Visit http://www.webmade.ca/mark/onedegree.html for a One Degree video

one degree.
saving money and the environment is simple

ANNUAL SAVINGS

For Canadian businesses, One Degree saves:

- *GHG emissions = 1.8 million tonnes*
- *Equivalent in cars = 327,500*
- *Actual dollars = +$800 million*

Adjusting our interior temperature one degree Celsius closer to the natural outdoor temperature will significantly help the environment while also generating substantial financial savings.

EXECUTIVE SUMMARY:

Heating and cooling (i.e., space conditioning) in Canada costs businesses nearly $15 billion every year. To save money, businesses hire energy efficiency specialists who typically recommend high-grade thermal windows, thermostat setback strategies, and high efficiency furnaces and air conditioners. However, the simplest strategy of all is to adjust the interior temperature of buildings 1°C closer to the natural outdoor temperature at all times. A one degree adjustment has been estimated to save 5.4% of total space conditioning costs and energy use. For Canadian businesses the collective savings amount to 1.8 million tonnes of GHG (greenhouse gas) emissions and over $800 million every year. Comfort isn't an issue either because people won't physically notice the change: medical research has found that human body temperatures fluctuate naturally by 1°F (0.5°C) every day. One Degree is simple, original and easy to implement, and yet the environmental and financial implications it generates are substantial. In short, it's smart business.

WHAT IS ONE DEGREE?

There are 732 million square meters of commercial space covering Canada's landscape[1]—most of which is either heated or cooled twelve months of the year. "Since Canada is a northern country, home [and business] heating consumes a much greater amount of energy for the average home [and business] on an annual basis compared with other countries."[2] This profile helps make space conditioning the most energy intensive activity for Canadian buildings. Prolific heating and cooling taxes our energy system while harming our natural environment and costing Canadian businesses and homeowners nearly $35 billion every year.[3] To help address this environmental and financial concern, businesses are challenged to adopt One Degree.

One Degree is an initiative that encourages businesses to permanently adjust their buildings' temperatures one degree Celsius closer to the natural outdoor temperature. The mission of One Degree is: *Saving Canadian businesses money on their heating and cooling bills while reducing the degrading effects of energy and resource consumption on our natural environment.*

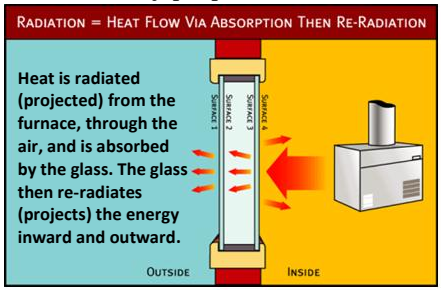
One Degree has been designed in three successive stages to ensure its mission is fulfilled:

1. Canadian retailers are targeted to adopt One Degree;
2. Every Canadian business is challenged to implement One Degree across all their buildings (including offices);
3. One Degree is marketed to the entire Canadian public to be adopted in all Canadian buildings (e.g., dwellings).

Because Canada's climate varies by geography, heating and cooling savings will be different for each business that implements One Degree. For example, businesses in southern Ontario will likely achieve both tangible heating *and* cooling savings, while companies in colder climates (e.g., Calgary) may save mostly on heating alone. Nevertheless, One Degree is a simple change which is easy to implement and won't physically be noticed by customers or employees, but it's yet to be done because many people don't realize the magnitude of the environmental and financial implications of heating and cooling.

HOW ONE DEGREE WORKS

One Degree is simple; however, it is important to note one consideration: the difference between indoor and outdoor temperatures. When the gap in indoor and outdoor temperatures is larger (i.e., warmer inside and cooler outside, or vice versa), a greater loss of hot or cold air will occur. This loss of energy (hot or cold air) occurs through radiant, convective and conductive heat transfer. Heat transfer can occur from hot outdoor air warming a cool building in the summer, or hot air exiting a heated building on a cold day. A diagram



Energy loss via radiation; Source: PPG Industries

NOTE: All scientific statements in this report have been referenced from quality articles in scientific journals or government publications. Statements pertaining to companies are supported by primary data (e.g., speaking to store managers) and/or secondary data (e.g., company reports). Many figures have been converted from Fahrenheit to Celsius where 1°C = 1.8°F. References to the residential sector are made to illustrate the impact of One Degree if adopted across all Canadian buildings. **Tables:** Due to rounding, the numbers in the tables may not add up to their reported totals. See attached *One Degree Master Backup.xls* for calculations and support.

[1] Environment Canada (July 2011). *Canada's Emissions Trends*. Canada (p. 30)

[2] Environment Canada (2009). *National Inventory Report 1990–2008: Greenhouse Gas Sources and Sinks in Canada* (Part 1). Canada (p. 79)

[3] Natural Resources Canada (September 2010). *Energy Efficiency Trends in Canada: 1990 to 2008.* Canada (p. 21)

illustrating radiant heat loss is shown here. As a result of heat transfer, the costs of heating and cooling rise exponentially, not linearly. That is, each subsequent degree of heating in the winter (and cooling in the summer) will cost more than the previous degree. Likewise, in the case of One Degree, an adjustment of 1°C will have the greatest savings—both environmental and financial—for the smallest adjustment.

Projected Savings through One Degree

Although a one degree change may seem small, the savings are significant. For 1°C the savings are:

- EnergyStar and the EPA assume a **5.4%** savings per degree Celsius of change; [4]
- The U.S. Department of Energy also claims savings of **5.4%** for 1°C (1.8% per 8 hours); [5]
- Natural Research Council Canada has pegged the savings **between 3.7% and 4.3%**;[6]
- Researchers Nelson and MacArthur calculate the savings **between 5.4% and 8.0%**.[7]

University of Alberta's Dr. Andre Plourde states that a general rule of thumb for savings is 5.4% per degree Celsius of adjustment.[8] Although estimates are conservative,[9] this report uses the same figure: 5.4% for a 1°C change. Illustrating that savings can exceed 5.4%, I used Honeywell's calculator for commercial energy savings[10] and found the annual energy savings to be 7.0% by adjusting a 50,000 square foot retail building's temperature by 1°C closer to the outside temperature all year.[11]

Nova Scotia Power's Tuft's Cove Generating Station
Source: CBC News

The Environmental Costs of Heating and Cooling

Despite many increases in efficiencies, from 1990 to 2008 the GHG emissions from the Canadian commerical sector rose 38%, which has contributed to businesses emitting roughly 13% of Canada's total GHG emissions each year. The commerical sector is the fastest growing area in terms of GHG emissions (even above transportation)[12] and now emits 65.3 megatonnes (Mt) of GHG, or $C0_2e$ (carbon dioxide equivalent), on an annual basis.[13] (One megatonne = one million tonnes).

Most of these emmissions have to do with heating and cooling. As indicated by energy consumption patterns, heating is the most significant contributor to GHG emissions for both the Canadian commerical and residential sectors. In fact, 52% of total energy consumption in the commercial sector is used for space heating and cooling, while the numbers are even higher in the residential sector. This heavy drain causes businesses to use over 1,200 petajoules (PJ) of energy every year, or about 645 PJ for heating and cooling alone. To put this in perspective, one PJ is "approximately equal to the energy used by almost 9,000 households in one year."[14] In other words, the energy used by businesses to solely heat and cool their buildings is enough to power nearly 6,000,000 households for an entire year.

Table 1: *Energy Use and GHG Emissions*[15]

	Energy Use (PJ/year)			GHG Emissions (Mt $C0_2e$/year)			**Heating/Cooling** GHG Equivalencies (thousands)			
	All Sources*	Heating	Cooling	All Sources*	Heating	Cooling	Cars	Gasoline (L)	Forest Acres	Trees
Retail**	203.6	97.4	9.4	11.0	5.2	0.5	1,021.8	2,211,453.7	1,111.1	133,618.0
Commercial	1205.9	576.9	55.7	65.3	31.1	3.0	6,065.7	13,127,994.0	6,595.9	793,205.1
Residential	1465.3	920.8	22.8	74.2	45.5	1.2	8,307.0	17,978,807.1	9,033.2	1,086,295.5

**All Sources includes heating and cooling figures in addition to other energy-consuming activities (e.g., lighting) **Retail uses more energy and emits more GHG per year than all other commercial activities save offices. GHG equivalencies are calculated using: http://www.epa.gov/cleanenergy/energy-resources/calculator.html*
NOTE: Commercial figures include Retail.

[4] EPA (2007). *Energy Efficiency with ENERGY STAR*. EnergyStar estimates savings for cooling only. (1°f = 1.8°C)
[5] U.S. Department of Energy (2011). *Energy Savers: Thermostats and Control Systems*. (http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12720)
[6] Manning, M. M., Swinton, M. C.., Szadkowski, F., Gusdorf, J., & Ruest, K. (2007). The Effects of Thermostat Setback and Setup on Seasonal Energy Consumption, Surface Temperatures and Recovery Times at the CCHT Twin House Facility. *Natural Research Council Canada, 113*(1), 1-12. **Findings**: 7-hour day and night setback of 6°C and 4°C saves 13% and 10%, respectively. Thus, 1°C for 24-hours yields 3.7% and 4.3% [(6°C/13%)*(24h/(7h*2))] and [(4°C/10%)*(24h/(7h*2))]
[7] Nelson, L. W., and MacArthur, J. W. (1978). Energy Savings Through Thermostat Setback. *American Society of Heating, Refrigeration and Air-Conditioning Engineers, 84*(2): 319-334. **Findings**: 8-hour day and night setback of 5.6°C and 2.8°C saves 20% and 15%, respectively. Thus, 1°C for 24-hours yields 5.4% and 8.0% [(5.6°C/20%)*(24h/(8h*2))] and [(2.8°C/15%)*(24h/(8h*2))]
[8] Plourde, A. (2003). Programmable Thermostats as Means of Generating Energy Savings: Some Pros and Cons. CBEEDAC (p. 2). **Conversion:** 1°F for 8-hours saves 1%. Thus, 1°C for 24-hours saves 5.4% (1%*1.8*3)
[9] Estimates are conservative because each is based on a larger setback strategy which experiences diminishing returns with each additional degree of adjustment.
[10] http://customer.honeywell.com/NR/rdonlyres/6172D9E9-BC48-425E-89EA-6FD92F118BC5/3688/CommercialProgrammableThermostatEnergySavingsEstim.xls
[11] Assumptions: 50,000 sq ft retail space consuming 1,530 MBTU's per year for heat and 85,294 kWh for cooling. 84% gas furnace efficiency.
  a. Prices (incl. tax): 44.5 cents/m^3 of natural gas and 12.3 cents/kWh of electricity. Based on 2008 Canadian commercial energy prices: (http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/tableshandbook2/com_00_7_e_4.cfm?attr=0)
  b. Annual heating and cooling expenses @ 21.5°C during heating season and 25.5°C during cooling season = $30,211
  c. Annual heating and cooling expenses @ 20.5°C during heating season and 26.5°C during cooling season = $28,096
[12] Natural Resources Canada (September 2010). *Energy Efficiency Trends in Canada: 1990 to 2008.* Canada (p.7)
[13] Natural Resources Canada (2011). *Energy Use Data Handbook: 1990 to 2008*. Canada (p. 8-9)
[14] Natural Resources Canada (September 2010). *Energy Efficiency Trends in Canada: 1990 to 2008.* Canada (p. 2)
[15] Data for energy use and GHG emissions were taken from Natural Resources Canada (2011). *Energy Use Data Handbook: 1990 to 2008*. Canada

Comparing with other energy-consuming activities in the commerical sector, heating emits over four times more GHG per year than lighting; together, heating and cooling emit more GHG than all water heating, auxiliary equipment, and lighting combined.[16] In comparison, in a typical year commerical heating emits nearly twice as much GHG as all Canadian passenger airplanes/jets combined and about 75% of the total emissions from all passenger cars.[17] However, with such a large impact comes a vast opportunity to save.

Assuming a 5.4% reduction in energy use, by adopting One Degree the Canadian retail sector would be able to reduce Canada's GHG emissions and energy consumption, respectively, by 310,000 tonnes of $C0_2e$ and 5.8 PJ per year. If the entire commercial sector were to come on board, the savings become roughly six times greater: 1.84 million fewer tonnes of $C0_2e$ would be emitted every year and 34.2 fewer PJ of energy would be used. This equates to taking 327,500 cars off the road or saving 42.8 million trees—*all by a one degree change*.

Table 2: *Energy Use and GHG Emissions Savings with One Degree*

	Energy Savings (PJ/year)			GHG Savings (Mt $C0_2e$/year)			GHG Equivalent Savings (thousands)*			
	Total	Heating	Cooling	**Total**	Heating	Cooling	Cars	Gasoline (L)	Forest Acres	Trees
Retail*	**5.8**	5.3	0.5	**0.31**	0.28	0.03	55.2	119,418.5	60.0	7,215.4
Commercial	**34.2**	31.2	3.0	**1.84**	1.68	0.16	327.5	708,911.7	356.2	42,833.1
Residential	**51.0**	49.7	1.2	**2.52**	2.46	0.06	448.6	970,855.6	487.8	58,660.0

Given the link between GHG emissions and related environmental concerns, it is important to consider the resources being used for space conditioning. In terms of overall energy use in the commercial sector, 87% comes from electricity and natural gas, with light and heavy fuel oil and kerosene making up the next major sources.[18] For heating purposes, many businesses use furnaces which burn these non-renewable resources directly or indirectly through electricity-powered systems. According to the Millennium Ecosystem Assessment, these fossil fuels are associated with numerous environmental problems that arise from "impacts to ecosystems during extraction, spills and air pollution during transportation, and air pollution and GHG emissions during processing and use."[19] However, as the figures above illustrate, a small change can reduce our impact and extend the life and value of these finite resources.

> ***1°C** = 310,000 tonnes of CO_2e, or 7.2 million trees, and $128 million in savings every year for **Canadian retailers***

The Financial Costs of Heating and Cooling

In addition to the environmental burden caused by heating and cooling in Canada, space conditioning costs businesses and homeowners a substantial amount of money. The Canadian commercial sector spent about $13.5 billion to heat and $1.4 billion to cool their buildings in 2008.[20] Homeowners spent even more with nearly $20 billion allocated for these purposes.

Table 3: *Financial and Energy Costs of Heating and Cooling and Estimated Savings with One Degree*

	Land Area (m^2)	Energy Allocation (% total energy)		Costs (thousands CDN $)			Estimated Annual Savings with One Degree (thousands CDN $)		
		Heating	Cooling	**Total**	Heating	Cooling	**Total**	Heating	Cooling
Retail	112,000,000	n/a	n/a	**$2,374,400***	$2,150,400*	$224,000*	**$128,218**	$116,122	$12,096
Commercial	732,000,000	48%	5%	**$14,840,000**	$13,440,000	$1,400,000	**$801,360**	$725,760	$75,600
Residential	1,756,000,000	63%	2%	**$19,890,000**	$19,278,000	$612,000	**$1,074,060**	$1,041,012	$33,048

**On average retail uses the same amount of energy for heating and cooling as the average commercial user (e.g., food services) so estimates are calculated as a percentage of total commercial space.*

Despite energy efficiency improvements, from 1990 to 2008 energy consumption from cooling grew the second fastest of all business-related energy consuming activities.[21] To add to this problem of rising use, energy prices are continuing to trend upward. From 1990 to 2008 commercial natural gas prices (incl. tax) increased 191%, while electricity costs rose between 42% and 46%.[22]

Fortunately to help businesses combat the rising costs of space conditioning, there is One Degree. To illustrate the impact of One Degree, Table 4 lays out the annual estimated savings by making a 1°C change for three of Canada's largest retailers. As we see from the numbers, a seemingly unnoticeable 1°C adjustment translates into sizeable financial savings for businesses. Although three examples are shown here, businesses from all sectors (e.g., warehouses and food services) can profit from adopting One Degree.

[16] Natural Resource Canada (2011). *Energy Use Data Handbook: 1990 to 2008*. Canada (p. 8-9)
[17] Natural Resource Canada (2011). *Energy Use Data Handbook: 1990 to 2008*. Canada (p. 10-11)
[18] Natural Resource Canada (2011). *Energy Use Data Handbook: 1990 to 2008*. Canada (p. 48-49)
[19] Millennium Ecosystem Assessment (2005). *Ecosystems and Human Well-Being: Opportunities and Challenges for Business and Industry* (p. 12)
[20] Natural Resources Canada (September 2010). *Energy Efficiency Trends in Canada: 1990 to 2008.* Canada (p.20)
[21] Natural Resource Canada (2011). *Energy Use Data Handbook: 1990 to 2008*. Canada (p. 48-49)
[22] Office of Energy Efficiency (2011). Commercial/Institutional Energy Prices. (http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/handbook_tables.cfm?attr=0)

Table 4: *Financial Heating and Cooling Estimates for Select Major Canadian Retailers*

	Total Retail Area (m^2)	% of Total Commercial Space	Estimated Annual Costs (thousands CDN $)*			Estimated Annual Savings with One Degree (thousands CDN $)**		
			Total	Heating	Cooling	**Total**	Heating	Cooling
Canadian Tire	209,032	0.291	**43,130.9**	39,061.9	4,069.0	**2,329.1**	2,109.3	219.7
Future Shop	358,977	0.049	**7,277.6**	6,591.1	686.6	**393.0**	355.9	37.1
Loblaw	4,626,571	0.642	**95,795.5**	84,946.8	8,848.6	**5,065.0**	4,587.1	477.8
Retail Sector	117,120,000	16.0	**2,374,400.0**	2,150,400.0	224,000.0	**128,217.6**	116,121.6	12,096.0

**To accommodate the diversity in buildings, local climate of stores, heating and cooling systems, and company practices, these estimates are based on the total heating and cooling costs of the entire commercial sector (located in Table 3). The percentage of total commercial space for each retailer is used to calculate the percentage of annual heating and cooling costs. Cross-checking estimates, these figures are close to those outputted using Honeywell's commercial energy savings calculator. **Assumes savings of 5.4% per degree of adjustment, which is a widely accepted conservative estimate.*

Starting One Degree with Retailers

Any business can and will benefit from adopting One Degree; however, retailers are the initial target market because:

1. **Size.** Besides office buildings, retailers have the largest spaces to heat and cool (112,000,000 m^2).
2. **Energy Intensity.** Retail uses 1.79 gigajoules/m^2,[23] which is moderately intense in comparison to other commercial types.
3. **Ease of Implementation.** Homeowners typically adjust their heat according to the outside climate. Conversely, businesses select a consistent temperature (often 20-21°C)[24] which makes a one degree change very easy to implement.
4. **Growth.** From 1990-2008, GHG emissions increased 21.9%, 79.0% and 41.6%, respectively, in commercial heating and cooling, and the retail sector as a whole.[25] Overall, GHG emissions are the fastest growing in the commercial sector.
5. **Visibility.** Businesses, especially retailers, are highly visible and are more easily able to start movements and initiate change.

Elaborating on ease of implementation, many of Canada's largest retailers, such as Wal-Mart, now control their store temperatures from a central location (e.g., Headquarters) and temperatures are determined by specialists rather than store managers.[26] For example, in the case of Future Shop, newer stores' temperatures are controlled via Novar, a company specializing in commercial energy management (www.novar.com). This method of temperature control makes introducing One Degree easy and seamless.

Considering the Stakeholders

For the most part, people don't notice minor changes in temperature.[27] In fact, researchers have found that **human body temperature varies naturally by approximately 1°F (0.5°C) throughout a day** and people don't notice.[28] Human temperature also varies naturally based on the seasons (called circannual rhythm).

As a component of *atmospherics*, extensive research has attempted to find the ideal temperature to increase consumer comfort and spending in retail environments and yet, for the most part, it doesn't take the *outdoor* (or Canadian) climate into consideration. For several reasons, a one degree shift in the temperature will not negatively affect consumer spending or comfort:

1. People won't physically notice a one degree change temperature;
2. Canadian consumers dress according to the outdoors, which often means warmer clothing during heating season;
3. Consumers prefer cooler retail environments[29] and become irritated and leave when stores are too warm.[30]

The Future of One Degree

One Degree is simple, original and easy to implement, and yet the environmental and financial implications it generates are substantial. By making a 1°C adjustment, businesses can reduce their environmental impact, save money and become better corporate citizens. While consumers won't physically notice the temperature change, they will recognize and reward smart environmental and financial decision making. Although tangible savings will be achieved within retail, this sector is just a sliver of what's to come in the months and years ahead for One Degree. Starting this initiative here will help One Degree gain traction while setting the Canadian business community apart from our competitors in terms of environmental and financial stewardship. One Degree is an easy solution to cutting costs and emissions. We should be proud; we should be excited.

Please visit this link for a One Degree promotional video: http://www.webmade.ca/mark/onedegree.html

[23] Natural Resources Canada (September 2010). *Energy Efficiency Trends in Canada: 1990 to 2008.* Canada (p. 21)
[24] Measuring temperatures across multiple Canadian retailers I found that store temperatures typically range between 20-21°C.
[25] Natural Resource Canada (2011). *Energy Use Data Handbook: 1990 to 2008.* Canada (p. 52-53)
[26] This information was obtained from speaking to several of Wal-Mart Canada's Store Managers and through email correspondence with employees at Wal-Mart Canada's Head Office in Mississauga.
[27] Zehner, W. J. & Terndrup, T. E. (1991). The Impact of Moderate Ambient Temperature Variance on the Relationship Between Oral, Rectal, and Tympanic Membrane Temperatures. *Clinical Pediatrics, 30*(4), 61-64.
[28] Mackowiak, P. A., Wasserman, S. S., & Levine, M. M. (1992). A Critical Appraisal of 98.6 Degrees F, the Upper Limit of the Normal Body Temperature, and Other Legacies of Carl Reinhold August Wunderlich. *The Journal of the American Medical Association, 268*(12), 1578-1580.
[29] d'Astous, D. (2000). Irritating Aspects of the Shopping Environment. *Journal of Business Research, 49*(2), 149-156.
[30] Engbrocks, S. (2008). The Impact of Temperature on a Consumer's Shopping Experience. *University Masstricht.* **Note:** Although a preference for cooler environments exists, too cool of stores in the summer have been shown to also have negative effects as consumers generally dress according to outdoor temperatures.