The Kyoto Accord

Introduction to a Very Complex Problem

Greenhouse Gases, The Greenhouse Effect, and Global Warming

The Kyoto Accord is not a new model of car from Honda. It is an agreement to cut greenhouse gas emissions.

Greenhouse Gases are those gases in our atmosphere which absorb heat radiating away from earth to space. This retention of radiant heat captured from the sun is sometimes called the Greenhouse Effect, and it keeps our home planet at around 15°C. Without it, the earth's temperature would be a very chilly –18°C. Only a small band of land around the equator would be able to support life as we know it. The rest of the earth would be in a permanent ice age, bleak and largely lifeless.

Global Warming refers to recent observations and theories that our planet is warming surprisingly rapidly. Some scientists reckon the rate of warming is faster than it has ever been. Because we have warmed before – several times. The earth has experienced perhaps a dozen ice ages, and (of course) warming followed each frosty episode. It is important to state that not all climate scientists agree that the earth is warming particularly rapidly, but a substantial majority of scientists do.

In brief, we are worried about the current warming episode for several reasons:

- First, we are close to the highest temperature our planet has seen for several million years.
- Second, the rate of warming is so rapid that our forests cannot adapt (warm-adapted species must replace existing trees). It now appears that mild winters may allow insect and fungal pests to decimate forests populated with species not resistant to them.
- We are experiencing an alarming increase in "severe weather events" – hurricanes, droughts (plus associated forest fires), and very cold winters coupled with extra hot summers. These have hit insurance companies hard.
- The effects of a warmer world are hard to predict – will increased evaporation cause drying or will it cause increased cloud formation and more rainfall? Our Great Lakes may be gradually shrinking. Is this really happening? If so, is this a result of the warming trend?

Greenhouse Gases

The greenhouse gases include carbon dioxide, methane, the freons, ozone, and nitrous oxide.

Carbon Dioxide – CO_2

The most important, *carbon dioxide* (CO_2), contributes around 50% to the greenhouse effect. That means it is responsible for half of the heat trapping of our atmosphere.

CO_2 is formed during the burning of all carbon-containing fuels. These fuels include gasoline, coal, and natural gas. Burning wood also creates CO_2, but this is reckoned to add no CO_2, because trees remove CO_2 from the air when they are growing. However, we have destroyed huge amounts of old forest, thus releasing the carbon which the trees had been storing for hundreds of years.

CO_2 is also released by all living animals – which effectively "burn" carbon-containing foods like sugar or fats. However, all animal "fuel" has been recently produced by plants which build these foods from atmospheric carbon dioxide, so no net CO_2 is formed by animal metabolism.

Quite a lot of CO_2 comes from volcanic vents, coal mines, decaying vegetable matter and other natural sources. Human activity is responsible for 4% of CO_2 emissions. Since the industrial revolution (~200 years ago), atmospheric CO_2 concentration has increased from 0.28% to 0.35%.

Methane – CH_4

Methane is responsible for about 18% of the heat trapping effect of the atmosphere. The main sources of methane are from the anaerobic (in the absence of air) decomposition of vegetation and animal remains. This occurs in composting and the municipal garbage dump. It also occurs in the soil where dead plant matter decays, in marshes and lake beds where old vegetation is decomposing into "marsh gas" (methane) – you can often see the methane bubbling up. Rice paddies are one of the largest man-made sources of methane.

Cattle and other livestock release methane formed in their large intestine by microbial action. Man, of course, also farts . . . The huge worldwide increase in cattle herds (mainly to supply fast food "burger" restaurants) has made these a substantial source of methane.

Methane is a problem in coal mines. As vegetable matter is compressed under ground into coal, methane is formed, and much eventually leaks out into the atmosphere. Disturbing the coal (mining) releases pockets of trapped methane. This is highly flammable. If a spark ignites it, the resulting flash may also ignite coal dust. Such explosions have killed many coal miners over the centuries.

Methane is always found in association with petroleum, and its pressure often brings the oil to the surface as a "gusher". Of course, methane is released from working oil wells. Today much of this is collected for distribution and sale as natural gas (85% methane). Inadvertent releases from natural gas wells and from pipelines is a source of atmospheric methane – particularly in Russia where thousands of kilometers of poorly maintained pipeline are leaking.

In total, human activity is responsible for about 60% of methane emissions. Moreover, CH_4 absorbs 21 times the radiant energy of CO_2. This means that an atmospheric CH_4 concentration of 0.001% has the heat trapping capacity of a CO_2 concentration of 0.021%.

Freons (Chlorofluorcarbons)

The *Freons* are a family of artificial chemicals. They were developed as refrigerants for use in freezers, air conditioning units, refrigerators, etc., but are also used as "blowing agents" for foaming rubbers and plastics (such as Styrofoam). These are synthetic substances and their atmospheric concentration was zero until about 1950, when they began to appear. The Freons are also very stable chemicals, so they tend to accumulate.

With respect to heat trapping, they are hundreds of times more potent than CO_2. So, despite the fact that their atmospheric concentration is very low, they are responsible for about 14% of the greenhouse effect.

Many chlorofluorocarbons also destroy the stratospheric ozone layer which protects the earth from damaging ultraviolet radiation. It was this effect which resulted in their being banned a number of years ago (the Montreal Accord). As very stable molecules, it will take a century or two before they completely vanish from the atmosphere.

Ozone – O_3

Oxygen normally exists as a two-atom molecule. Under certain circumstances, three oxygen atoms combine to form a molecule of *ozone*. High in the stratosphere ultraviolet bombardment creates ozone continually. This conveniently protects the earth's plant and animal life from overexposure to harmful ultraviolet radiation.

"Natural" ozone is formed in the wake of lightning bolts (or any electric spark), giving rise to that fresh, slightly astringent smell of an electrical storm. Ozone also forms in fires.

Ozone is also the product of human activity. Under the influence of ultraviolet radiation (sunlight) certain pollutants react to form ozone. NO_x emissions from power plants and cars react with hydrocarbons (unburnt gasoline, evaporating solvents, etc) to create ozone in city streets. Since ozone is highly reactive, its presence in the air can seriously damage lungs.

Mankind's contribution to ground level ozone is unknown. Ozone concentrations vary widely, but its contribution to the greenhouse effect is reckoned to be around 12%.

Nitrogen Oxides (NO_x)

There are at least 7 different oxides of nitrogen, including N_2O, NO, NO_2, N_2O_5, etc. These are collectively labeled NO_x. Whenever burning takes place, *nitrogen oxides* tend to form. In car engines this can be minimized by carefully controlling the air : fuel mixture; NOx emissions are then virtually eliminated in the catalytic converter.

Mankind's contribution to global NO_x emissions is reckoned at approximately 65% of total NO_x, which is estimated to be responsible for about 6% of the greenhouse effect.

Global Warming

Global warming is a complex problem. It is made more complex by the realization that our planet has warmed and cooled many times. We can readily identify more than a ½ dozen Ice Ages, when Arctic ice sheets extended far south to cover much of North America, Europe and Asia. We are now enjoying the Interglacial period following the last Ice Age, over 10,000 years ago.

Postglacial warming has not been smooth. About 1000 years ago, the Northern Hemisphere saw a "Little Ice Age" during which the Dutch Canals and the Thames River at London regularly froze over. This prolonged cold snap may have profoundly affected North American history. The cooling climate forced the Vikings to abandon a once thriving colony on the south coast of Greenland. They had just set up an outpost in Newfoundland and probably explored as far south as Cape Cod . . .

So, although the earth has warmed many times in the past, today's concern is focused first on the currently rapid rate of warming, and second on the possibility that the Earth is now as warm as it has ever been and a further rise in temperature would be "exploring" new territory.

Effects of Warming

To many Canadians, the prospect of warming excites us with thoughts of longer summers and less brutal winters. Anyway, with a winter like that of 2002-03, are we warming at all?

When climatologists speak of warming, they are referring to the 1°C rise in average temperature we have seen over the past century. Although this appears to be small, it is worth remembering that the temperature difference between an Ice Age and an Interglacial is only around 5°C - 6°C!

The most obvious effects of warming in our climate are later freeze-up of lakes and rivers and an earlier thaw. We now often experience a midwinter thaw which may even leave us snow-free for a week or two in January. A less obvious effect is lower water levels in the Great Lakes. These have ranged from 10cm to 60cm lower than their long-term average over the last decade. Cottagers find their docks are high and dry. Many marina and harbour operators have had to dredge their facilities to continue operating. Hydroelectric power stations generate less electricity because their head of water is lower. Lake vessels cannot carry a full load due to insufficient water depth in the seaway locks to accommodate their normal draft.

Inuit are finding that hunting has become hazardous. During the spring hunting season, the sea ice is thinner than usual, making their access to their prey (seal, sea lion, walrus, polar bear) very dangerous. Permafrost is melting, damaging many settlements which are built on piles driven into the normally frozen ground.

However, the most potentially damaging effect for us may be the inability of local flora to adapt to rising temperatures. One of the factors which has made the temperate regions so healthy is that our long cold winter tends to kill insects, bacteria, and other pests, reducing the number available to harm us in summer. Shorter, less brutal winters allow more of them to survive. Various pests have been causing problems in our boreal forests. Species of trees from further south would be resistant to these pests, but it will take hundreds of years for our forests to adapt. In other words, rapid warming could decimate Canada's forest cover.

West Nile Virus is a tropical disease of birds, humans and some animals which appears to have adapted itself to our climate. Malaria may be coming back. All are consequences of our warming climate.

Beyond our borders, some people suggest that warming will cause the polar ice caps to melt. That, in turn will raise sea levels. Already, low-lying regions like the Maldive Islands (off the west coast of India) are in danger of being lost. The heavily populated coastal areas of Bangladesh have been seeing more frequent and severe flooding. While such problems may appear not to concern us directly, they may bring pressure on us to accept even more immigrants than we now do.

However, natural disasters are the issue which finally got the attention of governments in the developed world. In particular, the government of the U.S.A. was (and still is) denying that the northern hemisphere is warming. Reports by meteorologists were dismissed, as were petitions by scientists and by environmentalists.

Public attention was finally focused when insurance companies reported that they had noticed a substantial increase in claims for flooding, tornadoes, forest fires, etc., over the past 2 decades. By now, most governments, with the major exception of the U.S.A., have realized that emissions of greenhouse gases should be curbed. That realization culminated in the **Kyoto Accord**, which has been ratified by almost the entire world, with Canada finally signing in 2002.

The Kyoto Accord

The Kyoto Accord agreed to reductions in greenhouse gas emissions for all developed industrial countries. Most underdeveloped countries were allowed to continue increasing their emissions for a number of years in recognition of the fact that their per capita emissions were very low and that some increase would be required if they were to continue improving their (very low) standard of living.

Among industrial countries, Europe agreed to cut emissions by an average of 8%, although individual countries like Germany and Denmark are cutting by 21%; Canada has agreed to 6%.

6% doesn't sound like much. However, the bad news is that the 6% is calculated from 1992, when the Accord was signed in Kyoto! Predictably, we have done absolutely nothing for a decade. In this period, our economy grew strongly, as did our greenhouse gas emissions! So now we are faced with having to cut emissions by 21% from today's values.

Making a difficult situation much harder, back in 1992, our deadline of 2008 was 16 years off. Today, our agreed deadline is just 5 years away, and no level of government has yet come up with a credible plan!

Hopeless Then?

Of course it is not hopeless! Not only that, but reducing our energy consumption will save a considerable amount of money by lower energy purchases. Also, reduced demand will exert downward pressure on energy prices – a two-way saving!

North American politicians have been suggesting that reducing our energy consumption will lower our standard of living to an unacceptable level. That is simply nonsense. Germany, Sweden, France, Holland, Denmark, Finland, Belgium, U.K. etc. all enjoy a standard of living as high as ours or higher, while using around half the amount of energy, as measured on a per capita basis, or based on how much energy it takes to create a dollar of G.N.P. (Gross National Product). Part of their prosperity can be attributed to spending far less on energy (and energy consuming equipment) than we do!

The problem lies in our different definitions of prosperity. In North America, we have tended to equate prosperity with energy consumption: "If you need to ask how much fuel the Cadillac Escalade uses, you probably cannot afford it." By contrast, European buyers of luxury cars (very few SUVs or minivans are sold in Europe) overwhelmingly choose to pay extra for diesel power because they prize fuel economy (70% of European luxury cars are diesel powered!). In the home, Europeans have been able to buy energy- and water-saving front-loading washing machines since the 1960's. In North America, where the majority of buyers are still choosing wasteful top-loaders, they have only been available since about 1990. In cold Scandinavia, costly, high quality house construction incorporating excellent insulation has been used for years – saving huge amounts of energy which might otherwise have been wasted for heating.

Other features of European society have supported public transit over private cars, again saving massive amounts of energy. Finally, Europeans are far more willing to indulge in physical activity on holiday: use sailboats instead of personal watercraft, cross-country skis instead of Ski-doos, hiking boots instead of ATVs, etc. This saves money on equipment, on fuel, and finally creates a population which is more physically fit and less prone to diseases associated with obesity than ours is. Other benefits include reduced toxic emissions associated with energy consumption, and cheaper automotive insurance rates attributable to lower mileages and time spent in cars.

What Can We Do?

Obviously, we cannot transform Canada or Ontario into Europe. Due to the different way in which our cities developed, we may never be able to reach European levels of energy consumption for transportation. Moreover, our generally lower energy (electricity, natural gas, etc.) costs make energy efficiency somewhat harder to "sell" than it is in Europe.

However, there is real money to be saved through domestic energy efficiency. The investment required to achieve it is relatively modest, and modular – you need not spend the money at once. (**For details, see the Energy Efficiency section on this website.**)

Similarly, energy efficiency in personal transportation is in ready reach – all you have to do is to re-evaluate your transportation requirements. Do you really need 4-wheel drive? A set of 4 good quality snow tires are likely to be more effective, cost far less to buy, and save you money year after year over the cost of an SUV! How often do you actually use the box on your pick-up truck? Would you not be better served to rent a pick-up truck for the 2-3 days in the year you actually need one, and enjoy a smooth-riding, fuel-efficient car for the remaining 362 days? Does luxury motoring really have to weigh 2.5 tonnes? There are some extremely luxurious cars available weighing 1.5 tonnes or less, burning less than half the fuel of a large SUV, and far less prone to rolling over in a crash or after an emergency maneuver.

Currently available domestic energy efficiency equipment and technology has the potential to save a typical Canadian family over $1000 *every year* (tax free!) for an initial investment of around $2000. That is a far better rate of return than anything offered by your stockbroker or bank manager! Paying attention to the type of vehicle you buy can save even more money, and may actually cost less than a gas-guzzling pickup truck, SUV, or minivan.

And while saving money, you will be helping our country meet its Kyoto obligations! If Canadians followed all the suggestions in the "Energy Efficiency" section of this website, we would be half-way to Kyoto – painlessly, while reducing our toxic energy-related emissions as a further bonus!

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