Chapter 1:

BUILDING AN ENVIRONMENTAL ETHIC

"live lightly on the earth"

What is Environmental Design?

"the modern architect has produced the most flagrantly uneconomic and uncomfortable buildings…which can be inhabited only with the aid of the most expensive devices of heating and refrigeration. The irrationality of this system of construction is visible today in every city from New York to San Francisco: glass sheathed buildings without any contact with fresh air, sunlight, or view." Lewis Mumford.

Environmentally sensitive design looks to design in harmony with, and in response to the climate. It attempts to use the natural solar and ventilation characteristics of the local climate/environment to inform the building design so to minimize use and dependency on consumptive non renewable energy sources. Sustainable building design looks to "live lightly on the earth" so that there will be quality and resources remaining for generations to come.

The Sustainable Ethic:

Sustainable building is not a new style of building. It is a way to think about how we design, construct, and operate buildings. Its primary goal is to lessen the harm poorly designed buildings cause by using the best of ancient building approaches in logical combination with the best of new technological advances. Its ultimate goal is to make possible offices, homes, even entire subdivisions that are net *producers* of energy, food, clean water and air, beauty, and healthy human and biological communities.

Green buildings try to take less from the earth and give more to people.

Sustainable Development:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

- -the United Nations World Commission on Environment and Development

Sustainable Checklist:

"Treat the Earth well. It was not given to you by your parents. It was loaned to you by your children." --- Kenyan Proverb.

Ideally a sustainable building should:

- make appropriate use of land
- use water, energy, lumber, and other resources efficiently
- enhance human health
- strengthen local economies and communities
- conserve plants, animals, endangered species, and natural habitats
- protect agricultural, cultural, and archaeological resources
- be nice to live in
- be economical to build and operate

What is Climate Change?

Climate change is a change in the "average weather" that a given region experiences. Average weather includes all the features we associate with the weather such as temperature, wind patterns and precipitation. When we speak of climate change on a global scale, we are referring to changes in the climate of the Earth as a whole. The rate and magnitude of global climate changes over the long term have many implications for natural ecosystems.

A natural system known as the "greenhouse effect" regulates the temperature on earth. Human activities have the potential to disrupt the balance of this system. As human societies adopt increasingly sophisticated and mechanized lifestyles, the amounts of heat-trapping gases in the atmosphere have been increased. By increasing the amount of these gases, humankind has enhanced the warming capability of the natural greenhouse effect. It is the human-induced enhanced greenhouse effect that causes environmental concern. It has the potential to warm the planet at a rate that has never been experienced in human history.

An international scientific consensus has emerged that our world is getting warmer. Abundant data demonstrates that global climate was warmed during the past 150 years. The increase in temperature was not constant, but rather consisted of warming and cooling cycles at intervals of several decades. Nonetheless, the long term trend is one of net global warming. Corresponding with this warming, alpine glaciers have been retreating, sea levels have risen, and climatic zones are shifting.

* The 1980s and 1990s are the warmest decades on record
* The 10 warmest years in global meteorological history have all occurred in the past 15 years
* The 20th century has been the warmest globally in the last 600 years.

Most experts agree that average global temperatures could rise by 1 to 3.5 degrees Celsius over the next century. In Canada, this could mean an increase in annual mean temperatures in some regions of between 5 and 10 degrees. In many locations it means the difference between a winter of rain or snow...

What are the greenhouse gases (GHG) and how are they produced?

We know that our atmosphere is a complex mixture of gases that trap the sun's heat near the earth's surface, similar to how the glass of a greenhouse traps the sun's warmth. The main greenhouse gases are water vapour (H_20), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3), and halocarbons (CFCs, HFCs, etc.). Without these "greenhouse" gases, the sun's heat would escape and the average temperature of the earth would be 33 degrees cooler (-18° C) – too cold to support life as we know it.

Human activities have resulted in the release of significant extra quantities of greenhouse gases, which remain in the atmosphere for long periods of time. This intensifies the natural greenhouse effect.

Carbon dioxide, or CO_2, is the most important of the greenhouse gases released by human activities. It is the main contributor to climate change because of the quantities released – especially through the burning of fossil fuels. When fossil fuels are burned, the carbon content is oxidized and released as carbon dioxide; every tonne of carbon burned produces 3.7 tonnes of carbon dioxide. The global consumption of fossil fuels is estimated to release 22 billion tonnes of carbon dioxide into the atmosphere every year – and the amounts are still climbing.

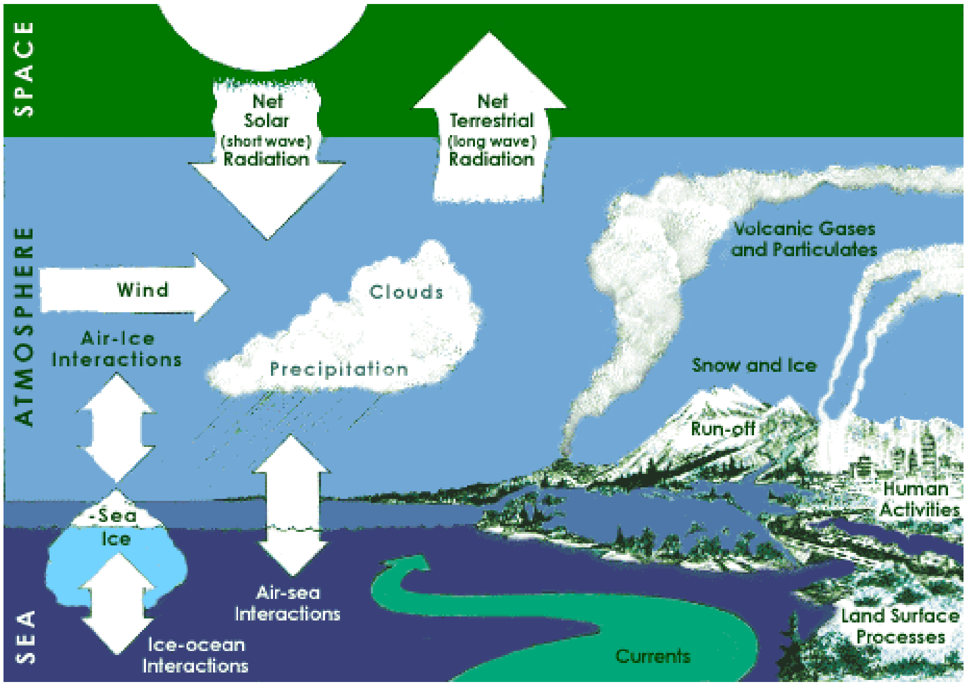
Methane is produced naturally when vegetation is burned, digested or rotted without the presence of oxygen. Large amounts of methane are released by garbage dumps, rice paddies and grazing cattle. Methane is significant because it has 21 times the heat-trapping effect of carbon dioxide.

Nitrous oxide occurs naturally in the environment but human activities are increasing the quantities. Nitrous oxide is released when chemical fertilizer is used in agriculture.

Since the beginning of the Industrial Revolution, concentrations of carbon dioxide have increased by 30 per cent, and methane by 145 per cent.

The Climate Cycle:

The layer of air surrounding our globe contains important gases such as water vapor and carbon dioxide, which absorb the heat radiated by Earth's surface and re-emit their own heat as a different type of radiation. We say they "trap" Earth's radiation and call this planetary warming mechanism the "greenhouse effect."



The Greenhouse Effect:

Scientists warn that we are currently upsetting the Earth's radiation balance through activities like burning fossil fuels and cutting forests. These actions release carbon dioxide and other greenhouse gases, which accumulate in the air and strengthen Earth's greenhouse effect.

Looking back through the ages, we see evidence that the planet has passed many times through warm and cold spells. One of the warmest known intervals was the Cretaceous period about 100 million years ago, near the end of the reign of the dinosaurs. With temperatures about 10 degrees C warmer than today, sea levels swelled because water was not locked up in major ice sheets near the poles.

Two million years ago the Earth's average temperature was about 5 degrees C below today's level. Bubbles of ice age air preserved in the glacial sheets of Antarctica and Greenland reveal that the atmospheric concentration of carbon dioxide and methane dropped significantly during the glacial times. Such low levels weakened the greenhouse effect and helped cool the Earth.

CO_2 Increases:

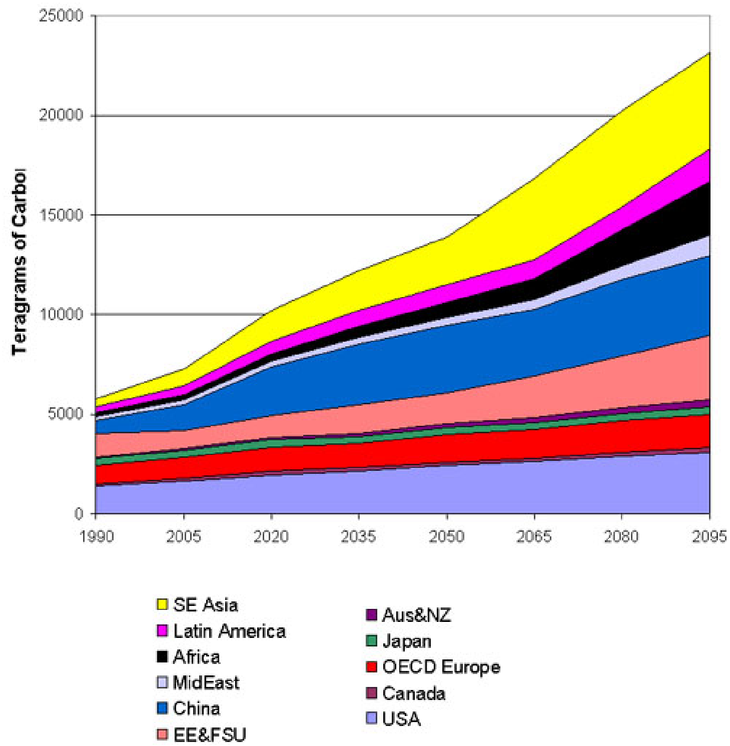
The burning of coal, oil and natural gas and the destruction of forests have raised the total amount of atmospheric CO_2 by 25% since the beginning of the industrial revolution. Plants have the ability to process CO_2 and produce oxygen. Deforestation seriously reduces the natural ability of the earth to rid itself of excess quantities of CO_2. The increase of rice cultivation and livestock rearing have also increased methane levels, another greenhouse gas.

CO_2 Production by Country in 1997

Country	CO_2 Produced (tonnes of carbon)	
	Total (millions)	**Per Capita**
U.S.	**1,489.6**	**5.48**
China	913.8	0.75
Russia	390.6	2.65
Japan	316.2	2.51
India	279.9	0.29
Germany	227.4	2.77
UK	142.1	2.41
Canada	**133.9**	**4.42**
Italy	111.3	1.94
Ukraine	100.4	1.97

Source: Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Tennessee

There is a fairly direct co-relation between the production of CO_2 and consumption of fossil fuel on a per capita basis.



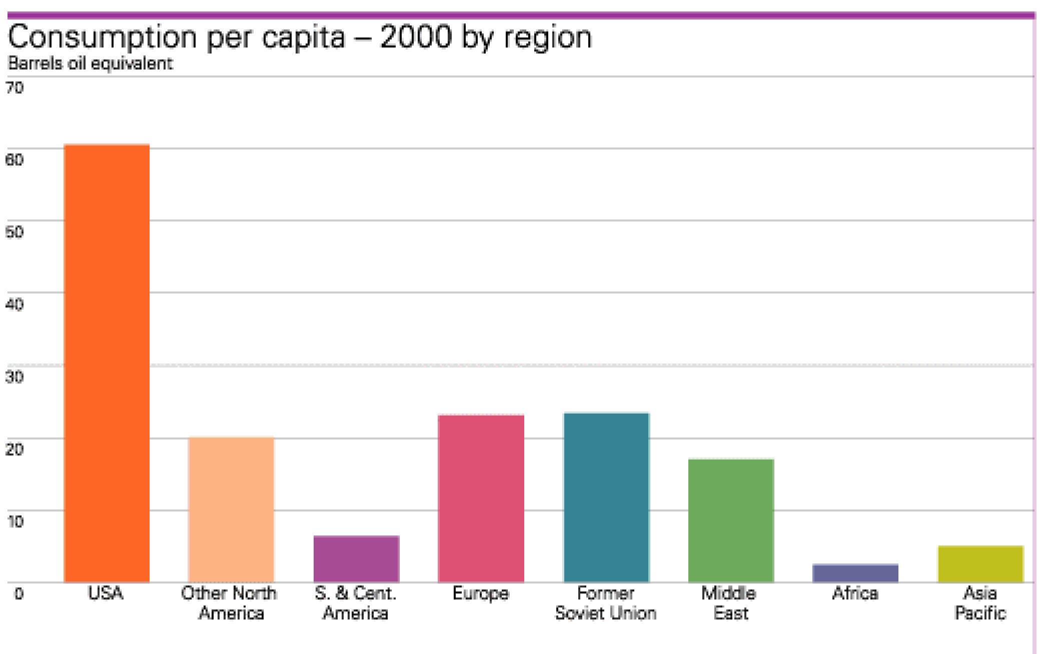
In the last three decades, the annual global release of carbon dioxide has doubled, and could double again in the next three decades unless nations of the world limit their consumption of fossil fuels.

The effects in the U.S. of such an increase could include a northward shift of southern forest species; forest dieback from heat and dry soils along southern portions of tree species ranges; and changes in forest productivity.

Climate changes would also affect crop yields and result in northward shifts in cultivated lands, stress livestock production, increase crop irrigation requirements and increase the incidence of agricultural pests and diseases.

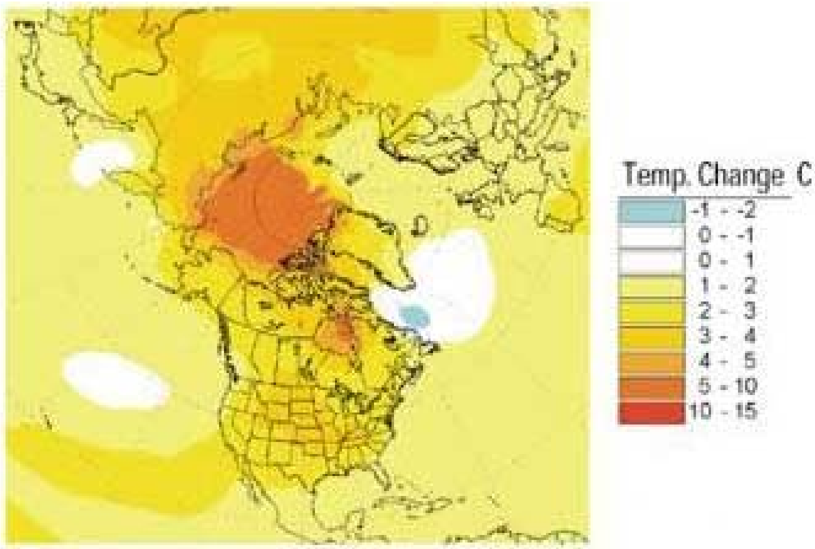
Air quality would likely deteriorate as a result of lower atmosphere ozone (smog) build-up. Smog levels in many urban areas would increase because higher global temperatures would speed the reaction rates producing ozone in the atmosphere. Higher ozone levels are tightly connected to higher temperatures.

Coastal wetlands have been able to keep pace with a sea level rise of approximately 1 millimeter (mm, about 0.04 inches) per year for the past 3,000 years. However, global average sea levels will rise by around 6 mm per year for the next century, which may ultimately drown these wetlands as well as erode and submerge many of the beaches, coastal communities and small islands.
Global warming could raise sea levels approximately 1/2 to 1 meter by the year 2100 by expanding ocean water, melting mountain glaciers, and causing ice sheets in Greenland to melt or slide in the ocean.
Climate change threats like hurricanes and sea level rise take on special significance given the fact that 50 percent of the U.S. population lives within 50 miles of a coastline.



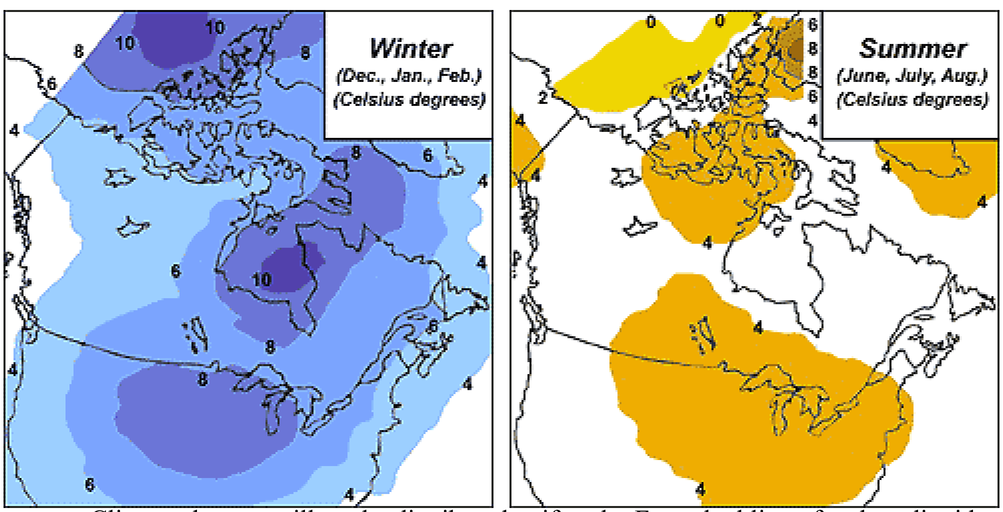
Climate Change in Canada:

Projected temperature change between 1975-1995 and 2040-2060



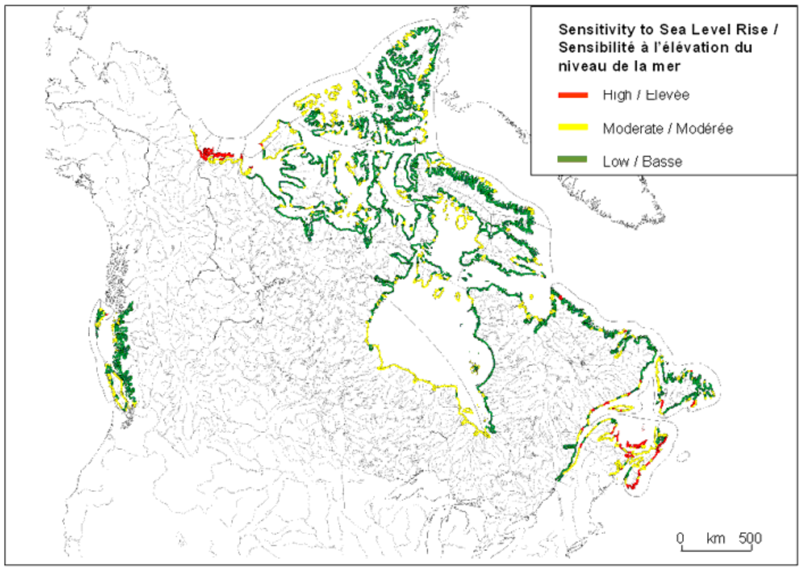
Combined Effects of Projected Greenhouse Gases and Sulphate Aerosol Increases - Canadian Model

Temperature projections for Canada for winter and summer seasons under doubled concentrations of CO_2



Climate changes will not be distributed uniformly. For a doubling of carbon dioxide concentrations, Canadian climate models project projects an increase of 3.5°C in the earth's average annual temperature but shows more substantial warming over much of Canada, particularly in winter.

In Canada, where the total coastline exceeds 240,000 kilometres, sea level rise is a significant issue. Climate warming is expected to cause warming of the oceans and melting of glacier ice resulting in a global increase in sea level. A rise in sea level increases the level of wave attack and tides, causing changes in the stability of shorelines as well as flooding of lowlands.



Kyoto Protocol:

To stabilize atmospheric concentrations of greenhouse gases at today's levels will require reducing human-generated emissions by 80 percent immediately.

There are six greenhouse gases covered under the protocol to the international convention on climate change (the Kyoto Protocol) – carbon dioxide (CO2), methane, nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6).

The Kyoto protocol was agreed upon through international co-operation under the United Nations Framework Convention on Climate Change (UNFCCC), which was created in 1992.

The Kyoto protocol came out of the UNFCCC's December 1997 meeting held in Kyoto, Japan. Under the agreement, industrialized nations must *reduce their emissions of greenhouse gases by an average of 5.2 per cent (from 1990 levels) by the period 2008 to 2012.*

The Role of "Sinks":

Canada was criticized by environmentalists for what they described as trying to use *loopholes* to undermine the commitments it made in Kyoto. Canada, along with the U.S. and Japan, proposed a plan that would allow it to get credit for what are called "carbon sinks" – forests and lands that absorb carbon dioxide pollution – which would help Canada meet its Kyoto obligations and avoid having to cut emissions.

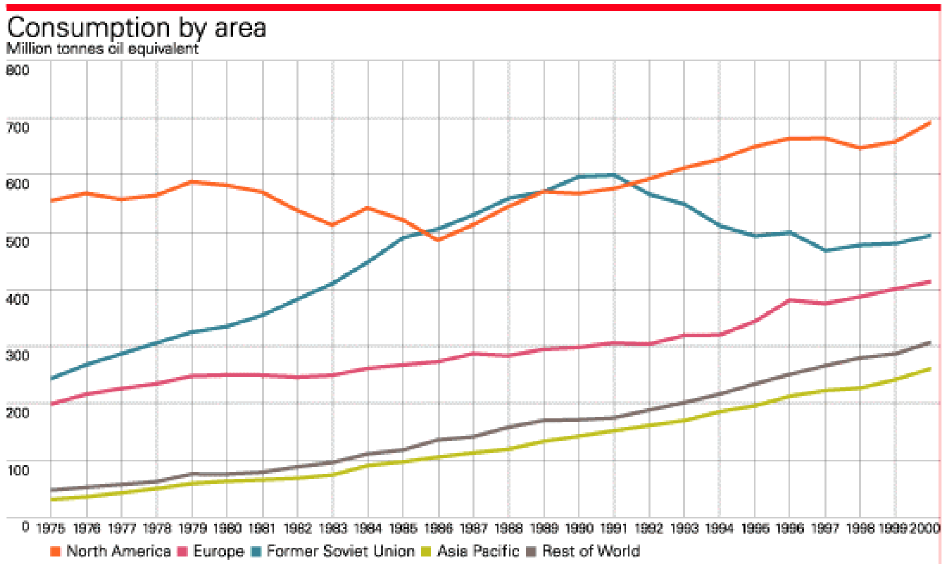
The critics, among which were the 15 countries that make up the European Union, say the plan distracts from the root cause of the problem – the world's dependency on fossil fuels.

Figures released by Ottawa in September 2000 show greenhouse gas emissions were 13 per cent higher in 1998 than in 1990.

Energy Use Patterns:

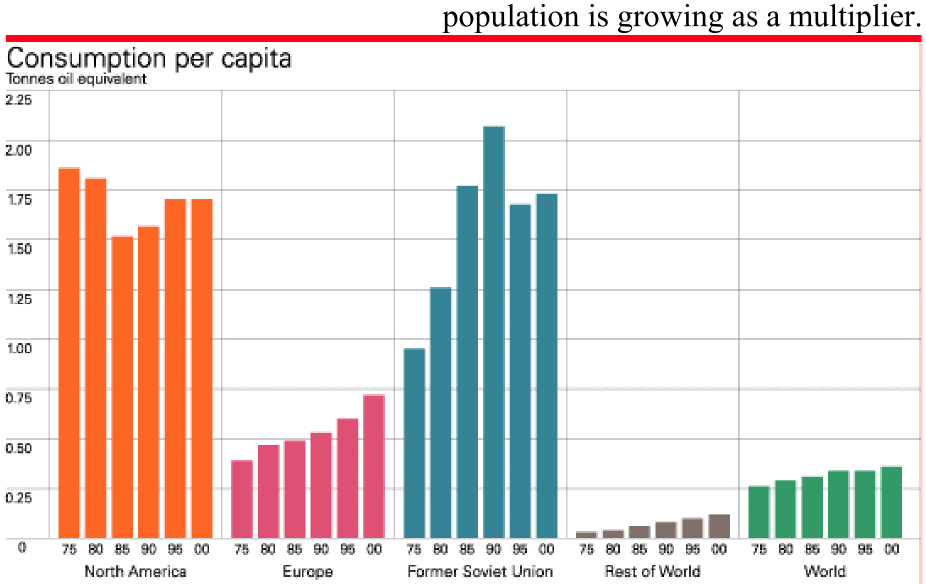
For the past half century, global energy growth marched in lockstep with economic growth. Energy use increased 400 percent to accommodate a doubling of world population and a quadrupling of Gross World Product. The world now consumes the equivalent of 175 million barrels of oil each day -- equal to 85,000 gallons of gasoline each second.

Consumption of Gas:



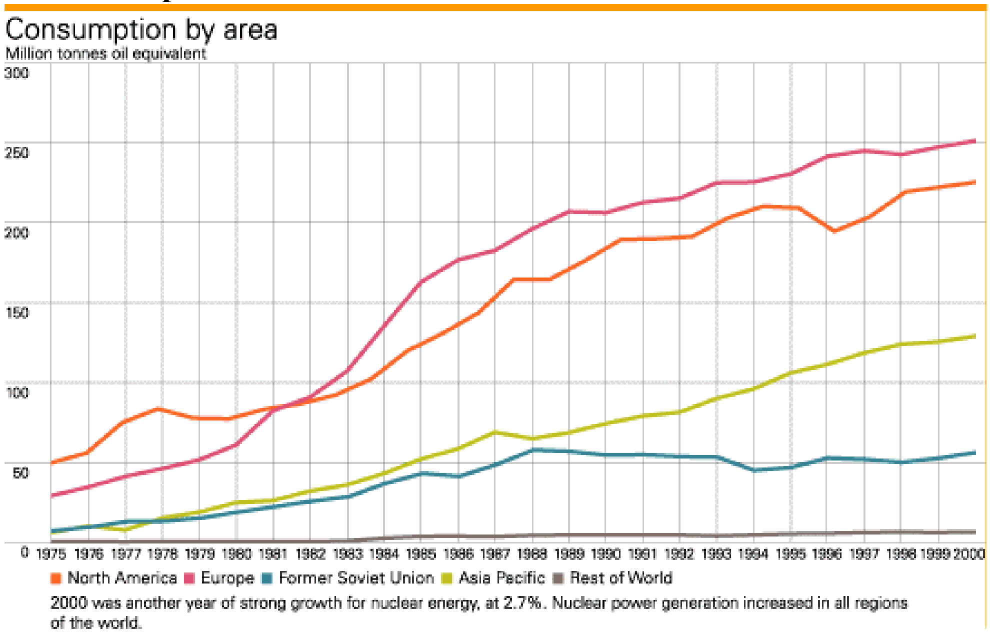
In 2000, world gas consumption increased by 4.8% over 1999, double the rate of growth in the previous year. Consumption increased in all regions for the second consecutive year. Consumption in the Former Soviet Union is now rising again but remains more than 15% below the level of 10 years ago.

When considering consumption per capita you must also consider the rate at which the population is growing as a multiplier.

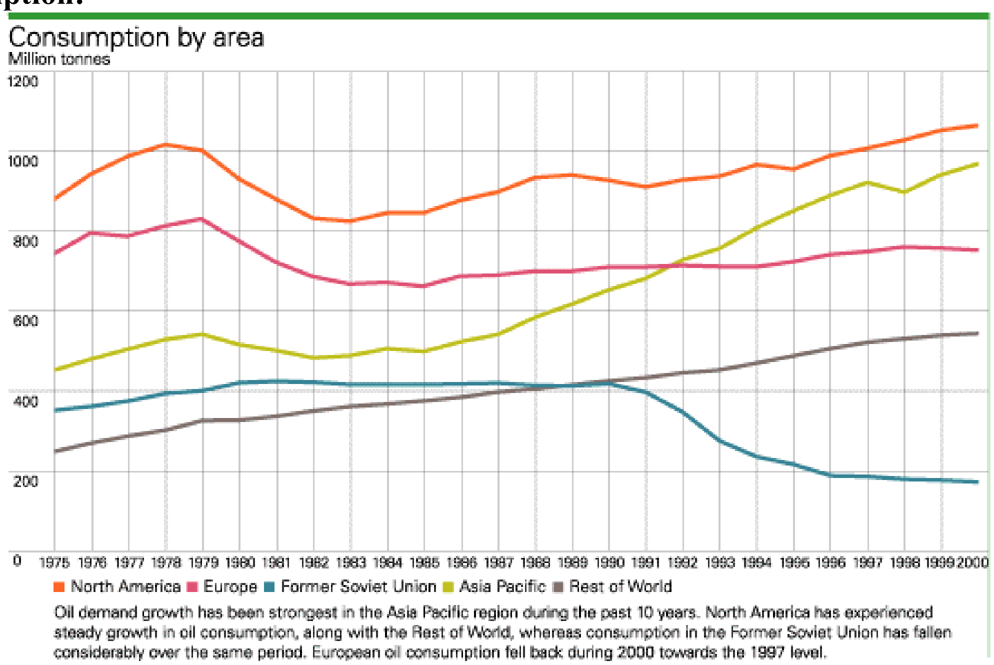


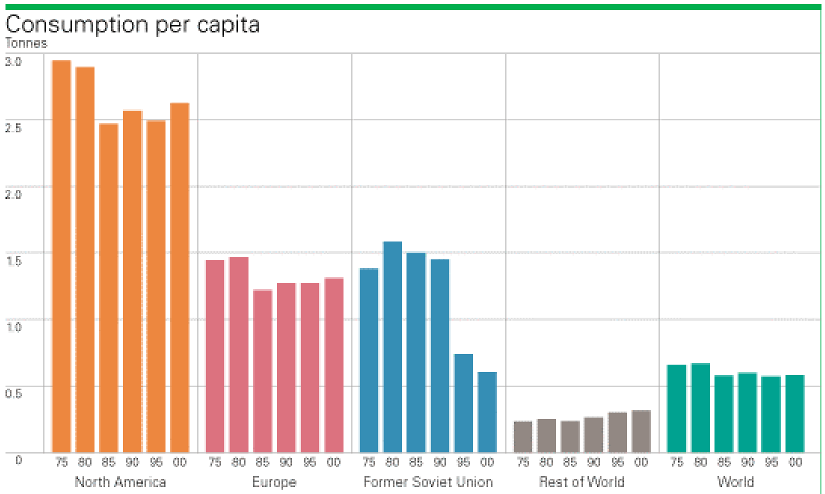
Consumption per capita continues to grow in Europe and the Rest of World, but remains fairly stable in North America. Three regions (North America, Europe and the Former Soviet Union) are responsible for nearly 75% of the world's natural gas consumption.

Nuclear Power Consumption:

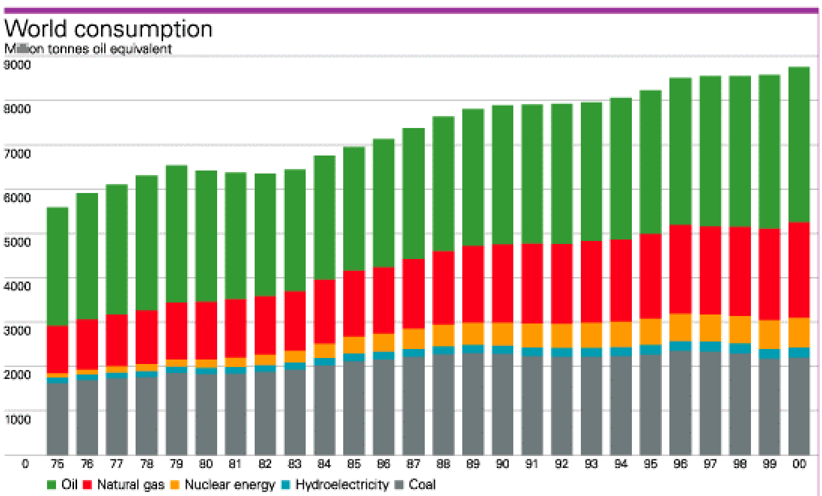


Oil Consumption:

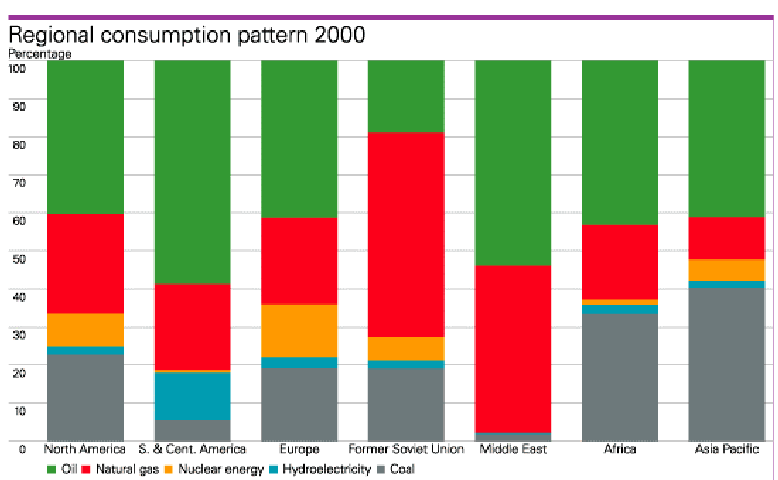




Oil consumption per capita varies greatly between regions. Consumption is strongly influenced by levels of economic development and trends in income (GDP) per capita.
At the global level, oil consumption per capita was much the same in 2000 as in 1985. Modest increases in North America, Europe and the Rest of World have been offset by a major fall in the Former Soviet Union.

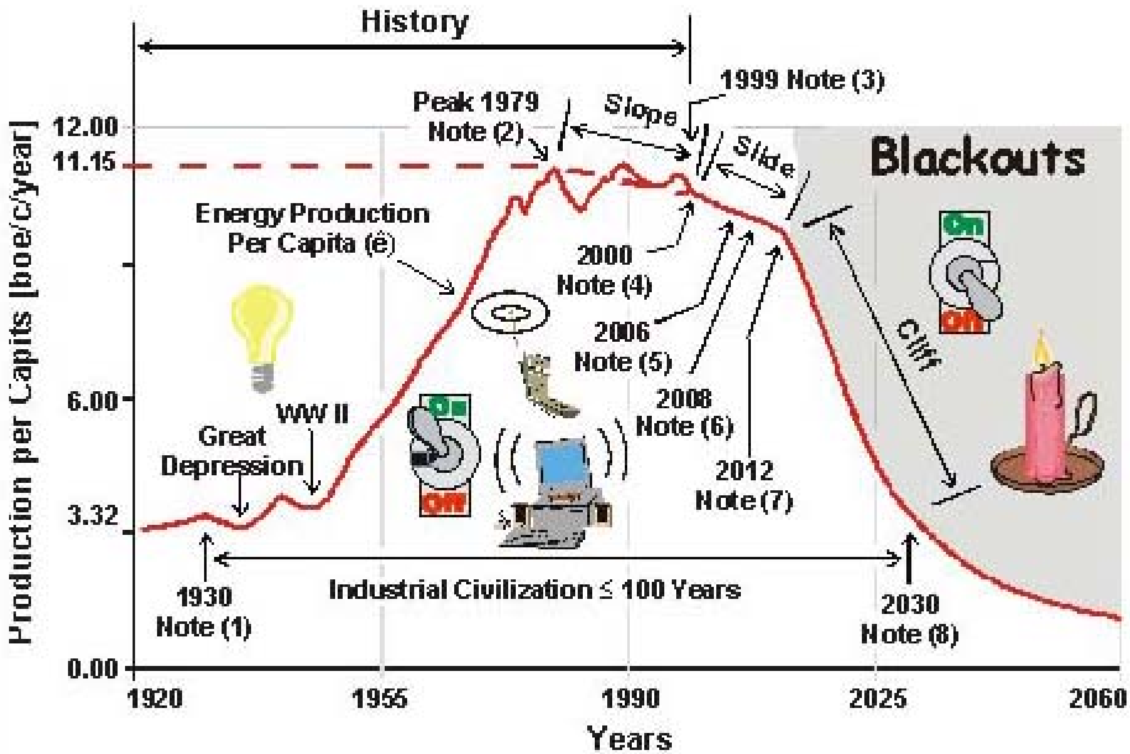


Total primary energy consumption increased by over 2% in 2000, well above the sub-1% pace of the previous three years. Natural gas was once again the fastest-growing fuel, followed by nuclear energy.

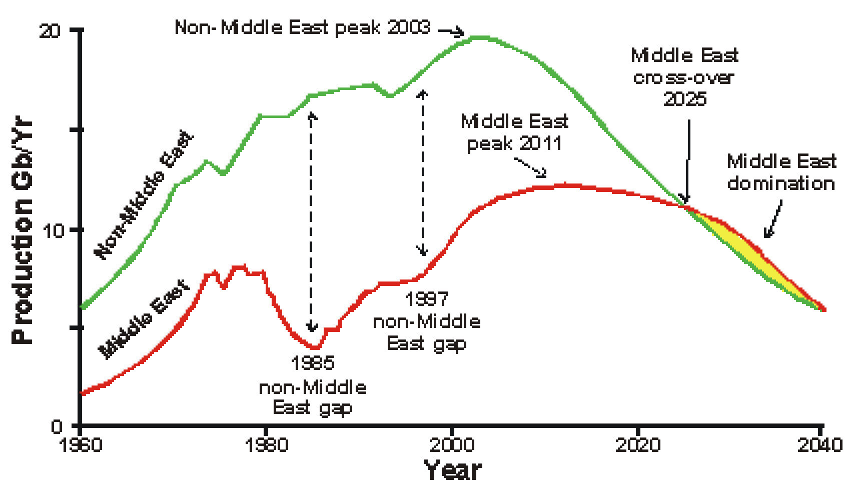


Oil remains the largest single source of energy in all regions of the world, except for the Former Soviet Union, where natural gas is the prime fuel.

The bottom line is that while consumption is ever increasing, production is felt to have peaked and is predicted to rapidly decline.



If fuel production declines, there is not enough fuel to heat and cool the present building stock in 40 years time -- not to mention heating and cooling any buildings we might add between now and then….
Also of concern is the growing reliance on non North American fuel sources, given the instability in the Middle East.



The U.S. economy consumes an immense quantity of material. In 1989, a total of about 4.5 billion metric tons of natural resources was consumed in the U.S. -- about 400,000 pounds per person. Construction materials and energy use each accounted for about 40 percent.

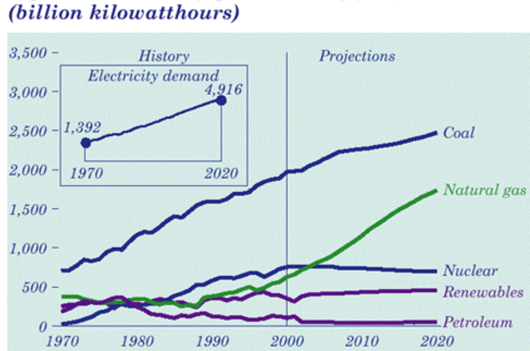
The ratio of U.S. per capita consumption to the world average varies from 1.5 for cement to 7 for plastic. In comparison to a country like India, the U.S. has less than one third the population size, but consumes nearly 3 times as much iron ore, 4.6 times as much steel, 3.6 times as much coal, 12 times as much petroleum, 3 times as many cattle, and 1.7 times as much roundwood. U.S. release of greenhouse gases is 19 times higher than India's.

A Few Nasty U.S. Facts (we Canadians are no better):

- Power plants burning coal, oil and natural gas produce 64% of the United States' sulfur dioxide emissions, 33% of mercury emissions, and 26% of nitrogen oxide emissions.
- Power plants deposit 11-15% of the nitrogen in the Chesapeake Bay, a factor thought to have contributed to the rapid growth of toxic organisms, such as blooms of toxic algae, in recent years.
- Electricity use accounts for 36% of America's greenhouse gas emissions. The coal, oil and natural gas used today may lead to a doubling of pre-industrial carbon concentration in the 21st century.
- Scientists at Oak Ridge National Lab hold federal hydroelectric dams primarily responsible for reducing Northwest salmon from 16 million to 300,000 wild fish per year.
- According to the Congressional Research Service, transporting nuclear waste to the proposed Yucca Mountain storage facility could result in 154 truck and 18 rail accidents per year, a small number of which might release radioactivity.

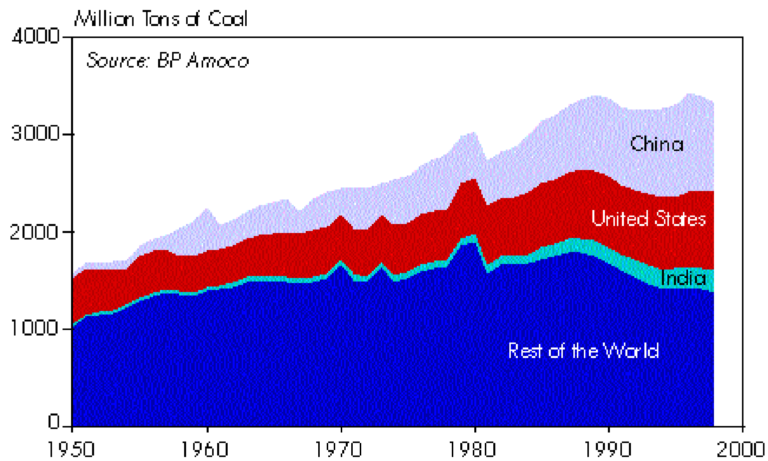
- State and federal documents indicate that every dump ever used to store low-level nuclear waste—a total of six—has leaked.

Figure 4. Electricity generation by fuel, 1970-2020 (billion kilowatthours)



History: Energy Information Administration (EIA), Form EIA-860B, "Annual Electric Generator Report— Nonutility"; EIA, *Annual Energy Review 2000*, DOE/EIA- 0384(2000) (Washington, DC, August 2001); and Edison Electric Institute. **Projections:** Table A8.

Americans are expected to use 27% more energy in 2020 compared to 1998, with electricity use being the main driver. Without a significant commitment to energy efficiency and renewable energy, high electricity consumption could result in 1,000 new power plants in 2020, the vast majority (97%) powered by fossil fuels. One estimate found that the mid-Atlantic states (New Jersey, Maryland, Delaware and Pennsylvania) are the target for over 30,000 megawatts-worth of new power plants, none of which are likely to be renewable.



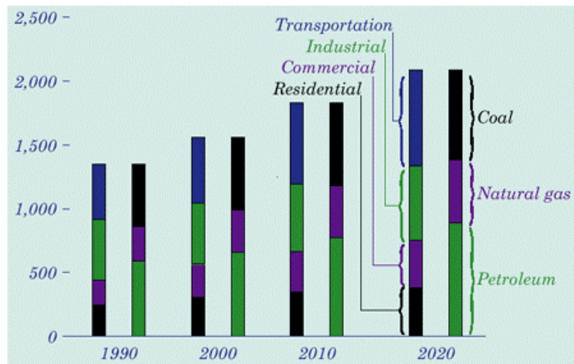
"Coal's share of world energy, which peaked at 62 percent in 1910, is down to 23 percent-roughly where it was in 1860," notes Worldwatch research associate Seth Dunn, author of "King Coal's Weakening Grip on Power" in the September/October issue of World Watch magazine. "While coal's market price is at an historic low, its environmental and health costs have never been higher."

Hastening coal's decline is imperative if climate change is to be slowed in the next century. Coal is the most carbon-intensive fossil fuel, releasing 29 percent more carbon per unit of energy than oil, and 80 percent more than natural gas. It accounts for 43 percent of annual global carbon emissions-approximately 2.7 billion tons. Coal is also the most abundant of the fossil fuels-with an estimated 1,000-year reserve. But burning the entire resource would release 3 trillion tons of carbon into the atmosphere, five times above the safe limit identified by scientists for averting serious climatic disruptions.

Two main ingredients of coal smoke are particulate and sulfur dioxide pollution, which cause 500,000 premature deaths and millions of new respiratory illnesses each year in urban areas worldwide. Several cities, including Beijing and Delhi, are near the pollution levels that London experienced during its famous "fog" that took 4,000 lives in 1952. Today's fogs are transcontinental travelers: dust clouds from Asian coal now reach the U.S. West Coast. In rural areas, coal smoke from cooking accounts for as many as 1.8 million deaths globally.

Since the oil price shocks of the 1970s and the high electricity prices of the 1980s, it has become clear that energy efficiency can play a major role in providing lower cost energy services. The energy savings Americans achieved since the mid-1970s have reduced the nation's annual energy bill by several hundred billion dollars per year. This efficiency has also eliminated the need for 14 million barrels of oil per day.

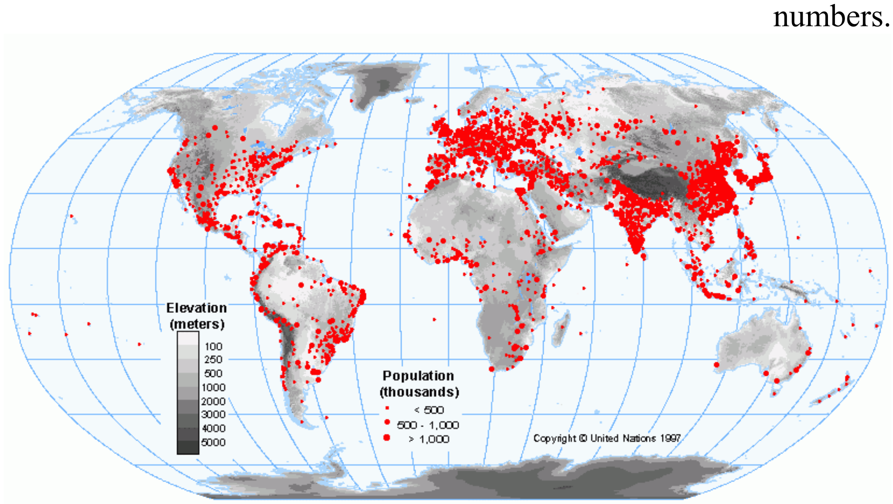
Figure 7. Projected U.S. carbon dioxide emissions by sector and fuel, 1990-2020 (million metric tons carbon equivalent)



History: Energy Information Administration, *Emissions of Greenhouse Gases in the United States 2000*, DOE/EIA-0573(2000) (Washington, DC, November 2001). **Projections:** Table A19.

Problems with Urbanization:

Cities are home to more people than ever before. In 1900, only 160 million people, one tenth of the world's population, were city dwellers. But soon after 2000, in contrast, half the world (3.2 billion people) will live in urban areas--a 20-fold increase in numbers.



In this urbanizing world, cities hold the key to achieving a sustainable balance between the Earth's resource base and its human energy. Industrialization in developing countries has led to urban health problems on an unprecedented scale. China, for instance, has reported 3 million deaths from urban air pollution over two years. Cities around the world affect not just the health of their people but the health of the planet. Urban areas take up just 2 percent of the world's surface but consume the bulk of vital resources.

The Role of Energy Efficiency:

Worldwide energy assessments now indicate that improving the energy efficiency of buildings, appliances, office equipment, factories, and vehicles could free-up more than a trillion dollars per decade. In addition, these improvements would prevent the release of a rash of environmental pollutants.

Environmental problems like acid rain, urban smog, and global climate change are directly linked to the combustion of fossil fuels. Greater reliance on energy efficiency offers countries worldwide a means of maintaining economic growth and environmental quality. For example, the U.S. Climate Change Action Plan will both reduce greenhouse gases by 108 million tons and save Americans $260 billion.

Currently, fossil fuels remain the world's most heavily used energy sources. Petroleum comprises 40 percent of commercial energy services, coal comprises about 27 percent, natural gas 22 percent, and hydropower and nuclear power each comprise about six percent. In addition, in many countries non-commercial fuels like wood comprise a large fraction of the energy sources.

Solar and wind power -- some of the most readily available renewable energy sources -- and emission free -- are grossly underutilized worldwide.

There is a rapidly expanding global market for competitively priced, clean, "green" energy services that don't pollute or destroy natural resources. In addition to low-cost energy efficiency options, these green goods include different renewable energy options like solar panels, wind turbines, bioenergy power plants, geothermal installations, and small scale hydro plants.

A study prepared for the United Nations Conference on Environment and Development (UNCED) held in Rio, Brazil, found extraordinary potential for renewable energy use worldwide. Over the next half century, energy efficiency could satisfy half of the world's energy demands, and renewables could satisfy half of the remaining demands.

Renewables?

Ideally a green building should not just get its daylight and heat, but also its electricity from the sun or other renewable energy sources.

Renewable energy sources include solar power, wind power, hydro, biomass and geothermal power.

Solar Power:

The energy derived from the sun is very versatile and can be used either by *passive* or *active* means.
Passive solar often uses direct gain, in combination with thermal mass storage to allow the heat to be stored and re-radiated into the building.
Solar power can be used on tube collectors to heat water.
Solar radiation can be processed through photo-voltaic cells to create electricity.
The sun can be used to daylight buildings and thereby avoid the use of electric lighting.

Wind Power:

The terms "wind energy" or "wind power" describe the process by which the wind is used to generate mechanical power or electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. This mechanical power can be used for specific tasks (such as grinding grain or pumping water) or a generator can convert this mechanical power into electricity to power homes, businesses, schools, and the like. In the United States, millions of windmills were erected as the American West was developed during the late 19th century. Most of them were used to pump water for farms and ranches. By 1900, small electric wind systems were developed to generate direct current, but most of these units fell into disuse as inexpensive grid power was extended to rural areas during the 1930s. By 1910, wind turbine generators were producing electricity in many European countries.

Biomass:

The term "biomass" means any plant derived organic matter available on a renewable basis, including dedicated energy crops and trees, agricultural food and feed crops, agricultural crop wastes and residues, wood wastes and residues, aquatic plants, animal wastes, municipal wastes, and other waste materials. Handling technologies, collection logistics and infrastructure are important aspects of the biomass resource supply chain.
Biopower technologies are proven electricity generation options in the United States, with 10 gigawatts of installed capacity.
A variety of *Biofuels* can be made from biomass resources, including the liquid fuels ethanol, methanol, biodiesel, and gaseous fuels such as hydrogen and methane.
Biofuels research and development is composed of three main areas: producing the fuels, finding applications and uses of the fuels, and creating a distribution infrastructure.

Geothermal Energy:

Geothermal energy technologies use the heat of the earth for direct-use applications, geothermal heat pumps, and electrical power production. Research in all areas of geothermal development is helping to lower costs and expand its use. In the United

States, most geothermal resources are concentrated in the West, but geothermal heat pumps can be used nearly anywhere.
Geothermal hot water near the Earth's surface can be used directly for heating buildings and as a heat supply for a variety of commercial and industrial uses. Geothermal direct use is particularly favored for greenhouses and aquaculture.

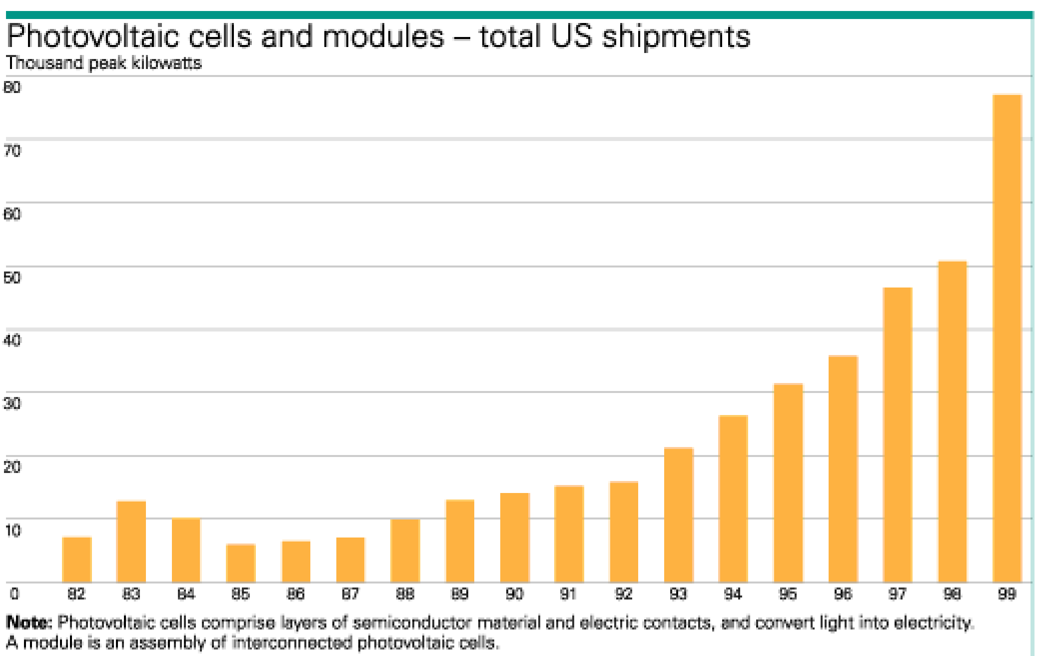
Hydro Power:

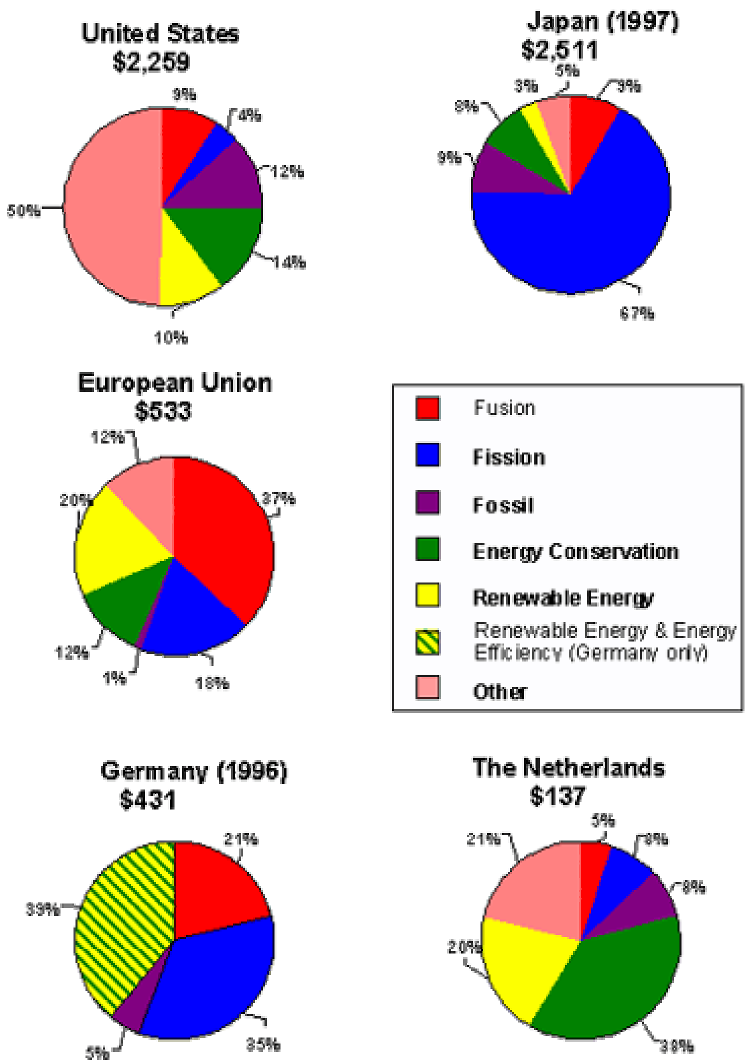
Flowing water creates energy that can be captured and turned into electricity. This is called hydropower . Hydropower is currently the largest source of renewable power, generating nearly 10% of the electricity used in the United States.

The most common type of hydropower plant uses a dam on a river to store water in a reservoir. Water released from the reservoir flows through a turbine, spinning it, which, in turn, activates a generator to produce electricity. But hydropower doesn't necessarily require a large dam. Some hydropower plants just use a small canal to channel the river water through a turbine.

Research and development in the area of renewables will be a key factor to reducing emissions and effecting an overall change in the way we think about heating, cooling and lighting our buildings.

Increase in PV Production:




United States
$2,259
9%
4%
12%
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50%
Japan (1997)
$2,511
5%
3%
8%
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European Union
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Renewable Energy & Energy Efficiency (Germany only)
Other
Germany (1996)
$431
21%
39%
5%
35%
The Netherlands
$137
5%
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20%
38%

Buildings: Problems or Solutions?

Targeting architects for education about energy and the environment is especially important because, whether aware of it or not, they play a central role in shaping the nation's future in these areas. With lifespans of decades or even centuries, buildings are among the most lasting objects we produce. They account for more than one-third of national energy use and over sixty percent of national electricity consumption. Buildings in the United States alone account for almost 10% of global energy use. They also serve as models for much of the new construction in the developing world. A quick sketch or clay model made by an architect in the earliest stages of design can affect building energy consumption well into the future. A thoughtless decision about building orientation may create a cooling load that lasts as much as a century. Decisions about the extent and type of glazing in a commercial or institutional building will affect power use for thousands of business days.

In design scheming a number of goals must be considered and balanced. These usually include economics, aesthetics, and spatial quality. All too often, however, energy issues and occupant health and well-being are not among the primary concerns. Many architects see energy considerations as something to be handed off and resolved by mechanical and electrical consultants. This attitude is rooted in the "machine-age" sensibility that came to the fore in architecture in the first half of this century, and achieved its apogee in the International Style of the "energy rich" decades of the 1950s and 1960s.

Many high-profile architects and senior architecture faculty were trained during these decades and developed a design process in which both energy use and building performance receive low priority. While consulting engineers can condition almost any space that an architect hands them in this compartmentalized process, there is a high price in energy, equipment and space when the building is not suited to its site and climate.

Environmental Architecture:

Environmentally responsible architecture CAN make a huge difference.

Five principles of an environmental architecture (Thomas A. Fisher, AIA, November, 1992):

* Healthful Interior Environment.
* Energy Efficiency.
* Ecologically Benign Materials.
* Environmental Form.
* Good Design.

Healthful Interior Environment.

* All possible measures are to be taken to ensure that materials and building systems do not emit toxic substances and gasses into the interior atmosphere. Additional measures are to be taken to clean and revitalize interior air with filtration and plantings.

Energy Efficiency.

* All possible measures are to be taken to ensure that the building's use of energy is minimal. Cooling, heating and lighting systems are to use methods and products that conserve or eliminate energy use.

Ecologically Benign Materials.

* All possible measures are to be taken to use building materials and products that minimize destruction of the global environment. Wood is to be selected based on non destructive forestry practices. Other materials and products are to be considered based on the toxic waste out put of production.

Environmental Form.

* All possible measures are to be taken to relate the form and plan of the design to the site, the region and the climate. Measures are to be taken to "heal" and augment the ecology of the site. Accommodations are to be made for recycling and energy efficiency. Measures are to be taken to relate the form of building to a harmonious relationship between the inhabitants and nature.

Good Design.

* All possible measures are to be taken to achieve an efficient, long lasting and elegant relationship of use areas, circulation, building form, mechanical systems and construction technology. Symbolic relationships with appropriate history, the Earth and spiritual principles are to be searched for and expressed. Finished buildings shall be well built, easy to use and beautiful.

Environmental *Building* Design for our Cold Climate:

First INSULATE, then INSOLATE.

Buildings can be designed using natural means to aid in heating and cooling.

Buildings designed for passive solar and daylighting incorporate design features such as large south-facing windows and building materials that absorb and slowly release the sun's heat. No mechanical means are employed in passive solar heating. Incorporating passive solar designs can reduce heating bills as much as 50 percent. Passive solar designs can also include natural ventilation for cooling. Daylighting can greatly reduce electricity requirements in all building types.

"Future generation is the most important" --- Confucius.

「無後為大」- 孔子

"It's not easy being green." --
Kermit the Frog, 1972.

(These notes are based on a Powerpoint presentation. If anyone is interested in obtaining a copy of this presentation – including more images – email me at tboake@uwaterloo.ca .)