Approved: 03/11/08
Date

MINUTES OF THE SENATE PUBLIC HEALTH AND WELFARE COMMITTEE

The meeting was called to order by Chairman James Barnett at 1:30 P.M. on March 5, 2008 in Room 136-N of the Capitol.

All members were present.

Committee staff present:
Terri Weber, Kansas Legislative Research Department
Sara Zafar, Kansas Legislative Research Department
Nobuko Folmsbee, Revisor of Statutes
Jan Lunn, Committee Secretary

Conferees appearing before the committee:
Howard Rodenberg, MD, MPH

Others attending:
See attached list.

Chairman Barnett requested that Terri Weber, Legislative Research Department, provide a brief description of the handouts she distributed: "Greenhouse Gases" from the National Oceanic and Atmospheric Administration (Attachment 1), "Greenhouse Gases and Society" (Attachment 2), and "Fast Facts" from the Environmental Protection Agency (Attachment 3). These attachments are incorporated into these minutes as a matter of record.

Chairman Barnett indicated that as legislators move forward with decisions related to energy, the Holcomb power plant, and impacts of greenhouse gasses on climate change the presentation would be beneficial to committee members. Dr. Howard Rodenberg was introduced.

Dr. Rodenberg is a previous Director of the Division of Health in the Kansas Department of Health and Environment, a previous State Health Officer, and a current emergency room physician. He has extended knowledge in public health and environmental issues.

Dr. Rodenberg presented comments (Attachment 4) and committee members reviewed a hard-copy of a slide show presentation (Attachment 5) that related to the science of climate change and its possible effects on the health of Kansans. His presentation included a description and definition of climate change, predicted effects of climate change on health, and mitigation strategies for the effects of climate change.

Dr. Rodenberg indicated there are greenhouse gasses whose molecules, within the atmosphere, trap the sun's heat energy and prevent it from being radiating into space, and in turn, radiate energy back to the earth's surface; thus, creating warming. These gases include: water vapor, carbon dioxide, methane, and other compounds. Predicted health effects of climate change and global warming are: temperature-related deaths and disability, changes in vector-borne disease, problems related to pollution, and increases in extreme weather events. Dr. Rodenberg spoke about the importance of mitigating these adverse effects by: (a) identifying and developing alternative energy strategies such as solar or wind power, (b) developing methods to eliminate greenhouse gases produced by using a "sink" or reservoir for removing carbon dioxide from the atmosphere, encouraging plankton growth in bodies of water, injecting carbon dioxide into underground geologic formations, (c) decreasing the "carbon footprint" and (d) reforestation.

Dr. Rodenberg also spoke to mercury emissions and the need to mitigate effects caused by human activity using filtration. He noted that current Environmental Protection (EPA) rules for mercury emissions have been vacated by the 2005 Clean Air Mercury Rule.

Senator Haley questioned what one or two areas were most important to implement in energy policy? Dr. Rodenberg offered his personal opinion that, on a large-scale, focus on alternative energy sources such as solar and wind should be explored, elimination or reduction of the "carbon footprint" should occur, and carbon dioxide injection strategies should be implemented.

gas emissions. Dr. Rodenberg responded that there is no magic number relating to the height of smoke stacks. What is important is the temperature of the air above and below the smoke stack, or the nocturnal temperature inversion level. If air coming out of a smoke stack is less warm than the air above, the smoke stack emission stays at ground level (and the inverse is true).

Questions were asked regarding the occurrence of extreme weather, mitigation techniques for mercury emissions, and whether documentation or reports had been developed or available to the Department of Health and Environment related to carbon dioxide emissions and/or mercury emissions and/or energy policy.

Chairman Barnett requested staff inquire of the Kansas Department of Health and Environment whether documentation and/or reports relative to energy policy, carbon dioxide emissions, and mercury emissions had been developed, and if so, that copies of such documentation be forwarded to the Senate Committee on Public Health and Welfare

Senator Brungardt asked about "acid rain" as a greenhouse gas; Senator Wagle asked whether nuclear energy is a viable alternative energy source. Dr. Rodenberg answered that "acid rain" is a greenhouse gas regulated very efficiently by the EPA; nuclear energy is a viable alternative energy source.

Members of the Committee reviewed the minutes of the February 20 and 21, 2008, meetings. Senator Haley moved to accept the minutes as submitted; Senator Schmidt seconded the motion. The minutes were unanimously accepted as written.

The meeting was adjourned at 2:25pm

SENATE PUBLIC HEALTH AND WELFARE COMMITTEE GUEST LIST

DATE: March 5, 2008

NAME	REPRESENTING
SEAN MILLER	CAPITOL STRATEGIES
Scott Heidner	Gaches Braden
Michael White	Senate President's office
Matt MANDA	Senate Majority LEADER'S Office
Nate Michel	Hein Law Firm

National Oceanic and Atmospheric Administration

Greenhouse Gases

Frequently Asked Questions

Introduction

What are greenhouse gases?

Many chemical compounds present in Earth's atmosphere behave as 'greenhouse gases'. These are gases which allow direct sunlight (relative shortwave energy) to reach the Earth's surface unimpeded. As the shortwave energy (that in the visible and ultraviolet portion of the spectra) heats the surface, longer-wave (infrared) energy (heat) is reradiated to the atmosphere. Greenhouse gases absorb this energy, thereby allowing less heat to escape back to space, and 'trapping' it in the lower atmosphere. Many greenhouse gases occur naturally in the atmosphere, such as carbon dioxide, methane, water vapor, and nitrous oxide, while others are synthetic. Those that are man-made include the chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs) and Perfluorocarbons (PFCs), as well as sulfur hexafluoride (SF_6). Atmospheric concentrations of both the natural and man-made gases have been rising over the last few centuries due to the industrial revolution. As the global population has increased and our reliance on fossil fuels (such as coal, oil and natural gas) has been firmly solidified, so emissions of these gases have risen. While gases such as carbon dioxide occur naturally in the atmosphere, through our interference with the carbon cycle (through burning forest lands, or mining and burning coal), we artificially move carbon from solid storage to its gaseous state, thereby increasing atmospheric concentrations.

Water Vapor

Water Vapor is the most abundant greenhouse gas in the atmosphere, which is why it is addressed here first. However, changes in its conentration is also considered to be a result of climate *feedbacks* related to the warming of the atmosphere rather than a direct result of industrialization. The feedback loop in which water is involved is critically important to projecting future climate change, but as yet is still fairly poorly measured and understood.

As the temperature of the atmosphere rises, more water is evaporated from ground storage (rivers, oceans, reservoirs, soil). Because the air is warmer, the relative humidity can be higher (in essence, the air is able to 'hold' more water when its warmer), leading to more water *vapor* in the atmosphere. As a greenhouse gas, the higher concentration of water vapor is then able to absorb more thermal IR energy radiated from the Earth, thus further warming the atmosphere. The warmer atmosphere can then hold more water vapor and so on and so on. This is referred to as a 'positive feedback loop'. However, huge scientific uncertainty exists in defining the extent and importance of this feedback loop. As water vapor increases in the atmosphere, more of it will eventually also condense into clouds, which are more able to reflect incoming solar radiation (thus allowing less energy to reach the Earth's surface and heat it up). The future monitoring of atmospheric processes involving water vapor will be critical to fully understand the feedbacks in the climate system leading to global climate change. As yet, though the basics of the hydrological cycle are fairly well understood, we have very little comprehension of the complexity of the feedback loops. Also, while we have good atmospheric measurements of other key greenhouse gases such as carbon dioxide and methane, we have poor measurements of global water vapor, so it is not certain by how much atmospheric concentrations have risen in recent decades or centuries, though satellite measurements, combined with balloon data and some in-situ ground measurements indicate generally positive trends in global water vapor.

Carbon Dioxide

The natural production and absorption of carbon dioxide (CO_2) is achieved through the terrestrial biosphere and the ocean. However, humankind has altered the natural carbon cycle by burning coal, oil, natural gas and wood and since the industrial revolution began in the mid 1700s, each of these actvities has increased in scale and distribution. Carbon dioxide was the first greenhouse gas demonstrated to be increasing in atmospheric concentration with the first conclusive measurements being made in the last half of the 20th century. Prior to the industrial revolution, concentrations were fairly stable at 280ppm. Today, they are around 370ppm, an increase of well over 30%. The atmospheric concentration has a marked seasonal oscillation that is mostly due to the greater extent of landmass in the northern hemisphere (NH) and its vegetation. A greater drawdown of CO_2 occurs in the NH spring and summer as plants convert CO_2 to plant material through photosynthesis. It is then released again in the fall and winter as the plants decompose.

Methane

Methane is an extrememly effective absorber of radiation, though its atmospheric concentration is less than CO_2 and its lifetime in the atmosphere is brief (10-12 years), compared to some other greenhouse gases (such as CO_2, N_2O, CFCs). Methane(CH_4) has both natural and anthropogenic sources. It is released as part of the biological processes in low oxygen environments, such as in swamplands or in rice production (at the roots of the plants). Over the last 50 years, human activities such as growing rice, raising cattle, using natural gas and mining coal have added to the atmospheric concentration of methane. Direct atmospheric measurement of atmospheric methane has been possible since the late 1970s and its conentration rose from 1.52 ppmv in 1978 by around 1%/year to 1990, since when there has been little sustained increase. The current atmospheric concentration is ~1.77 ppmv, and there is no scientific consensus on why methane has not risen much since around 1990.

Tropospheric Ozone

Ultraviolet radiation and oxygen interact to form ozone in the stratosphere. Existing in a broad band, commonly called the 'ozone layer', a small fraction of this ozone naturally descends to the surface of the Earth. However, during the 20th century, this tropospheric ozone has been supplemented by ozone created by human processes. The exhaust emissions from automobiles and pollution from factories (as well as burning vegetation) leads to greater concentrations of carbon and nitrogen molecules in the lower atmosphere which, when it they are acted on by sunlight, produce ozone. Consequently, ozone has higher concentrations in and around cities than in sparsely populated areas, though there is some transport of ozone downwind of major urban areas. Ozone is an important contributor to photochemical smog. Though the lifetime of ozone is short, and is therefore not well-mixed through the atmosphere, there is a general band of higher ozone concentration during NH spring and summer between 30�N and 50�N resulting from the higher urbanization and industrial activity in this band. Concentrations of ozone have risen by around 30% since the pre-industrial era, and is now considered by the IPCC to be the third most important greenhouse gas after carbon dioxide and methane. An additional complication of ozone is that it also interacts with and is modulated by concentrations of methane.

Nitrous Oxide

Concentrations of nitrous oxide also began to rise at the beginning of the industrial revolution and is understood to be produced by microbial processes in soil and water, including those reactions which occur in fertilizer containing nitrogen. Increasing use of these fertilizers has been made over the last century. Global concentration for N_2O in 1998 was 314 ppb, and in addition to agricultural sources for the gas, some industrial processes (fossil fuel-fired power plants, nylon production, nitric acid production and vehicle emissions) also contribute to its atmospheric load.

CFCs etc.

CFCs (chlorofluorocarbons) have no natural source, but were entirely synthesized for such diverse uses as refrigerants, aerosol propellants and cleaning solvents. Their creation was in 1928 and since then concentrations of CFCs in the atmosphere have been rising. Due to the discovery that they are able to destroy stratospheric ozone, a global effort to halt their production was undertaken and was extremely successful. So much so that levels of the major CFCs are now remaining level or declining. However, their long atmospheric lifetimes determine that some concentration of the CFCs will remain in the atmosphere for over 100 years. Since they are also greenhouse gas, along with such other long-lived synthesized gases as CF_4 (carbontatrafuoride), SF_6 (sulfurhexafluoride), they are of concern. Another set of synthesized compounds called HFCs (hydrofluorcarbons) are also greenhouse gases, though they are less stable in the atmosphere and therefore have a shorter lifetime and less of an impact as a greenhouse gas.

Carbon Monoxide and other reactive gases

Carbon monoxide (CO) is not considered a direct greenhouse gas, mostly because it does not absorb terrestrial thermal IR energy strongly enough. However, CO is able to modulate the production of methane and tropospheric ozone. The Northern Hemisphere contains about twice as much CO as the Southern Hemisphere because as much as half of the global burden of CO is derived from human activity, which is predominantly located in the NH. Due to the spatial variability of CO, it is difficult to ascertain global concentrations, however, it appears as though they were generally increasing until the late 1980s, and have since begun to decline somewhat. One possible explanation is the reduction in vehicle emissions of CO since greater use of catalytic converters has been made.

Volatile Organic Compounds (VOCs) also have a small direct impact as greenhouse gases, as well being involved in chemical processes which modulate ozone production. VOCs include non-methane hydrocarbons (NMHC), and oxygenated NMHCs (eg. alcohols and organic acids), and their largest source is natural emissions from vegetation. However, there are some anthropogenic sources such as vehicle emissions, fuel production and biomass burning. Though measurement of VOCs is extremely difficult, it is expected that most anthropogenic emissions of these compounds have increased in recent decades.

Additional Information

[Intergovernmental Panel on Climate Change]
[U.S. Environmental Protection Agency]
[World Data Center for Greenhouse Gases]
[A Paleoclimate perspective on global warming]

Greenhouse Gases and Society

by Nick Hopwood and Jordan Cohen

Greenhouse gases naturally blanket the Earth and keep it about 33 degrees Celsius warmer than it would be without these gases in the atmosphere. This is called the �Greenhouse Effect�. Over the past century, the Earth has increased in temperature by about .5 degrees Celsius and many scientists believe this is because of an increase in concentration of the main greenhouse gases: carbon dioxide, methane, nitrous oxide, and fluorocarbons. People are now calling this climate change over the past century the beginning of�Global Warming.� Fears are that if people keep producing such gases at increasing rates, the results will be negative in nature, such as more severe floods and droughts, increasing prevalence of insects, sea levels rising, and Earth's precipitation may be redistributed. These changes to the environment will most likely cause negative effects on society, such as lower health and decreasing economic development. However, some scientists argue that the global warming we are experiencing now is a natural phenomenon, and is part of Earth's natural cycle. Presently, nobody can prove if either theory is correct, but one thing is certain; the world has been emitting greenhouse gases at extremely high rates and has shown only small signs of reducing emissions until the last few years. After the 1997 Kyoto Protocol, the world has finally taken the first step in reducing emissions.

The Greenhouse Effect

The "greenhouse effect" is the heating of the Earth due to the presence of greenhouse gases. It is named this way because of a similar effect produced by the glass panes of a greenhouse. Shorter-wavelength solar radiation from the sun passes through Earth's atmosphere, then is absorbed by the surface of the Earth, causing it to warm. Part of the absorbed energy is then reradiated back to the atmosphere as long wave infared radiation. Little of this long wave radiation escapes back into space; the radiation cannot pass through the greenhouse gases in the atmosphere. The greenhouse gases selectively transmit the infared waves, trapping some and allowing some to pass through into space. The greenhouse gases absorb these waves and reemits the waves downward, causing the lower atmosphere to warm.(www.eb.com:180)

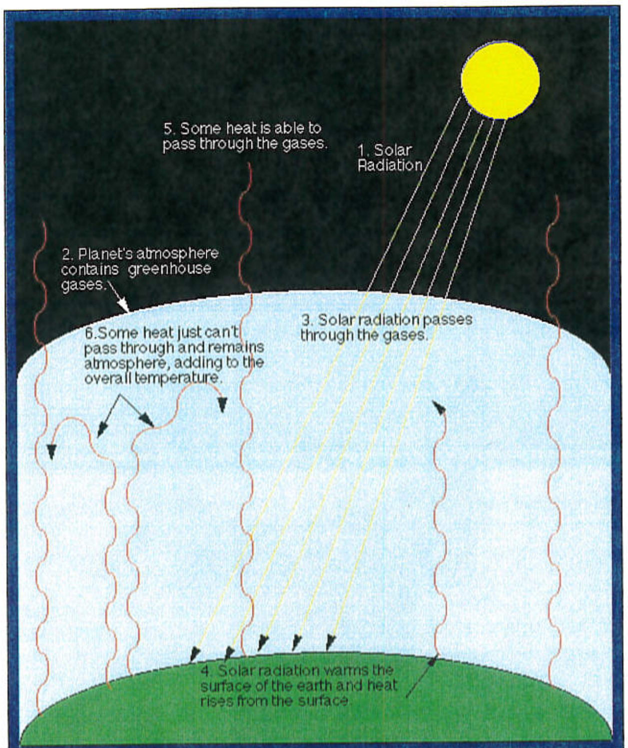
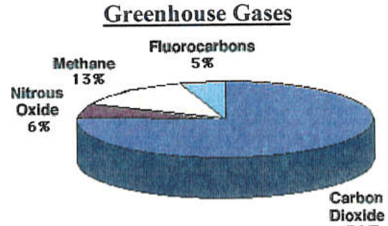


Diagram to help explain the process of global warming and how greenhouse gases create the "greenhouse effect"
www.eecs.umich.edu/mathscience/funexperiments/agesubject/lessons/images/diagrampage.html

Greenhouse Gases



This graph shows the distribution of GHG in Earth's atmosphere. Carbon Dioxide is clearly the majority.
www.abcnews.com/sections/us/global106.html

PUBLIC HEALTH AND WELFARE
ATTACHMENT: 2
DATE: 03/05/08

The U.S. Inventory of Greenhouse Gas Emissions and Sinks: Fast Facts

U.S. Greenhouse Gas Emissions and Sinks (Tg CO_2 Equivalents)

Gas/Source	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Change from 1990 to 2005: Absolute	Change from 1990 to 2005: Percent
CO_2	**5,061.6**	**5,016.2**	**5,111.3**	**5,240.3**	**5,333.5**	**5,384.6**	**5,566.8**	**5,640.6**	**5,678.5**	**5,754.8**	**5,940.0**	**5,843.0**	**5,892.7**	**5,952.5**	**6,064.3**	**6,089.5**	**1,027.9**	**20.3%**
Fossil Fuel Combustion	4,724.1	4,682.9	4,786.3	4,912.9	4,986.7	5,030.0	5,218.1	5,277.5	5,306.3	5,377.9	5,584.9	5,511.7	5,557.2	5,624.5	5,713.0	5,751.2	1,027.1	21.7%
Non-Energy Use of Fuels	117.3	123.5	116.5	119.5	130.9	133.2	132.7	140.5	153.5	161.2	141.0	131.4	135.3	131.3	150.2	142.4	25.1	21.4%
Cement Manufacture	33.3	32.5	32.8	34.6	36.1	36.8	37.1	38.3	39.2	40.0	41.2	41.4	42.9	43.1	45.6	45.9	12.6	38.0%
Iron and Steel Production	84.9	75.9	73.4	69.0	73.2	73.3	67.4	71.7	67.4	63.5	65.1	57.9	54.6	53.4	51.3	45.2	(39.7)	(46.7)%
Natural Gas Systems	33.7	32.8	32.2	33.4	33.5	33.8	31.5	31.3	29.3	30.3	29.4	28.8	29.6	28.4	28.2	28.2	(5.5)	(16.4)%
Municipal Solid Waste Combustion	10.9	12.5	12.6	13.4	14.0	15.7	17.0	17.6	17.0	17.5	17.9	18.3	18.5	19.5	20.1	20.9	10.0	91.0%
Ammonia Manufacture and Urea Application	19.3	19.2	20.0	20.4	21.1	20.5	20.3	20.7	21.9	20.6	19.6	16.7	17.8	16.2	16.9	16.3	(3.0)	(15.5)%
Lime Manufacture	11.3	11.1	11.4	11.7	12.1	12.8	13.5	13.7	14.0	13.5	13.3	12.9	12.3	13.0	13.7	13.7	2.4	21.2%
Limestone and Dolomite Use	5.5	5.0	4.9	4.9	5.5	7.4	7.8	7.2	7.4	8.1	6.0	5.7	5.9	4.7	6.7	7.4	1.9	33.7%
Soda Ash Manufacture and Consumption	4.1	4.0	4.1	4.0	4.0	4.3	4.2	4.4	4.3	4.2	4.2	4.1	4.1	4.1	4.2	4.2	0.1	2.1%
Aluminum Production	6.8	6.9	6.8	6.2	5.5	5.7	6.0	6.0	6.2	6.3	6.1	4.4	4.5	4.5	4.2	4.2	(2.6)	(38.4)%
Petrochemical Production	2.2	2.3	2.4	2.6	2.7	2.8	2.8	2.9	3.0	3.1	3.0	2.8	2.9	2.8	2.9	2.9	0.7	30.5%
Titanium Dioxide Production	1.3	1.3	1.5	1.6	1.7	1.7	1.7	1.8	1.8	1.9	1.9	1.9	2.0	2.0	2.3	1.9	0.6	46.9%
Ferroalloy Production	2.2	1.9	2.0	1.9	2.0	2.0	2.1	2.2	2.2	2.2	1.9	1.5	1.3	1.3	1.4	1.4	(0.8)	(35.3)%
Phosphoric Acid Production	1.5	1.4	1.5	1.3	1.5	1.5	1.6	1.5	1.6	1.5	1.4	1.3	1.3	1.4	1.4	1.4	(0.1)	(9.5)%
Carbon Dioxide Consumption	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.8	1.0	1.3	1.2	1.3	(0.1)	(6.5)%
Zinc Production	0.9	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.2	1.1	1.1	1.0	0.9	0.5	0.5	0.5	(0.5)	(51.0)%
Lead Production	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	(0.0)	(7.2)%
Silicon Carbide Production and Consumption	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.2	(0.2)	(41.6)%
Land Use, Land-Use Change, and Forestry (Sink)[a]	*(712.8)*	*(793.0)*	*(794.5)*	*(765.3)*	*(833.9)*	*(828.8)*	*(832.9)*	*(862.3)*	*(808.6)*	*(782.2)*	*(756.7)*	*(767.5)*	*(811.9)*	*(811.9)*	*(824.8)*	*(828.5)*	*(115.7)*	*16.2%*
International Bunker Fuels[b]	*113.7*	*120.1*	*109.9*	*99.8*	*97.7*	*100.6*	*102.2*	*109.8*	*114.5*	*105.1*	*101.1*	*97.6*	*89.1*	*83.7*	*97.2*	*97.2*	*(16.5)*	*(14.5)%*
Wood Biomass and Ethanol Consumption[b]	*219.3*	*220.1*	*230.5*	*225.7*	*232.2*	*236.8*	*241.2*	*236.5*	*218.1*	*222.4*	*228.3*	*203.2*	*204.4*	*209.6*	*224.8*	*206.5*	*(12.9)*	*(5.9)%*
CH_4	**609.1**	**604.4**	**611.0**	**597.1**	**606.6**	**598.7**	**597.3**	**580.7**	**569.6**	**562.0**	**563.7**	**547.7**	**549.7**	**549.2**	**540.3**	**539.3**	**(69.8)**	**(11.5)%**
Landfills	161.0	161.6	166.1	165.3	163.4	157.1	153.4	146.5	138.9	135.4	131.9	127.6	130.4	134.9	132.1	132.0	(29.0)	(18.0)%
Enteric Fermentation	115.7	114.9	117.2	116.6	118.1	120.6	118.2	116.1	114.5	114.6	113.5	112.5	112.6	113.0	110.5	112.1	(3.6)	(3.1)%
Natural Gas Systems	124.5	125.7	126.1	127.5	128.8	128.1	130.2	128.5	125.8	121.7	126.6	125.4	125.0	123.7	119.0	111.1	(13.3)	(10.7)%
Coal Mining	81.9	79.0	77.0	65.1	65.2	66.5	63.4	62.8	62.8	58.7	55.9	55.5	52.0	52.1	54.5	52.4	(29.5)	(36.0)%
Manure Management	30.9	32.2	31.1	31.8	34.1	35.1	33.7	35.4	38.7	38.3	38.7	40.1	41.1	40.5	39.7	41.3	10.4	33.7%
Petroleum Systems	34.4	34.4	33.2	32.2	31.7	31.1	30.8	30.3	29.7	28.5	27.8	27.4	26.8	25.8	25.4	28.5	(6.0)	(17.3)%
Wastewater Treatment	24.8	25.2	25.7	25.7	25.5	25.1	25.7	26.5	26.5	26.6	26.4	25.9	25.8	25.6	25.7	25.4	0.6	2.5%
Forest Land Remaining Forest Land	7.1	2.6	4.1	3.5	8.0	4.0	11.1	4.9	3.9	9.0	14.0	6.0	10.4	8.1	6.9	11.6	4.5	63.7%
Stationary Combustion	8.0	8.2	8.4	8.0	7.8	7.8	8.1	7.5	6.9	7.0	7.4	6.8	6.8	7.0	7.1	6.9	(1.1)	(13.5)%
Rice Cultivation	7.1	7.0	7.9	7.0	8.2	7.6	7.0	7.5	7.9	8.3	7.5	7.6	6.8	6.9	7.6	6.9	(0.2)	(3.2%)
Abandoned Underground Coal Mines	6.0	6.1	6.6	6.9	8.1	8.2	8.4	7.5	6.9	7.0	7.3	6.7	6.1	5.9	5.8	5.5	(0.5)	(8.0)%
Mobile Combustion	4.7	4.6	4.6	4.5	4.5	4.3	4.2	4.0	3.8	3.6	3.5	3.2	3.1	2.9	2.8	2.6	(2.1)	(44.7)%
Petrochemical Production	0.9	0.9	0.9	1.0	1.1	1.1	1.1	1.2	1.2	1.3	1.2	1.1	1.1	1.1	1.2	1.1	0.2	25.1%
Iron and Steel Production	1.3	1.2	1.2	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.1	1.0	1.0	1.0	1.0	(0.4)	(28.0)%
Field Burning of Agricultural Residues	0.7	0.6	0.8	0.6	0.8	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.8	0.9	0.9	0.2	24.2%
Silicon Carbide Production and Consumption	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	(0.0)	(66.7)%
Ferroalloy Production	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	(0.0)	(43.0)%
International Bunker Fuels[b]	*0.2*	*0.2*	*0.2*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.2*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*(0.1)*	*(34.9)%*
N_2O	**482.0**	**484.0**	**477.3**	**519.6**	**487.2**	**484.2**	**546.8**	**506.0**	**528.8**	**472.7**	**499.8**	**502.5**	**479.2**	**459.8**	**445.2**	**468.6**	**(13.4)**	**(2.8)%**
Agricultural Soil Management	366.9	367.2	358.8	396.5	359.2	353.4	413.1	377.6	405.0	350.0	376.8	389.0	366.1	350.2	338.8	365.1	(1.8)	(0.5)%
Mobile Combustion	43.7	45.8	48.8	50.9	52.6	53.7	54.4	55.1	55.1	54.3	53.2	49.7	47.1	43.8	41.2	38.0	(5.7)	(13.1)%
Nitric Acid Production	17.8	17.8	18.3	18.6	19.6	19.9	20.7	21.2	20.9	20.1	19.6	15.9	17.2	16.7	16.0	15.7	(2.2)	(12.1)%
Stationary Combustion	12.3	12.2	12.4	12.7	12.8	12.8	13.4	13.5	13.4	13.4	14.0	13.5	13.4	13.7	13.9	13.8	1.5	12.2%
Manure Management	8.6	9.0	8.7	9.1	9.0	9.0	8.7	9.0	9.2	9.2	9.6	9.8	9.7	9.3	9.4	9.5	0.9	10.3%
Wastewater Treatment	6.4	6.5	6.6	6.7	7.0	6.9	7.0	7.1	7.3	7.5	7.6	7.6	7.7	7.8	7.9	8.0	1.6	25.6%
Adipic Acid Production	15.2	14.8	13.1	14.0	15.0	17.2	17.0	10.3	6.0	5.5	6.0	4.9	5.9	6.2	5.7	6.0	(9.2)	(60.7)%
Settlements Remaining Settlements	5.1	5.2	5.3	5.5	5.7	5.5	5.7	5.7	5.7	5.8	5.6	5.5	5.6	5.8	6.0	5.8	0.7	13.1%
N_2O Product Usage	4.3	4.2	3.9	4.5	4.5	4.5	4.5	4.8	4.8	4.8	4.8	4.8	4.3	4.3	4.3	4.3	(0.0)	(0.4)%
Forest Land Remaining Forest Land	0.8	0.3	0.5	0.5	0.9	0.6	1.3	0.8	0.7	1.3	1.7	1.0	1.4	1.2	1.1	1.5	0.8	97.6%
Field Burning of Agricultural Residues	0.4	0.4	0.4	0.3	0.5	0.4	0.4	0.4	0.5	0.4	0.5	0.5	0.4	0.4	0.5	0.5	0.1	36.2%
Municipal Solid Waste Combustion	0.5	0.4	0.5	0.4	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	(0.1)	(15.0)%
International Bunker Fuels[b]	*1.0*	*1.0*	*0.9*	*0.9*	*0.9*	*0.9*	*0.9*	*1.0*	*1.0*	*0.9*	*0.9*	*0.9*	*0.8*	*0.8*	*0.9*	*0.9*	*(0.1)*	*(8.5)%*
HFCs, PFCs, and SF_6	**89.3**	**81.0**	**86.3**	**87.5**	**91.9**	**103.5**	**120.5**	**129.2**	**142.7**	**141.0**	**143.8**	**133.8**	**143.0**	**142.7**	**153.9**	**163.0**	**73.7**	**82.5%**
Substitution of Ozone Depleting Substances	0.3	0.6	2.9	7.6	15.1	32.2	44.9	57.4	65.5	73.1	80.9	88.6	96.9	105.5	114.5	123.3	123.0	36,899.1%
HCFC-22 Production	35.0	30.8	34.9	31.8	31.6	27.0	31.1	30.0	40.1	30.4	29.8	19.8	19.8	12.3	15.6	16.5	(18.4)	(52.7)%
Electrical Transmission and Distribution	27.1	26.0	25.9	25.1	23.7	21.8	19.9	18.3	15.5	15.9	15.2	15.1	14.3	13.8	13.6	13.2	(13.9)	(51.3)%
Semiconductor Manufacture	2.9	2.9	2.9	3.6	4.0	5.0	5.5	6.3	7.1	7.2	6.3	4.5	4.4	4.3	4.7	4.3	1.4	47.7%
Aluminum Production	18.5	15.6	14.3	13.7	12.1	11.8	12.4	10.8	8.6	8.5	8.6	3.5	5.2	3.8	2.8	3.0	(15.6)	(84.1)%
Magnesium Production and Processing	5.4	5.1	5.4	5.5	5.4	5.6	6.6	6.4	5.8	5.9	3.0	2.4	2.4	2.9	2.6	2.7	(2.8)	(50.9)%
Total	**6,242.0**	**6,185.6**	**6,286.0**	**6,444.4**	**6,519.2**	**6,571.0**	**6,831.4**	**6,856.4**	**6,919.6**	**6,930.5**	**7,147.2**	**7,027.0**	**7,064.6**	**7,104.2**	**7,203.7**	**7,260.4**	**1,018.4**	**16.3%**
Net Emissions (Sources and Sinks)	**5,529.2**	**5,392.6**	**5,491.5**	**5,679.1**	**5,685.3**	**5,742.2**	**5,998.5**	**5,994.1**	**6,111.0**	**6,148.2**	**6,390.5**	**6,259.5**	**6,252.7**	**6,292.3**	**6,378.9**	**6,431.9**	**902.7**	**16.3%**

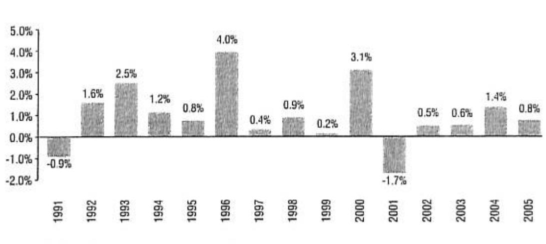
+ Does not exceed 0.05 Tg CO_2 Eq
[a] Sinks are only included in net emissions total.
[b] Emissions from International Bunker Fuels and Wood Biomass and Ethanol Consumption are not included in totals.

Note: Totals may not sum due to independent rounding. Emissions weighted using GWP values from IPCC Second Assessment Report (1996) in keeping with UNFCCC reporting guidelines.

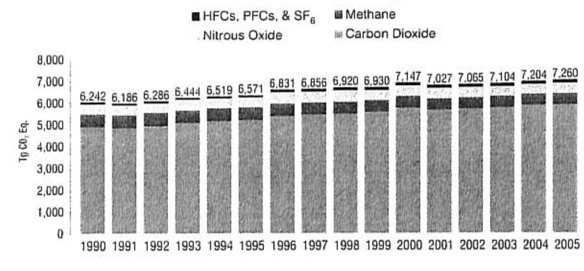
1990-2005 Trends

- Total GHG emissions rose 16 percent since 1990 (increasing 1.6 percent since 2000)
- Dominant gas emitted was CO_2, mostly from fossil fuel combustion
- Methane emissions decreased by 11 percent
- Nitrous oxide emissions decreased by 3 percent
- HFC, PFC, and SF_6 emissions have grown by 83 percent

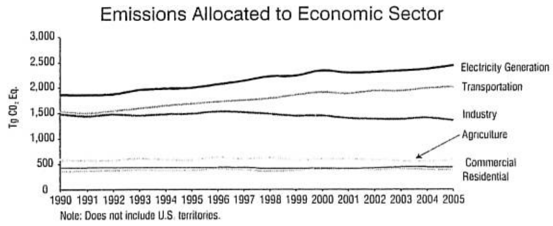
Annual Percent Change in U.S. GHG Emissions



U.S. GHG Emissions by Gas



Emissions Allocated to Economic Sector



Note: Does not include U.S. territories.

Public Health & Welfare
Attachment 3
3/5/08

The U.S. Inventory of Greenhouse Gas Emissions and Sinks:

Reference Tables and Conversions

Global Warming Potentials (100 Year Time Horizon)

Gas	GWP SAR[a]	GWP TAR[b]
Carbon dioxide (CO_2)	1	1
Methane (CH_4)*	21	23
Nitrous oxide (N_2O)	310	296
HFC-23	11,700	12,000
HFC-125	2,800	3,400
HFC-134a	1,300	1,300
HFC-143a	3,800	4,300
HFC-152a	140	120
HFC-227ea	2,900	3,500
HFC-236fa	6,300	9,400
HFC-4310mee	1,300	1,500
CF_4	6,500	5,700
C_2F_6	9,200	11,900
C_4F_{10}	7,000	8,600
C_6F_{14}	7,400	9,000
SF_6	23,900	22,200

[a] *IPCC Second Assessment Report* (1996)
[b] *IPCC Third Assessment Report* (2001)

* The methane GWP includes the direct effects and those indirect effects due to the production of tropospheric ozone and stratospheric water vapor. The indirect effect due to the production of CO_2 is not included.

Note: GWP values from the *IPCC Second Assessment Report* are used in accordance with UNFCCC guidelines.

Global Warming Potential (GWP) is defined as the cumulative radiative forcing effects of a gas over a specified time horizon resulting from the emission of a unit mass of gas relative to a reference gas. The GWP-weighted emissions of direct greenhouse gases in the U.S. Inventory are presented in terms of equivalent emissions of carbon dioxide (CO_2), using units of teragrams of carbon dioxide equivalents (Tg CO_2 Eq.).

Conversion:

$$\text{Tg} = 10^9 \text{ kg} = 10^6 \text{ metric tons} = 1 \text{ million metric tons}$$

The molecular weight of carbon is 12, and the molecular weight of oxygen is 16; therefore, the molecular weight of CO_2 is 44 (i.e., 12+[16×2]), as compared to 12 for carbon alone. Thus, the weight ratio of carbon to carbon dioxide is 12/44.

Conversion from gigagrams of gas to teragrams of carbon dioxide equivalents:

$$\text{Tg } CO_2 \text{ Eq.} = \left(\frac{\text{Gg}}{\text{of gas}}\right) \times (\text{GWP}) \times \left(\frac{\text{Tg}}{1{,}000 \text{ Gg}}\right)$$

Guide to Metric Unit Prefixes

Prefix/Symbol	Factor	
Tera (T)	10^{12}	1,000,000,000,000
Giga (G)	10^{9}	1,000,000,000
Mega (M)	10^{6}	1,000,000
Kilo (k)	10^{3}	1,000
Hecto (h)	10^{2}	100
Deca (da)	10^{1}	10
—	10^{0}	1
Deci (d)	10^{-1}	.1
Centi (c)	10^{-2}	.01
Milli (m)	10^{-3}	.001
Micro (μ)	10^{-6}	.000001
Nano (n)	10^{-9}	.000000001
Pico (p)	10^{-12}	.000000000001

Unit Conversions

1 pound	= 0.454 kilograms	= 16 ounces	
1 kilogram	= 2.205 pounds	= 35.27 ounces	
1 short ton	= 0.9072 metric tons	= 2,000 pounds	
1 metric ton	= 1.1023 short tons	= 1,000 kilograms	
1 cubic foot	= 0.02832 cubic meters	= 28.3168 liters	
1 cubic meter	= 35.315 cubic feet	= 1,000 liters	
1 U.S. gallon	= 3.78541 liters	= 0.03175 barrels	= 0.02381 barrels petroleum
1 liter	= 0.2642 U.S. gallons	= 0.0084 barrels	= 0.0063 barrels petroleum
1 barrel	= 31.5 U.S. gallons	= 119 liters	= 0.75 barrels petroleum
1 barrel petroleum	= 42 U.S. gallons	= 159 liters	
1 foot	= 0.3048 meters	= 12 inches	
1 meter	= 3.28 feet	= 39.37 inches	
1 mile	= 1.609 kilometers	= 5,280 feet	
1 kilometer	= 0.6214 miles	= 3,280.84 feet	
1 square mile	= 2.590 square kilometers	= 640 acres	
1 square kilometer	= 0.386 square miles	= 100 hectares	
1 acre	= 43,560 square feet	= 0.4047 hectares	= 4,047 square meters

Energy Conversions

The common energy unit used in international reports of greenhouse gas emissions is the joule. A joule is the energy required to move an object one meter with the force of one Newton. A terajoule (TJ) is one trillion (10^{12}) joules. A British thermal unit (Btu, the customary U.S. energy unit) is the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit at or near 39.2 Fahrenheit.

1 TJ =
- 2.388×10^{11} calories
- 23.88 metric tons of crude oil equivalent
- 9.478×10^{8} Btu
- 277,800 kilowatt-hours

Energy Units

Btu	British thermal unit	1 Btu
MBtu	Thousand Btu	1×10^{3} Btu
MMBtu	Million Btu	1×10^{6} Btu
BBtu	Billion Btu	1×10^{9} Btu
TBtu	Trillion Btu	1×10^{12} Btu
QBtu	Quadrillion Btu	1×10^{15} Btu

$$CO_2 \text{ Emissions from Fossil Fuel Combustion} = \text{Fuel Combusted} \times \text{Carbon Content Coefficient} \times \text{Fraction Oxidized} \times (44/12)$$

May include adjustments for carbon stored in fossil fuel-based products, emissions from international bunker fuels, or emissions from territories.

Carbon Intensity of Different Fuel Types

The amount of carbon in fossil fuels per unit of energy content varies significantly by fuel type. For example, coal contains the highest amount of carbon per unit of energy, while petroleum has about 25 percent less carbon than coal, and natural gas about 45 percent less.

Converting Various Physical Units to Energy Units

The values in the following table provide conversion factors from physical units to energy equivalent units and from energy units to carbon contents. These factors can be used as default factors, if local data are not available.

Conversion Factors to Energy Units (Heat Equivalents) Heat Contents and Carbon Content Coefficients of Various Fuel Types

Fuel Type	Heat Content	Carbon (C) Content Coefficients	Carbon Dioxide (CO_2) per Physical Unit
Solid Fuels	**Million Btu/Metric Ton**	**kg C/Million Btu**	**kg CO_2/Metric Ton**
Anthracite Coal	20.48	28.26	2,122.0
Bituminous Coal	21.67	25.49	2,025.6
Sub-bituminous Coal	15.55	26.48	1,509.7
Lignite	11.67	26.30	1,125.6
Coke	22.50	31.00	2,557.0
Unspecified Coal	22.68	25.34	2,106.9
Gas Fuels	**Btu/Cubic Foot**	**kg C/Million Btu**	**kg CO_2/Cubic Foot**
Natural Gas	1,030	14.47	0.0546
Liquid Fuels	**Million Btu/Petroleum Barrel**	**kg C/Million Btu**	**kg CO_2/Petroleum Barrel**
Crude Oil	5.80	20.33	432.3
Natural Gas Liquids and LRGs	3.72	16.99	231.9
Motor Gasoline	5.22	19.33	369.8
Aviation Gasoline	5.05	18.87	349.3
Kerosene	5.67	19.72	410.0
Jet Fuel	5.67	19.33	401.9
Distillate Fuel Oil	5.83	19.95	426.1
Residual Fuel Oil	6.29	21.49	495.4
Naphtha for Feedstock	5.25	18.14	349.1
Petroleum Coke	6.02	27.85	615.2
Other Oil for Feedstock	5.83	19.95	426.1
Special Naphthas	5.25	19.86	382.2
Lubricants	6.07	20.24	450.1
Waxes	5.54	19.81	402.2
Asphalt & Road Oil	6.64	20.62	501.7
Still Gas	6.00	17.51	385.2
Misc. Products	5.80	20.33	432.0

Note: For fuels with variable heat contents and carbon content coefficients, 2005 U.S. average values are presented. All factors are presented in gross calorific values (GCV) (i.e., higher heating values). LRG = Liquid Refinery Gas. Miscellaneous products includes all finished products not otherwise classified, (e.g., aromatic extracts and tars, absorption oils, ram-jet fuel, synthetic natural gas, naptha-type jet fuel, and specialty oils).

Density Conversions

Methane (Natural Gas)	1 cubic meter	=	35.32 cubic feet	=	0.676 kilograms
Carbon dioxide	1 cubic meter	=	35.32 cubic feet	=	1.854 kilograms
Natural gas liquids	1 metric ton	=	11.60 barrels	=	1,844.20 liters
Unfinished oils	1 metric ton	=	7.46 barrels	=	1,186.04 liters
Alcohol	1 metric ton	=	7.94 barrels	=	1,262.36 liters
Liquefied petroleum gas	1 metric ton	=	11.60 barrels	=	1,844.20 liters
Aviation gasoline	1 metric ton	=	8.90 barrels	=	1,415.00 liters
Naphtha jet fuel	1 metric ton	=	8.27 barrels	=	1,314.82 liters
Kerosene jet fuel	1 metric ton	=	7.93 barrels	=	1,260.72 liters
Motor gasoline	1 metric ton	=	8.53 barrels	=	1,356.16 liters
Kerosene	1 metric ton	=	7.73 barrels	=	1,228.97 liters
Naphtha	1 metric ton	=	8.22 barrels	=	1,306.87 liters
Distillate	1 metric ton	=	7.46 barrels	=	1,186.04 liters
Residual oil	1 metric ton	=	6.66 barrels	=	1,058.85 liters
Lubricants	1 metric ton	=	7.06 barrels	=	1,122.45 liters
Bitumen	1 metric ton	=	6.06 barrels	=	963.46 liters
Waxes	1 metric ton	=	7.87 barrels	=	1,251.23 liters
Petroleum coke	1 metric ton	=	5.51 barrels	=	876.02 liters
Petrochemical feedstocks	1 metric ton	=	7.46 barrels	=	1,186.04 liters
Special naphtha	1 metric ton	=	8.53 barrels	=	1,356.16 liters
Miscellaneous products	1 metric ton	=	8.00 barrels	=	1,271.90 liters

Note: Gas densities are at room temperature and pressure.

For more information on calculating CO_2 emissions per kWh, download eGRID at: **http://www.epa.gov/cleanenergy/egrid**

For other related information, see: **http://www.epa.gov/climatechange** **http://unfccc.int**

Source for all data: *U.S. Inventory of Greenhouse Gas Emissions and Sinks 1990-2005* (EPA 2007)

Download the inventory at: http://www.epa.gov/climatechange/emissions/usinventoryreport.html

3-2

TESTIMONY ON THE PROJECTED HEALTH EFFECTS OF CLIMATE CHANGE

Senate Committee on Public Health and Welfare

Howard Rodenberg, MD MPH

March 5, 2008

Chairman Barnett and Member of the Committee, my name is Dr. Howard Rodenberg. Until last November, I had the honor to serve as the Director of the Division of Health in the Kansas Department of Health and Environment, and to be the State Health Officer. I am now working again as an emergency physician, but continue to have a strong interest in making Kansas a national leader in public health.

I appreciate the opportunity to give you a brief overview of the science of climate change and it's possible effects on the health of Kansans and the nation. It is my belief that a full and frank discussion of these factors should and will strongly influence decisions about the energy future of tour state. Its my goal today to provide a brief introduction to climate change…what it is, what are its' causes, what might be its' effects, and how we might mitigate these consequences.

The Warm Earth and Greenhouse Gases

The earth normally goes through cycles of global warming and cooling. These cycles are a result of a number of a number of factors. The relative quantity of "greenhouse gases" in the atmosphere is a critical factor influencing these cycles. Other drivers include solar variation, subtle changes in the earth's orbit, plate tectonics, volcanism, and the manner in which the oceans distribute heat.

The role of "greenhouse gases" is critical to note. The atmosphere of the earth can be thought of as a "closed" system, within which no substance save energy (heat) can get in or out. Greenhouse gases are those molecules within the atmosphere that trap the sun's heat energy within the atmosphere, preventing it from being radiated into space and, in turn, radiating the energy back to the surface. These gases include water vapor, carbon dioxide (CO2), methane (CH4), and other compounds. They are crucial to maintaining normal global temperatures; without them, the mean temperature of the earth's surface would hover just below 0 F. Not all greenhouse gases are created equal; a molecule of methane has 23 times the global warming potential, or GWP, of a molecule of CO2. (Global warming potential is a relative measure of the degree to which a molecule of gas contributes to global warming as compared to a molecule of CO2.)

Increased amounts of greenhouse gases within the atmosphere lead to increased surface temperatures. For example, increased surface temperatures induce evaporation of ice sheets and bodies of water, increasing the content of water vapor in the atmosphere. This increases global heat retention, and the cycle is magnified and begins again. The planet Venus, often thought of as the "twin" of the earth, is an example of a runaway greenhouse gas effect. It's atmosphere is composed mostly of carbon dioxide, and it's barren and arid surface bakes at over 872 F, hot enough to melt lead. From the standpoint of human activity, increased temperatures increase demand for cooling of homes and business, driving up CO_2 production at power stations and further increasing the temperature, which again drives increased energy demands and further CO_2 production. It is also critical to note that of the major factors contributing the climate change, the quantity of greenhouse gases in the atmosphere is the only one over which humans have some control.

What is Climate Change?

It's important at the outset to differentiate weather from climate. Weather refers to events that occur in the "present," over days or perhaps weeks. Climate describes the overall character of events and conditions as measured over time (decades, centuries, or more). This difference is critical, for you'll often hear that the presence of a cold snap argues against a theory of global warming. Similarly, a heat spell cannot be taken in and of itself as evidence of climate change. (While the contemporary debate rightly focuses on global warming, climate change is actually a more correct term to use because it describes epochs when the earth cools as well.)

As previously noted, the earth normally undergoes cyclical climate changes of both warming and cooling throughout history. In the context of the history of the earth, we are still technically in an ice age (defined as a time in which sheets of ice continue to cover areas of the planet). We happen to be in a warmer period of the current ice age known as an interglacial. This is important to note because glaciers have been recognized as a sensitive early indicator of climate change. But just as weather cannot be taken as an indication of climate, the fact that we still have ice on the planet does not argue against the concept of global warming. This key difference is emphasized by noting the current retraction of the glacier sheet across the globe, a clear sign of warming.

While climate change is a long-term natural phenomena, there is unmistakable evidence that the normal cycle of global warming is being accelerated, and that the cause of this acceleration is human activity ("anthropogenic" factors). The majority of the impact is caused by the burning of fossil fuels such as oil and coal, followed by the production of methane though large-scale agricultural production. Both of these activities produce "greenhouse gases," which are significant drivers of global warming as we've discussed. Interestingly, cement manufacturing also accounts for a small percentage of CO_2 release. There is also a human influence on global warming based on land use patterns, deforestation, and development, but this effect is marginalized by the contributions of greenhouse gas production.

Since the 1850's, CO_2 levels have risen from 280 parts per million (ppm) to 380 today, and if they continue on the current trend they would near 600 ppm by the end of the century. CO_2 levels are known to be higher now than at any time in the past 750,000 years, and it's speculated that they are higher now than at any point in the past 20 million years. Means of determining these historical trends vary, but evaluation of ice core samples at the poles provide the most accurate evidence of recent change.

Predicted Effects of Climate Change on Health

The increase in CO_2, and the accelerated "greenhouse effect," lie behind the predictions of a mean global temperature change of up to 6 C during our children's lifetime. Rises in global temperature are considered to result in rises in sea level and changes in agricultural production, biodiversity (species extinctions), the number and severity of extreme weather events, and significant effects on human health.

It's somewhat more difficult to specify the effects of climate change on Kansas. The climate of Kansas features a large air mass division across the middle of the state, which is one of the reasons for the stark differences in the ecology between the eastern and western thirds of the state. As a result of this air mass, different parts of Kansas could expect to see differing effects in an era of global warming. Eastern Kansas will become wetter, while western counties will become drier and more arid. Experts in climatology would be better equipped than I to provide more detailed estimates of the effects of climate change on both the agricultural industry and upon the parks and wetlands of Kansas. As an interested citizen, it would be my hope that the legislature would study this issue in depth.

The predicted health effects of climate change fall into five major categories. The first is that of temperature-related death and disability. This category includes direct effects such as heat strokes and heat illness, as well as indirect effects such as stress on other organ systems induced by heat. The second relates to changes in rates of vector-borne (mosquitos, et al) diseases due to hotter, wetter environments. Problems linked to air pollution represent a third broad class, and increases in food and water-borne disease encompass a fourth. The fifth category includes the negative health effects of extreme weather events such as tornadoes and flooding.

In Kansas, it's probably safe to say that all of these categories would be likely to apply. However, it should be noted that these effects are posited to occur in a regional sense at best. Models do not yet exist that can accurately predict specific local effects. This being said, thinking specifically about Kansas a final possible health effect comes to mind. Climactic changes may also result in decreased agricultural production and crop-shifting. While it's unlikely that Kansans will suffer from nutritional disorders as may occur in the undeveloped world, these events may influence the economic well-being of the state.

Mitigating the Effects of Climate Change

While climate change is inevitable over geologic time, human activity is clearly accelerating the timeline of events, making the consequences of global warming something our children can expect to confront. As someone interested in public health, I hope to see the human effects on climate change minimized in order to preserve the health of Kansans. Therefore, the final part of this presentation will briefly review what things can be done to prevent a worsening of the problem.

Many people use the term "carbon offset" to describe actions which mitigate greenhouse gas emissions. The term is most often thought of as an economic tool where greenhouse gas production is "traded" for dollars to be used elsewhere to remove or reduce other emissions from the atmosphere. For clarity, in this discussion we'll use the term in a way more focused on science than economics. "Carbon footprint" is also commonly used in this discussion; it refers to the impact of human activity relative to the amount of greenhouse gases produced, measured in units of CO2.

There are three main strategies to mitigating these effects. The first is to simply eliminate the means of production of greenhouse gases. Industries and means of transportation that produce greenhouse gases are no longer sanctioned and alternatives, such as solar or wind power, must be identified and developed. Speaking strictly from the standpoint of efficacy, without regard for the economics of the issue, it is the most immediate way to curb greenhouse gas emissions.

A second strategy is to get rid of the greenhouse gases produced. For example, carbon dioxide can be taken up by a "sink," a reservoir used to remove CO2 from the atmosphere. Examples of this strategy include reforestation, in which the large-scale planting of trees encourages CO2 uptake in the process of photosynthesis. Encouraging plankton growth in bodies of water and adapting agricultural processes are other examples of "natural" ways to enhance CO2 removal from the environment. "Artificial" methods include carbon capture during the combustion process and injecting CO2 into underground geologic formations such as oil fields, coal seams, and saline aquifers. Each of these methods is controversial to a degree. For example, there is some debate as to the efficacy of reforestation given different climatic and geographic conditions. In many cases, experience and technology have yet to fully support the theory. Nonetheless, they do offer real potential and, in my own view, should be aggressively explored as part of a comprehensive, cutting-edge energy plan

The third strategy is to maximize the energy output per unit of greenhouse gas created, therefore decreasing the "carbon footprint" of the total amount of energy produced. This can be done in two ways. The first is by influencing the process of production itself, using technologies to burn fuels more efficiently with less "off-gassing." The second is the use alternate energy sources to increase the total amount of energy produced per unit of greenhouse gas. On a small-scale, this is what hybrid automobiles do; they use the power from the combustion engine to charge a battery, which provides more power for the auto given the same amount of fuel used than a traditional gasoline engine. Supplementing fossil fuel power plats with wind or solar energy projects through fiscal "carbon offsets" such as fees or taxes is a larger model for the same basic concept. Combustion of agricultural methane to produce both energy and CO2, a gas with a lower GWP than methane, is a variation of this idea.

Once again, I need to include a caveat that these are large-scale mitigation strategies. To my understanding, accurate models do not yet exist that are able to predict how much or how little any single project contributes to global climate change, nor how much or how little any particular strategy will mitigate these effects. One is not necessarily preferable to the other, and all are reasonable and logical ways to approach the problem. This being said, if we acknowledge that global warming is a reality and that human activity is accelerating the process to our detriment, it is my personal belief that we have an obligation to begin to lay a groundwork for change using any or all of our options.

A Note on Mercury

While not directly related to the topic of climate change, concern has also been expressed about the allowable levels of mercury produced by the combustion of coal in power plants. Mercury emissions are carried through the atmosphere are deposited through precipitation into bodies of water, where it transforms into methylmercury. Methylmercury has been implicated in impaired neurodevelopment in children, especially those exposed as a fetus. Mercury exposure has also been linked with increased risk of coronary artery disease. Most exposures occur through ingestion of contaminated fish. There is controversy about the current "acceptable" levels of mercury emissions, effects of methyl mercury in combination with other contaminants such as polychlorinated biphenyls (PCB's), and effects of local deposition in mercury "hot spots." From the standpoint of health, the need to address mercury emissions follows similar logic to that of greenhouse gases. If mercury is produced by human activity, and we are able to document its' harms, it seems reasonable to begin mitigating potential problems. However, Federal Environmental Protection Agency (EPA) rules for mercury emissions are currently in flux following a recent court decision which vacated the 2005 Clean Air Mercury Rule.

Thank you for allowing me to present this material to you. I hope you'll find it helpful as you continue your discussions about both climate change and the energy future of Kansas. With any luck, I've raised more questions for you then provided answers, and our time together has spurred your own interest in the topic. This review has been necessarily simplistic, and I would encourage the legislature to continue to study this issue, using the expertise we have in our colleges and universities to help clarify these issues and make them as specific to Kansas as the science allows. Thank you once again, and I'll be happy to stand for any questions you might have at the appropriate time.

SELECTED REFERENCES

Intergovernmental Panel on Climate Change Working Group Reports. Text available at http://ipcc.ch/

United States Centers for Disease Control and Prevention, National Center for Environmental Health. http://www.cdc.gov/nceh/climatechange/

United States Environmental Protection Agency, Climate Change Science. http://epa.gov/climatechange/

Climate Change and Public Health

Committee on Public Health and Welfare
Howard Rodenberg MD MPH
March 5, 2008

Today's Agenda...

- How does the earth "work"...how does it control temperature?"
- What is climate change?
- What are the effects on health?
- What can we do about it?

Climate is Cyclical

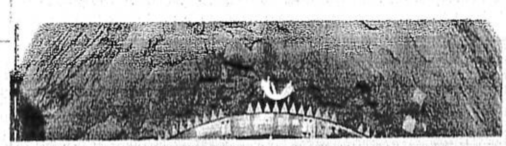
- Earth normally has cycles of global warming and cooling
- Mediated by "greenhouse gases," solar variations, orbital changes, oceans, plates, and volcanos

Greenhouse Gases

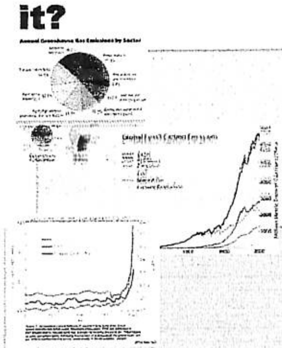
- The atmosphere as a closed system
- Energy (heat) only gets in and out
- Greenhouse gas molecules absorb and radiate heat back to earth
- Include water vapor, CO2, and methane

Greenhouse Gases and Global Warming

- Increased greenhouse gases lead to increased surface temperature
- An accelerating cycle (natural and man-made)
- Venus as a "runaway" example



Climate Change: What is it?



- Climate or weather?
- Warming cycle accelerated by human activity
- Burning of fossil fuels, agriculture
- Documented by rising CO2 levels (highest on 20 million years?)

PUBLIC HEALTH AND WELFARE
ATTACHMENT: 5
DATE: 03/05/08

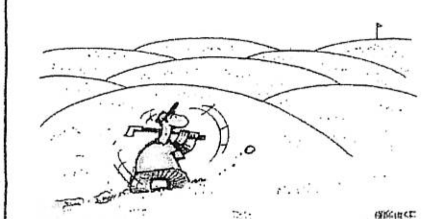
Effects of Climate Change

- Rise in global temperatures
- Rise in sea levels
- Changes in agricultural production
- Specific Kansas effects
  - Differ between east and west
  - Economic effects on agriculture

"YOU DON'T SUPPOSE HE'D BE IMPRESSED WE VOTED FOR AL GORE?"

Health and Climate Change in Kansas

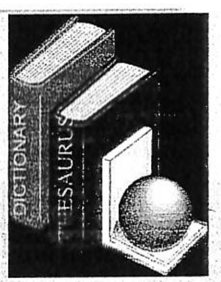
- Temperature-related illness and death
- Vector-borne disease
- Air pollution
- Food and water-borne disease
- Extreme weather events
- Secure in predicting effect, but poor models of magnitude



The sand bunker on the post global warming golf course.

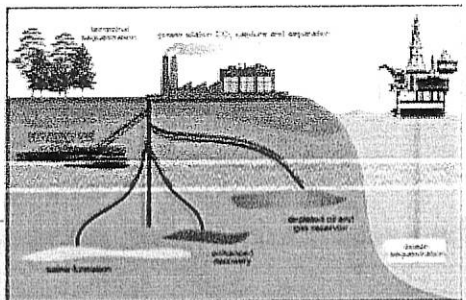
Mitigating Climate Change

- Control of human accelerators
- "Carbon offset"
  - Technical definition
  - Financial definition
- "Carbon footprint"



Mitigation Strategies

- Eliminate sources of greenhouse gas production
- Dispose of greenhouse gases produced
  - Use of "carbon sinks"
  - Natural methods
  - Artificial methods

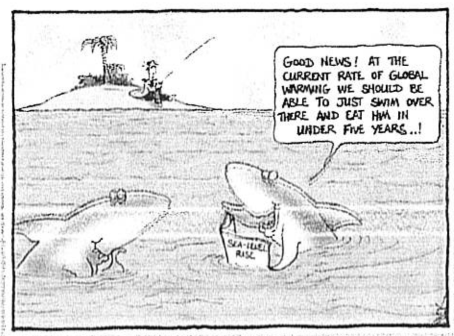


Mitigation Strategies (Con't)

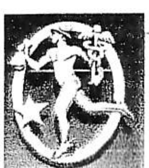
- Maximize energy output per unit of greenhouse gas produced (less "footprint")
  - More effective production
  - Alternate energy sources increase total energy produced per unit of gas
    - Hybrid cars
    - Wind and solar projects
    - Fiscal "carbon offsets" and "carbon taxes"

Caveats and Cautions

- All are large-scale strategies
- All are logical and reasonable ways to address the problem
- All should be part of a comprehensive effort to mitigate greenhouse gas production and prevent health effects



A Note on Mercury



- Result of coal burning
- Falls to earth with precipitation; ingested through fish
- Neurodevelopmental disorders, CAD
- Toxicity levels
- Rules in flux
- Greenhouse gas analogy?

Thank You!