: GHG Reduction Policies

I am conducting research into changing behavior to reduce GHG emissions. One of my findings related to changing driving behavior, is that drivers do not purchase EVs and hybrids to save money, but because of an emotional commitment to being environmental, to send a message to car companies, and because of input from peers.

Suggestions to tap-into these behavioral insights and increase purchase of these vehicles are to:

- provide larger subsidies for EVs and home charging stations (ecoAuto)
- provide preferred parking and use of High Occupancy Vehicle (HOV) lanes to EVs and hybrids (MOT).
- targets for percentage EVs and hybrids should be set

In addition, programs to raise awareness of the negative effects of idling should be developed, especially at schools and drive through establishments. Driving efficiency should be included as part of driver education, and effective fuel efficiency gauges should be installed in all cars**.**

Thank-you for considering my input.

Regards,

Pauline C. Watson, P. Eng.

Engineering and Sustainable Policy Inc.