

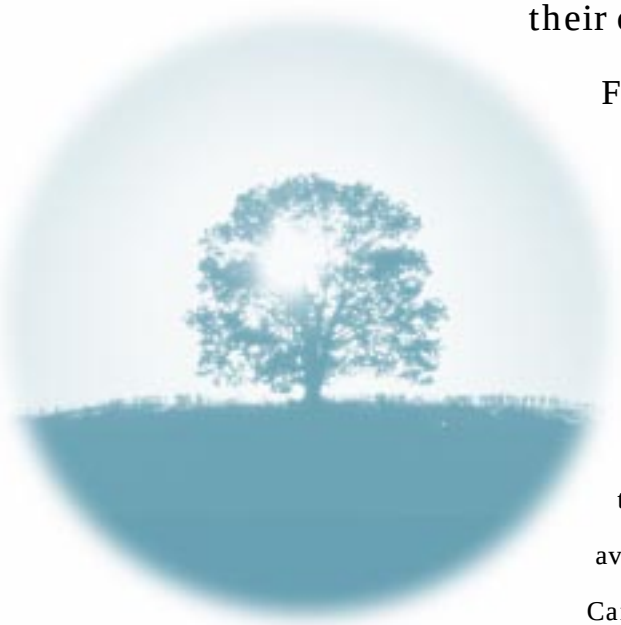


POWER Shift

COOL SOLUTIONS TO GLOBAL WARMING

A transformation **is taking place in one the most basic aspects of our daily lives — the way we use energy. From Japanese 'hybrid' automobiles to the explosive growth of the Danish wind-turbine industry, nations with vision are shifting to cleaner, more efficient energy systems …**

… As they do, they reduce atmospheric pollution and the risks of climate change, while increasing employment and enhancing their competitive edge in the global economy. For instance, investments in energy efficiency have been found to produce four times more jobs than equivalent spending in new supplies of conventional energy.



Yet this shift in energy use and the corresponding decline in pollution are not happening at the speed they could occur, and indeed must occur, if we are to avoid significant and dangerous changes in our climate. Canada is a rich, industrialized nation that has often led the world in technological advances, including within our energy sectors. But we are lagging behind Europe and Japan in utilizing new energy-efficient technologies and techniques, even though these new approaches could reduce energy costs, improve air quality and public health, stimulate new industries and create new jobs. The knowledge and the tools to move forward are available. What is lacking is the will and the vision to do so.

The low-carbon future that is described here is the result of analytical modelling work by Ralph Torrie, one of Canada's foremost sustainable energy experts and an internationally recognized authority in this field. Torrie assessed end-use energy projections based on expected population and economic growth, and found that Canada's emissions will continue to grow to 30 per cent above today's levels by 2030. From this base case he then calculated the changing energy balances across the country as he applied practical, available technologies to reduce energy consumption. This model points the way forward to a low-carbon Canada, in which we cut greenhouse gases in half and begin to meet our international obligations to protect the global climate.

The technology is here. The need is pressing. Canada must seize the considerable opportunities in a low-carbon future and seize them now.

"We must act now to protect our climate"

DR. DAVID SUZUKI

I believe in the most profound way that global climate change is a severe threat to both nature and to human development. For many years now, scientists in the climate field have been warning us of the likely changes caused by increasing emissions of greenhouse gases: higher temperatures, more extreme weather, major impacts upon nature. While many of us understand these warnings, our leaders are refusing to act upon the advice of scientists to reduce emissions of greenhouse gases.

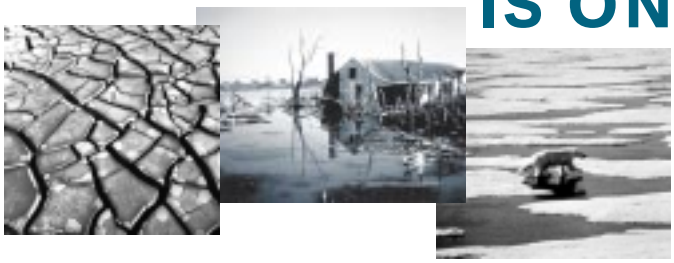
But act we must. In these pages the David Suzuki Foundation and energy efficiency expert Ralph Torrie have sketched out the path to a future in which Canada emits far less greenhouse gases. That vision is as exciting as it is necessary. As our industrial, media and political leaders dance around the modest goals of the Kyoto Protocol, it is helpful to examine this analysis because it directs us to our ultimate goal: achieving and then surpassing the 50% cuts that are needed.

Is this bold? Yes. Achievable? Yes. Is it utopian? No, because this analysis is based upon existing technologies and efficiency techniques, and applies them broadly throughout Canadian society.

But it is far more than technology that will eventually put us on the path to a low-carbon, climate-friendly future. We must examine closely the attitudes in our society that encourage and even reward energy waste and inefficiency. We must challenge and confront the ethics of treating the atmosphere as a free dumping ground. In short, we must learn to regard our air and our climate as the precious resources they are – vital elements of nature that cannot be ignored without consequences.

That is the root of this initial effort to describe a low-carbon future. I welcome it and urge you, and every Canadian, to help make it a reality.

the heat IS ON



Gases such as carbon dioxide, methane and nitrous oxide are "heat-trapping" gases that produce a natural greenhouse effect and keep the Earth warm enough to sustain life. The combustion of fossil fuels and other human activities, however, are dramatically increasing the atmospheric concentration of these gases. This is magnifying the greenhouse effect, and the result is climate change.

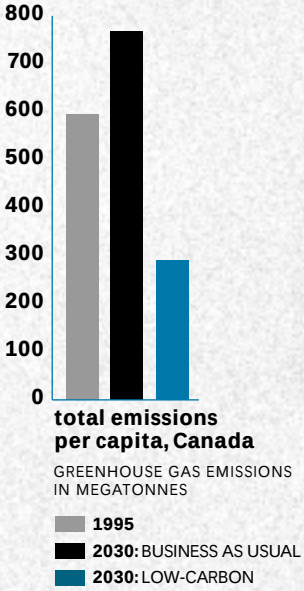
Since the Industrial Revolution, the concentration of carbon dioxide (CO_2) in the Earth's atmosphere has mushroomed from 280 parts per million to 360 ppm – levels far higher than at any time during the last 450,000 years. By 2050, greenhouse gas (GHG) concentrations will climb to a level equivalent to 560 ppm of CO_2 unless we make substantial changes.

In the past decade, North Americans have witnessed many calamitous weather changes and ecological impacts resulting from global warming. We can expect scenarios like the ones described below to become both more common and more extreme as GHG concentrations continue to increase.

- Polar bears, high-arctic caribou and other animals that depend on cold are suffering as changing weather patterns disrupt their feeding habits.
- Salmon stocks in B.C. appear to be migrating further north as water temperatures rise.
- Ice in the Arctic has thinned by nearly 40 per cent in the last 30 years.
- Epic flooding of the Sagueney and Red rivers caused the evacuation of 15,000 people, and untold human suffering.
- The 1998 ice storm affected millions of Canadians and crippled much of Ontario and Quebec. Costs are estimated at more than $3 billion.
- The last two decades of the 20th century were the warmest on record. As this trend continues, we will face longer and more frequent heat waves.
- Sea levels are already rising, causing severe erosion of coastal communities and estuaries.
- Repair of the ozone layer may be slowed as a result of global warming, increasing public-health risks such as cataracts and skin cancer.

Unless strong measures are taken, especially by North Americans, scientists say we can only expect the situation to get worse. To avert these disasters, we must reduce GHG emissions significantly. This means making energy efficiency a priority and switching to environmentally friendly energy sources. Buildings, vehicles, industry and all sorts of energy-using equipment must become much more efficient and much less dependent on fossil fuels. This will allow us to close down coal-fired power plants, squeeze more useful energy out of the fossil fuels we do use, and begin the transition to a renewable energy economy.

Canada leads IN ENERGY WASTE



Canadians and Americans use more energy per capita – the annual equivalent of 7.86 tonnes of oil – than the citizens of any other country in the world. That's partly because of our winters, as well as our modern industrial economy. But that's no excuse. Denmark and Sweden, industrialized nations that experience similar weather, use far less energy – 3.99 tonnes of oil equivalent and 5.87 tonnes, respectively – than we do. And Germany, an industrialized nation with a high standard of living, uses just 4.23 tonnes of oil equivalent per capita – about half as much as North America.

If Canadians continue to consume energy for the next 30 years as we have in the past, greenhouse emissions will swell by 30 per cent to 780 megatonnes a year – or 21 tonnes of CO_2 equivalent for each man, woman and child.

WHAT ARE THE "GREENHOUSE" GASES?

Carbon dioxide (CO_2), the primary greenhouse gas, is produced by living organisms and by human activities, particularly through the combustion of fossil fuels. In Canada, 76% of our contribution to global warming comes from CO_2.

Methane, the second most common greenhouse gas, is produced by decomposing plant and animal material, and is the primary constituent of natural gas. Although total methane emissions are much smaller than CO_2, it is a far more potent greenhouse gas with 21 times as much global-warming potential per molecule as CO_2. Methane is responsible for about 12% of Canada's contribution to global warming.

Nitrous oxide (N_2O) is another greenhouse gas produced from the combustion of fossil fuels. It is also released through the production and application of nitrogen fertilizers and from natural sources. It has a global-warming potential 310 times greater than CO_2. Nitrous oxide emissions account for 11% of Canada's contribution to global warming.

A number of modern industrial chemicals also act as powerful greenhouse gases:

Hydrofluorocarbons (HFCs), developed as a substitute for chlorofuorocarbons (CFCs), and used in refrigeration and the manufacture of semi-conductors, have a global-warming potential which ranges from 140 to 11,700 times greater than CO_2.

Per-fluorocarbons (PFCs), released during the aluminium refining process, have a global-warming potential 7,400 times greater than CO_2.

Sulphur hexafluoride (SF_6), used in heavy industry to insulate high-voltage equipment and released in the production of magnesium, has a global-warming potential 25,000 times greater than CO_2.

All together these emissions account for 1% of Canada's contribution to global warming.

THE KYOTO PROTOCOL

Canada, along with 180 other nations, signed and ratified the 1992 United Nations Framework Convention on Climate Change, an international treaty aimed at preventing dangerous interference with the climate system.

In 1997, a set of emission-reduction targets was agreed on at Kyoto, Japan. Under the Kyoto Protocol, Canada committed to lower GHG emissions to a level 6% below that of 1990 by 2010.

Even if Canada met this target – and there is no concrete plan in place to help us do so – would that mean climate protection could be achieved?

Unfortunately, the answer is no. The prevailing scientific assessment is that unless we can reduce GHG emissions on a global basis by 50–80%, we will face challenges from a changing climate that are likely to be far beyond our capabilities for adaptation.

cool solutions
TO GLOBAL WARMING

clean air

clean energy

climate protection

Canadians can cut GHG emissions by 50 per cent of current levels over the next 30 years. This vision of a "low-carbon future" is based on an analytical model that breaks down GHG emissions into "end uses" by particular types and activities – for instance, emissions linked to water heaters in houses or apartments, or emissions from diesel buses and trucks.

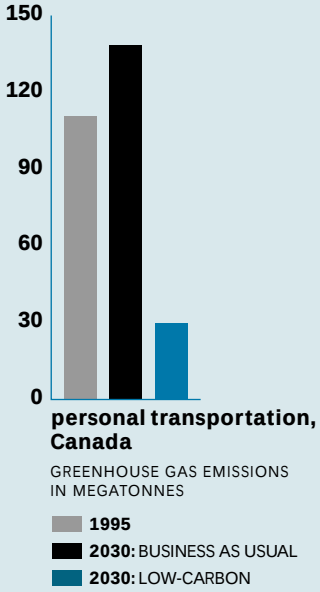
This type of end-use model runs various scenarios regarding the level and mix of activity, technological efficiency, and fuel shares showing the effect on GHG emission levels.

The analysis begins with Canada's GHG emissions in 1995 – some 600 million tonnes, of which about 500 million tonnes resulted from fossil-fuel production and consumption. The remainder comes from a variety of non-energy sources, including agricultural and industrial processes and municipal waste.

Assuming population growth of 19 per cent and a growth in transportation of 38 per cent over the next 30 years, several scenarios can be produced for GHG emissions in seven key sectors: moving people, residential buildings, commercial buildings, industrial energy use, freight transportation, electricity production, and non-energy sources.




personal transportation



personal transportation, Canada

GREENHOUSE GAS EMISSIONS IN MEGATONNES

- **1995**
- **2030:** BUSINESS AS USUAL
- **2030:** LOW-CARBON

If we do nothing to reduce emissions from this sector, by 2030 we will be pumping 140 million tonnes of GHGs into the atmosphere, well above the 1995 total of 110 million tonnes. And 90 per cent of those gases will come from personal vehicles – cars, minivans and SUVs – with the remainder coming mainly from airplanes.

Five factors determine the GHG emissions from travel: the number of trips, the length of trips, the mode of travel (e.g. walking, cycling, single-occupancy car, multiple-occupancy car, transit, etc.), the fuel efficiency of the vehicle, and the type of fuel being used by the vehicle. In the low-carbon scenario, changes in all these factors lead to reductions in greenhouse emissions.

Canadians are among the most mobile people on Earth. The average Canadian travels some 20,000 kilometres a year, mostly in personal vehicles. The low-carbon scenario assumes that per capita mobility levels remain constant, with the amount of travel increasing at the same rate as population, reaching about 120 per cent of 1995 levels by 2030.

TAKING ACTION

- Demand eases: While a "business as usual" scenario assumes that per capita mobility will continue to increase in the future, in the low-carbon scenario, people are encouraged to gain access to what they need and want with fewer and shorter trips – partly via increasing use of the Internet, but also thanks to a move in urban planning to design new neighbourhoods and transform old ones to reduce automobile dependency.
- Fuel efficiency triples: In the low-carbon scenario, vehicle efficiency, alternative fuels and some mode shifts will achieve GHG reductions from personal transportation. Fuel efficiency will be between two and three times higher in 2030 than it is today, and a new generation of vehicles will be powered by hybrid gasoline/electric engines and electric motors run by hydrogen fuel cells. The hydrogen will usually be produced from natural gas, but in some locales from surplus hydro-electric capacity. When hydrogen is made from natural gas, the full fuel cycle efficiency is about 75 per cent, representing a several-fold increase over the current efficiency of internal combustion vehicles; when made from hydro-electricity, the result is an almost zero-emission vehicle.
- Transit use expands: Transit's share of work-related trips will grow to 10 to 20 per cent, depending on the length of trip. Highly efficient vehicles will run on alternative fuels, and a more diversified and customer-responsive transit system will use high-tech systems to provide something approaching door-to-door, on-demand service.

photos, l-r

Pedal power and public transit; European trolley cars; Electric car prototype; Bullet train

Residential retrofits; High efficiency water tank; Integrated residential solar

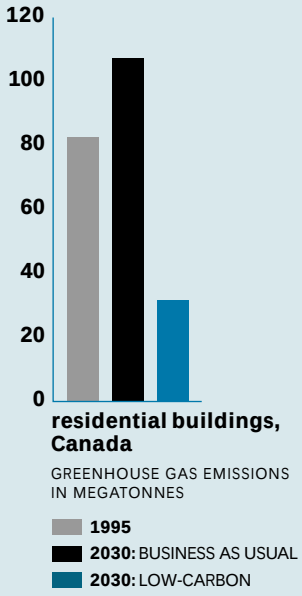



residential buildings

In 1995, the energy for space heating, water heating, and electrical appliances in Canadian homes created about 80 million tonnes of GHG emissions. If we do nothing, this will balloon to 107 million tonnes in 2030, mainly as a result of growth in the number of households.

The low-carbon scenario assumes population growth to 36.8 million in 2030, an increase of 19 per cent from 2000. The number of households will grow by 30 per cent, and housing-type shares will remain at 1995 values: 55 per cent of households in single-family detached dwellings, 10 per cent in single-family attached housing, 33 per cent in apartments, and 2 per cent in other types of housing.

The level of conveniences enjoyed by Canadian households will not be reduced, and current ownership rates of major appliances will be maintained. However, dramatic changes will occur in the energy required for space heating, water heating, and appliances in our homes, as well as in the source of this energy.



residential buildings, Canada

GREENHOUSE GAS EMISSIONS IN MEGATONNES

- **1995**
- **2030:** BUSINESS AS USUAL
- **2030:** LOW-CARBON

TAKING ACTION

- Retrofitting existing homes and apartments: A massive program over the next 30 years will refit 80 per cent of Canada's housing stock, providing about 1,000,000 person-years of skilled employment. This program includes upgrading attic and basement insulation to achieve double airtightness; replacing doors with steel polyurethane core doors; replacing windows with triple low-e argon-filled types; replacing furnaces and wood stoves with highly efficient models.
- New homes and apartments: All new homes will be built to the current R-2000 standards, an easily achievable improvement over today's average new home. In addition, new apartments will be built to standards four times more energy-efficient than today's.
- Appliances: Hot-water tanks are "conserver tank" models; no oil-fired tanks exist in 2030. Solar-water heaters replace between 30 per cent and 40 per cent of natural gas requirements. The average bulb comes down to about 20 watts, similar to that of a good compact fluorescent today. Through energy-efficiency improvements, refrigerators use about 300 kWh/year, half the amount of a new fridge today. Small appliances and household electronics use, on average, half the electricity of today's models.
- Space heating: Improved energy efficiency of housing results in huge reductions in energy requirements, with additional emission reductions from fuel switching and the use of solar-water heaters. Small decentralized heat-and-power stations provide space heating to new apartment buildings. Natural gas is preferred for space heating in all housing stock, and electricity's role continues to drop, even in hydro-rich areas.

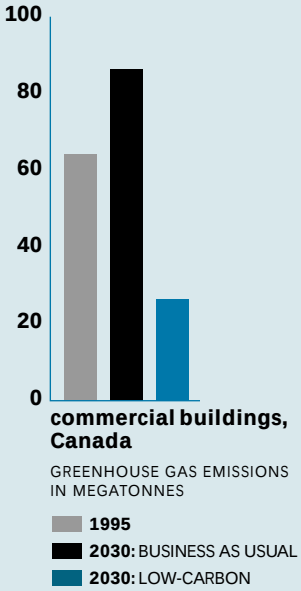



commercial buildings

Today, energy use in commercial buildings contributes about 64 million tonnes of GHGs. If we do nothing, this figure will rise to 86 million tonnes.

In the low-carbon scenario, floor area in all types of commercial buildings expands by 60 per cent, reflecting the on-going expansion of the Canadian economy. However, the Internet and other new patterns of work and shopping could make these assumptions about growth much too high.

The total floor area of educational buildings grows by 129 per cent, outstripping population growth by a wide margin and reflecting a commitment to creating a highly educated work-force. Hospitals and other health-care facilities grow by 137 per cent of 1995 levels, reflecting an anticipated increase in demand for health-care services.



commercial buildings, Canada

GREENHOUSE GAS EMISSIONS IN MEGATONNES

1995
2030: BUSINESS AS USUAL
2030: LOW-CARBON

TAKING ACTION

- Existing buildings: Space-heating requirements are cut by about 50 per cent through improved energy efficiency, computerized control systems, and increased use of solar energy. Outdoor cold air rather than air-conditioners is used whenever possible. Improved fan, pump and blower design, variable speed drives, and high-efficiency motors reduce energy consumption by 30 per cent. Heat-recovery ventilators are used universally. Windows are highly efficient, low-e argon-filled. Day-lighting, high-efficiency fluorescent lighting, super-high efficiency centralized light sources, more efficient office equipment, and fibre optic "light pipes" reduce energy use. Refrigeration uses half today's energy requirements.
- New buildings: Energy use is cut in half through systematic integration of energy efficiency at the design stage, usually at a lower capital cost than conventional design. Natural convection moves air, and natural vegetation "cleans" air, reducing energy use. Super high-efficiency centralized light sources and fibre optic "light pipes" reduce lighting costs by 50 per cent. Heat is produced by small, decentralized heat-and-power plants; waste heat is captured from on-site hydrogen reformers and fuel cells.

photos, l-r

Aircraft hangar daylighting retrofit; High efficiency lightbulbs; Energy-efficient new construction; Solar thermal for institutional buildings

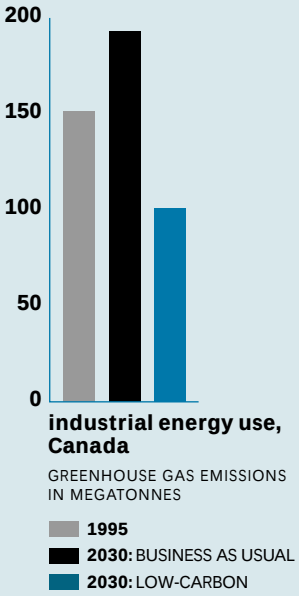
Electric motor retrofit; Recycling; Manufacturing; Heavy industry




industrial energy use

In 1995, the energy consumption of Canada's heavy industrial and manufacturing sectors resulted in emissions of 151 million tonnes of GHGs. If we do nothing, this will increase to 193 million tonnes as production continues to expand using today's high energy use per unit of production.

Heavy industry includes those where fuel and electricity consumption is typically ten times higher than in general manufacturing. These include mining and smelting, pulp and paper, industrial chemicals, primary metals, and cement-making. In the low-carbon scenario, the real value of output of these industries grows to 120 per cent of current levels. For other manufacturing industries, agriculture, forestry, and construction, growth in output is much stronger, reaching 140 per cent of 1995 levels by 2030.

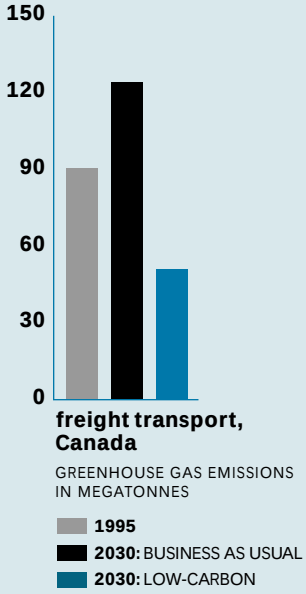


TAKING ACTION

- Heavy industry: Except for some use of ethanol as an alternative liquid fuel, the fuel and electricity use of these industries is also held at current levels. Through efficiency improvements, energy use per dollar of output improves at the rate of 1 per cent a year. Doubling waste reduction and recycling paper, plastics, glass, and aluminum contributes to further reductions in energy consumption of heavy industries. Recycling a tonne of paper reduces GHG emissions by as much as two tonnes for newsprint and four tonnes for fine paper, by lowering both pulp-mill energy and forest-harvest requirements.
- Other manufacturing industries, agriculture, forestry, and construction: Fuel shares change only slightly, with natural gas providing 90 per cent of the heat requirements of these industries and the use of petroleum fuels declines. On average, energy use per dollar of output improves by 30 per cent for fuel use, 50 per cent for lighting, and 40 per cent for motors and other electrical devices. These gains are achieved by using the most energy-efficient, currently available technologies.




freight transport



In 1995, GHG emissions from the transportation of freight totalled 90 million tonnes. If we do nothing, that total wil rise to 124 million tonnes.

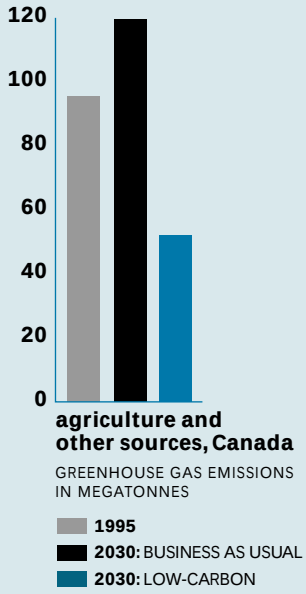
In the low-carbon scenario, freight transport grows by 38 per cent, and the current mix of trucks, rail and air freight is assumed. However, vehicle fuel-efficiency doubles, reflecting improvements in internal-combustion vehicles and the emergence of hydrogen fuel cell technology.

TAKING ACTION

- Hydrogen fuel cells power 45 per cent of this sector.
- Ethanol emerges as a significant source of fuel for both transportation and industrial applications, net GHG emissions fall to about half those from gasoline or diesel fuel; in the longer term, a nearly zero emission ethanol fuel could be produced from sustainable agricultural or biomass sources.

agriculture and other non-energy emission sources

In 1995, the combined GHG emissions from these varied non-energy sources totalled 95 million tonnes. If we do nothing, that will rise to 117 million tonnes in 2030.



TAKING ACTION

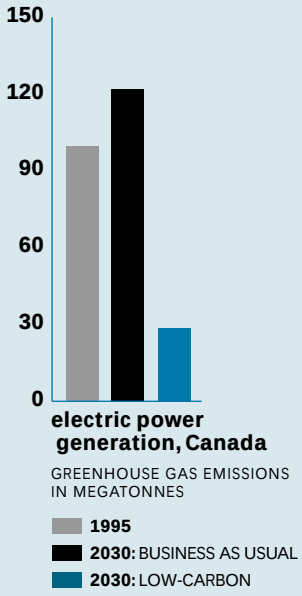
- Landfills: Methane gas that is emitted from landfills is eliminated as a source of GHG emissions, as virtually 100 per cent is recovered to power electricity generation and fuel-cell technology.
- Agriculture: In 1995, agricultural methane emissions accounted for about 27 million tonnes of CO_2 equivalent emissions, about 5 per cent of Canada's total GHG emissions. In the low-carbon scenario, despite a 30 per cent increase in the animal population, advanced in-feed composition and manure management methods allow this total to hold constant. Undoubtedly, greater reductions can be achieved here.
- Non-energy emissions: In 1995, non-energy emissions of GHGs from industrial processes such as cement making, adipic-acid production, and aluminum and magnesium refining contributed about 48 million tonnes to total emissions of greenhouse gases, or about 8 per cent of total emissions. In the low-carbon scenario, adipic acid emissions are eliminated and 25 to 35 per cent reductions are achieved in the other processes.




electric power generation

In 1995, the actual production of electricity created 100 million tonnes of GHGs each year. By 2030, if we do nothing, that figure will rise to 122 million tonnes.

In 1995, electricity provided 22 per cent of Canada's energy needs. Only about a third of this came from power stations fired by fossil fuels, but these power stations were responsible for about 15 per cent of Canada's total emissions. In the "business as usual" scenario, these emissions continue to grow due to increased demand for electricity and increased use of natural gas and other fossil fuels for power generation.



TAKING ACTION

- Demand lower for electricity: In the low-carbon scenario, demand for electricity drops by one third due to the efficiency measures described in the preceding sections. Even with the same mix of electricity sources, this would reduce emissions from power plants to 70 megatonnes, 30 megatonnes below 1995 and more than 60 megatonnes below the "business as usual" scenario.
- Fuels for electrical production switched: Actually, these savings more than double, thanks to the much lower level of power plant fossil-fuel consumption made possible by this lower demand. In fact, B.C., Manitoba, and Quebec will enjoy a surplus of hydro power in the low-carbon scenario, even after shutting down all fossil fuel plants. Some of this surplus will be used to produce hydrogen for fuel-cell vehicles. In the other provinces, all the large coal, oil, and nuclear power plants are retired by the year 2030, and a host of small, efficient, combined heat and power stations (fueled by natural gas) provide any power needed beyond the existing hydro capacity. Some of the waste heat from these plants could be used to heat industrial and commercial buildings, thus adding to their overall efficiency.
- New, renewable electricity sources: In the low-carbon scenario, a million homes and businesses have grid-connected, solar photovoltaic systems, either retrofitted or integrated into the design of new buildings. While this is not a large contribution, its rapid growth suggests a 50-fold contribution by 2050. Wind power also begins to contribute and, like solar, will be more important in the long term.

photos, l-r

Energy-efficient rail transport; Ethanol fueled truck; Methane from landfill; Cows, an agricultural methane source

Solar electric panel; Nuclear power; Wind energy; Coal plant

Clearing THE ATMOSPHERE

The GHG savings described in this analytical model show a 50 per cent target for 2030 is realistic – without any as-yet-uninvented breakthroughs. The measures described here are based on available technologies. But in order to get there, we must insist on a combined leadership effort on the part of both the public and private sectors to bring greenhouse gas emissions down to half their current levels. In that effort, regulation, public investment, innovative market mechanisms, and cultural change will all have important roles to play.

A whole-systems approach to engineering design, architecture, and community planning is urgently required so that investment patterns can anticipate and prevent the structural inefficiency, environmental malignancy, and economic unsustainability that characterized so much of 20th-century technology.

Strategies for low-carbon futures – and for environmental sustainability in general – are not threats to our future prosperity, but the keys to it.

David Suzuki Foundation

Finding solutions

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