

An introduction to climate change issues

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Preface

Last June, the EQC voted to study issues related to climate change. As outlined in the draft work plan, the study will examine climate change, review the Montana Climate Change Advisory Committee report, and possibly suggest legislation.

Climate change is a complex issue with many facets, including scientific, economic, and political. This paper and other reading materials are an introduction to the science of climate change and an overview of local, state and national actions related to climate change. This primer is not comprehensive, but is meant provide EQC members with a starting point from which they can steer the study.

The Basics

Climate change is a term that includes any significant change in measures of climate, such as temperature, precipitation or wind that lasts for several decades or longer. Climate change may result from:

- * natural factors, such as changes in the sun's intensity or slow changes in the earth's orbit around the sun;
- * natural processes within the climate system such as changes in ocean circulation; and
- * human activities that change the atmosphere's composition, including the burning of fossil fuels, or changes to the land surface such as deforestation, reforestation, urbanization or desertification.¹

Greenhouse gases are central to the climate change debate. Visible light from the sun passes through the atmosphere and is absorbed by the Earth's surface - some of that energy is then emitted back to the atmosphere as heat. Greenhouse gases trap that heat, which would otherwise be released into space, raising the temperature of the atmosphere and, subsequently, the Earth's surface. This is called the greenhouse effect. Primary greenhouse gases include:²

- * Water vapor contributes the most to the greenhouse effect and occurs in the atmosphere as a result of the natural cycle of water

¹ Environmental Protection Agency. www.epa.gov/climatechange/basicinfo.html

² Pew Center on Climate Change.
www.pewclimate.org/global-warming-basics/faq_s/glance_faq_science.cfm

* Carbon dioxide also cycles naturally between the atmosphere and living organisms. Plants and algae remove CO₂ from the atmosphere via photosynthesis, while all living things release CO₂ via respiration (i.e., breathing). Carbon dioxide also cycles back and forth between water on the Earth's surface (freshwater and the oceans) and the atmosphere. In addition to these natural processes, humans release large quantities of CO₂ to the atmosphere by burning fossil fuels, deforestation, and other industrial processes.

* Methane is a natural byproduct of decomposition, but significant quantities are also produced by agriculture and animal husbandry as well as by fossil fuel production.

* Nitrous oxide (N₂O) - Nitrous oxide is released naturally from terrestrial soils and oceans, but substantial quantities are also generated from the use of nitrogen fertilizers in agriculture and through some industrial processes.

* A number of other natural and man-made gases also contribute to the greenhouse effect, including tropospheric ozone, and industrial gases such as halocarbons.

* Aerosols are airborne particles within the atmosphere. Some aerosols, such as sulfate aerosols and black carbon aerosols are also produced by fossil fuel combustion. Sulfate aerosols tend to reflect incoming solar radiation, cooling the Earth's surface. Black carbon aerosols absorb, rather than reflect, solar radiation, which shades the Earth's surface, but warms the atmosphere.

While the greenhouse effect is necessary for the planet to be warm enough to be livable, there are concerns that an increasing accumulation of greenhouse gases are causing an increase in global temperatures.

During the past century, global surface temperatures have increased at a rate near 0.11°F per decade. But this trend has increased to a rate approximately 0.32°F per decade during the past 25 to 30 years. There have been two sustained periods of warming, one beginning around 1910 and ending around 1945, and the most recent beginning about 1976.³

Since the beginning of this century, each year has ranked among the 10 warmest years of the observational period ranging from 1850 to the present.⁴

The Issues

Debates about climate change are scientific, economic, political, and rife with complexities. That said, major points of contention include to what degree are human-produced greenhouse gases affecting the climate and what are those effects?

³ National Climatic Data Center, 2006.
<http://lwf.ncdc.noaa.gov/oa/climate/research/2006/ann/global.html>

⁴ World Meteorological Association, 2006.
http://www.wmo.ch/pages/themes/wmoprod/documents/WMO_1016_E.pdf

A 2001 report prepared by the National Academy of Sciences at the request of President George W. Bush concluded, "Greenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise. Temperatures are, in fact, rising. The changes observed over the last several decades are likely mostly due to human activities, but we cannot rule out that some significant part of these changes is also a reflection of natural variability."⁵

Citing the report, the president called for a reduction in the production of greenhouse gasses.⁶

Today, statements about human produced greenhouse gasses affecting the climate are even stronger than those issued by the National Academy of Sciences in 2001. This statement on the EPA web site is reflective of others:

"Scientists know with virtual certainty that:

- * Human activities are changing the composition of Earth's atmosphere. Increasing levels of greenhouse gases like carbon dioxide (CO₂) in the atmosphere since pre-industrial times are well-documented and understood.

- * The atmospheric buildup of CO₂ and other greenhouse gases is largely the result of human activities such as the burning of fossil fuels.

- * The major greenhouse gases emitted by human activities remain in the atmosphere for periods ranging from decades to centuries. It is therefore virtually certain that atmospheric concentrations of greenhouse gases will continue to rise over the next few decades.

- * Increasing greenhouse gas concentrations tend to warm the planet."

A working group of the Intergovernmental Panel on Climate Change recently concluded, "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations."⁷

⁵Climate Change Science: An Analysis of Some Key Questions (2001)
http://books.nap.edu/openbook.php?record_id=10139&page=1

⁶ Presidential statement, 2001. www.climatevision.gov/statements.html

⁷ The World Meteorological Organization and the United Nations Environment Programme established the Intergovernmental Panel on Climate Change (IPCC) in 1988. Its role is to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation. The IPCC does not carry out research nor does it monitor climate related data or other relevant parameters. It bases its assessment mainly on peer reviewed and published scientific/technical literature.

"Discernible human influences now extend to other aspects of climate, including ocean warming, continental-average temperatures, temperature extremes and wind patterns."⁸

However, conclusions about climate change are not unanimous.

Richard S. Lindzen, a meteorology professor at the Massachusetts Institute of Technology, was a member of the panel that wrote the 2001 National Academy of Sciences report. At the time, he wrote that the summary passage quoted above was a "zinger" that overshadowed the report's caveats, mainly, according to Lindzen, "Our primary conclusion was that despite some knowledge and agreement, the science is by no means settled."⁹

At a 2005 conference on climate change at Yale University, Lindzen said there is basic agreement on three points:¹⁰

- * The global mean surface temperature is always changing. It has increased and decreased over the last 60 years. Over the last century, it has increased, meaning there has been some global warming.

- * Carbon dioxide is a greenhouse gas and its increase should contribute to warming. It is increasing, and a doubling would increase the greenhouse effect (mainly due to water vapor and clouds) by about 2 percent.

- * There is good evidence that humans are responsible for the recent increase in CO₂, though climate itself (as well as other natural phenomena) can also cause changes in CO₂.

However, Lindzen contends that models used by the IPCC fail to correctly take into account the effect of water vapor and clouds. "Even if we attribute all warming over the past century to man made greenhouse gases (which we have no basis for doing), the observed warming is only about one-third to one-sixth of what models project," Lindzen said.

"At this point, it is doubtful that we are even dealing with a serious problem. If this is correct, then there is no policy addressing this non-problem that would be cost-effective," Lindzen said. "Even if we believe the problem to be serious, we have already reached the levels of climate forcing that have been claimed to be serious."¹¹

The validity of the models used in the IPCC working group report cited above also are criticized by the George C. Marshall Institute. "The models have systematic flaws, the input data is

⁸ IPCC, 2007: Summary for Policymakers. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.

⁹ Wall Street Journal, 2001. <http://eaps.mit.edu/faculty/lindzen/OpEds/LindzenWSJ.pdf>

¹⁰ Global Warming: Looking Beyond Kyoto, Yale, 2005. <http://www.ycsg.yale.edu/climate/forms/LindzenYaleMtg.pdf>

¹¹ Ibid.

unreliable prior to 1970 at the earliest, and the historical record of climate is incomplete and flawed."¹²

The Effects

Possible effects of climate change, according to an IPCC working group, include:¹³

- * Less water available in mid and semi-arid low latitudes.
- * More species at risk for extinction and increased risks for wildfire.
- * A decrease in cereal productivity at low latitudes, an increase in higher latitudes.
- * Increased damage from floods and storms.
- * An change in disease vectors, an increase in mortality due to heat waves, floods, and droughts, and other health problems.

For North America, the report said:¹⁴

- * Warming in western mountains is projected to cause decreased snowpack, more winter flooding, and reduced summer flows, increased competition for over-allocated water resources.
- * Disturbances from pests, diseases, and fire are projected to have increasing impacts on forests, with an extended period of high fire risk and large increases in area burned.
- * Moderate climate change in the early decades of the century is projected to increase aggregate yields of rain-fed agriculture by 5 percent to 20 percent, but with important variability among regions. Major challenges are projected for crops that are near the warm end of their suitable range or depend on highly utilized water resources.
- * Cities that currently experience heat waves are expected to be further challenged by an increased number, intensity and duration of heat waves during the course of the century, with potential for adverse health impacts. Elderly populations are most at risk.
- * Coastal communities and habitats will be increasingly stressed by climate change impacts interacting with development and pollution. Population growth and the rising value of infrastructure in coastal areas increase vulnerability to climate variability and future climate change, with losses projected to increase if the intensity of tropical storms increases. Current adaptation is uneven and readiness for increased exposure is low.

¹² Working Group (WG) I Contribution to the IPCC's Fourth Assessment Report (AR4): A Critique, 2007. www.marshall.org/pdf/materials/515.pdf. The Marshall Institute, established in 1984 as a nonprofit corporation, conducts technical assessments of scientific issues with an impact on public policy. Provides a critical examination of the scientific basis for global climate change policy.

¹³ Working Group II Contribution to the Intergovernmental Panel on Climate Change Fourth Assessment Report, 2007. www.ipcc.ch/SPM13apr07.pdf

¹⁴ Ibid.

The Marshall Institute criticized the report for its modeling and use of worst-case scenarios that assumed nothing would be done to curb greenhouse gasses.¹⁵

"This is an unrealistic assumption since a variety of actions are currently being taken to control greenhouse gas emissions, some voluntary, some mandatory, and those in the future will be shaped by new knowledge," the critique said.

Addressing Climate Issues

Various public and private organizations at the national, regional, state and local levels are addressing climate change.

The national climate change policy has three main goals:¹⁶

- * Slowing the growth of emissions.
- * Strengthening science, technology and institutions.
- * Enhancing international cooperation.

In 2002, the United States pledged to reduce the greenhouse gas intensity of the American economy by 18 percent over the 10-year period from 2002 to 2012. Voluntary, public-private programs focus on energy efficiency, renewable energy, methane and other non-carbon dioxide gases, agricultural practices and implementation of technologies to achieve greenhouse gas reductions.¹⁷

Greenhouse gas emissions aren't restricted by the federal government, however the U.S. Supreme Court ruled that the Environmental Protection Agency has failed to use its authority to regulate carbon in automobile exhaust as a pollutant. In the absence of federal laws on the subject of greenhouse gas emissions, states are forming individual and regional tracking and reductions programs.

A Western Regional Climate Action Initiative includes Arizona, California, New Mexico, Oregon, Utah, and Washington. The Canadian provinces of British Columbia and Manitoba also joined. States will identify, evaluate, and implement ways to reduce greenhouse gas emissions. The initiative requires an overall regional goal to reduce emissions. A market-based, multisector mechanism must be developed to achieve that reduction. Members also will participate in a greenhouse gas registry. Montana currently has observer status with the organization. The Montana Climate Change Advisory Council (MCCAC) recommended that Montana join the initiative.

¹⁵ The Marshall Institute, 2007. Evaluating Working Group (WG) II's Contribution to the IPCC's Fourth Assessment Report (AR4) www.marshall.org/pdf/materials/526.pdf

¹⁶ www.epa.gov/climatechange/policy/index.html

¹⁷ Ibid.

The Regional Greenhouse Gas Initiative (RGGI) includes Connecticut, Delaware, Maine, Maryland, New Hampshire, New Jersey, New York, and Vermont. Starting in 2009, carbon emissions from power plants in those states will be capped at current levels--about 121 million metric tons annually. The cap remains until 2015 when the states then incrementally reduce emissions by 10% by 2019. It establishes the first cap-and-trade program for carbon dioxide. It is the first mandatory cap and trade program for emissions in the U.S.¹⁸

Thirty-one states, including Montana, are part of the Climate Registry, a national initiative to track greenhouse gas emissions. The registry, a nonprofit organization, will be used to track, measure, verify, and publicly report greenhouse gases. The registry will accept data starting in January 2008. State agencies, corporations, and educational institutions will be invited to report emissions under the voluntary program. Some states also have specific sources and facilities that are required to report under regulatory programs. In Montana, facilities are not required to report carbon emissions, but the MCCAC reached agreement on a recommendation that a mandatory reporting program be designed.

Thirty states, including Montana, have completed or are working on climate action plans.¹⁹ In 2006, the Western Governor's Association stated their support for local, state, regional, and national programs that would "reduce anthropogenic greenhouse gas emissions in a manner that is consistent with scientific research and will not significantly harm the U.S. economy."²⁰

In the private sector, members of the American Petroleum Institute formed a climate challenge program to reduce greenhouse gas emissions. Companies are using cogeneration, also known as combined heat and power technology, to turn waste heat into energy and have been working around the world to reduce natural gas flaring, another source of greenhouse gas emissions. Companies also are researching alternative fuels and other technologies.²¹

Addressing climate change in Montana

Gov. Brian Schweitzer in 2005 asked Montana's Department of Environmental Quality to form a Climate Change Advisory Committee to thoroughly study the impact of climate change in Montana.

The Montana Climate Change Advisory Committee has 18 members who represent industry, environment, local and tribal governments, transportation, and agriculture. The DEQ contracted with the Center for Climate Strategies to develop a comprehensive inventory and forecast of

¹⁸ Model Rule and Amended Memorandum of Understanding, Regional Greenhouse Gas Initiative.

¹⁹ Climate Change: Action by States to Address Greenhouse Gas Emissions, by Jonathan Ramseur, Congressional Research Service, January 2007, page 6.

²⁰ www.westgov.org/wga/press/plenary1-pr.htm

²¹ www.api.org/ehs/climate/new/companiesaddress.cfm

greenhouse gas emissions in Montana from 1990 to 2020 as well as to develop policy options for reducing greenhouse emissions.

The Center for Climate Strategies is a nonprofit organization that works with groups like the MCCAC to design and implement policies that address climate mitigation. The organization has teamed with 15 other states to develop greenhouse gas reduction plans.

The MCCAC concluded its work earlier this year and final recommendations are scheduled for release in the coming weeks.

The mayors of Billings, Bozeman and Missoula have signed on to the U.S. Mayors Climate Protection Agreement, in which mayors commit to reduce emissions in their cities to 7 percent below 1990 levels by 2012.²²

Recent Legislation

During the 2007 Legislative session, lawmakers debated several greenhouse gas and climate change-related bills. There were additional bills considered that examined fuel efficiency standards, building efficiency requirements, overall energy efficiency and auditing, renewable energy, and energy conservation related to climate change. The bills listed here focus specifically on carbon sequestration and greenhouse gas regulation.

HB 3 "Jobs and Energy Development Incentives Act"// Approved Special Session// Rep. Llew Jones.

Provides permanent property tax rate reductions from 12 percent to 3 percent of market value for new investments in transmission lines for "clean" electricity, "clean" liquid and carbon sequestration pipelines. Property taxes on new generation technology with sequestration goes from 6 percent to 3 percent. New DC converter stations serving two regional power grids go from 6 percent to 2.25 percent. Nonpermanent incentives from 3 percent to 1.5 percent are available for new investments in biodiesel, biomass and other defined technologies.

HB 25 Revise Electric Industry Restructuring laws.// Approved Regular Session///Rep. Alan Olson

The "Electric Utility Industry Generation Reintegration Act" includes a carbon sequestration component. Until the state or federal government has adopted uniform, applicable standards for the capture and sequestration of carbon dioxide, HB 25 prohibits the PSC from approving electric generating units primarily fueled by coal unless a minimum of 50 percent of the CO₂ produced by the facility is captured and sequestered. Natural gas plants also must include cost-effective carbon offsets.

The bill applies only to electric generating units constructed after January 1, 2007. Montana joins California, Oregon, and Washington as states that have adopted a CO₂ emissions performance standard for electric generating units.

²² www.usmayors.org/climateprotection/

HB 24 Revise laws related to carbon dioxide for energy purposes//Approved Regular Session//Rep. Harry Klock

Provides common carrier status to pipelines carrying carbon dioxide that is transported for permanent sequestration in a geological formation.

This bill, however, was contingent upon the passage and approval of SB 218, which authorized the Board of Environmental Review to adopt rules establishing a carbon sequestration program and permit system. SB 218 was tabled, so HB 24 is void.

HB 55 Carbon sequestration -- ecosystem services leasing and licensing. Tabled by House Natural Resources//Rep. Kevin Furey

Authorized the Department of Natural Resources and Conservation to lease or license state trust lands for carbon sequestration or other ecosystem services such as open space or biodiversity. The board of land commissioners was charged with promulgating rules for this program.

HB 227 Create carbon sequestration loan program. Tabled by House Appropriations//Rep. Ron Erickson

Established a carbon sequestration revolving loan account administered by the DNRC. Funded by interest income off a portion of the interest on coal severance taxes. Funds from the loan account would be used to provide loans to individuals, small businesses, units of local government, units of the university system, and nonprofit organizations for the purpose of terrestrial carbon sequestration. The amount of a loan could not exceed \$50,000, and the loan must be repaid within 10 years

HB 282 Sequestration to slow global warming. Tabled by House Natural Resources//Rep. Ron Erickson

Required all coal-fired electrical generation facilities or synthetic fuel facilities that file construction permits with the DEQ to capture CO₂ at the site and permanently store it in a geological formation or provide verification that 100 percent of the carbon emissions would be offset.

HB 753 Montana global warming solutions act. Tabled by House Natural Resources//Rep. Betsy Hands

Required the DEQ to develop and the Board of Environmental Review to adopt a global warming program for the State of Montana that included identification of historical and current sources of greenhouse gas emissions. A plan also would have been developed to reduce emissions to 1990 levels.

Modeled after legislation in California, it also would have allowed the BER to adopt a schedule of fees that would be paid by greenhouse gas emission sources.

HB 828 Study carbon sequestration. Died in process// Rep. Alan Olson

Outlined a study of carbon sequestration issues in Montana and required the Energy and Telecommunications Interim Committee to complete such a study.

HJ 60 Study climate change. Tabled by Federal Relations, Energy and Telecommunications// Rep. Sue Dickenson

Required a study that would review existing federal and state regulations related to greenhouse gas emissions, energy efficiency, renewable energy, and tax incentives. Included review and analysis of findings by Governor's Climate Change Advisory Council.

SB 105 Tax break for equipment to sequester carbon. Tabled House Taxation// Sen. Greg Lind
Placed equipment specifically used for carbon sequestration in class 5 (3 percent) and made such property exempt from taxation for three years after it becomes operational.

SB 218 Sequestration standards for carbon dioxide. Tabled by House Natural Resources// Sen. Greg Lind

Required the state to develop a new program to monitor underground injection of carbon dioxide. The Board of Environmental Review would be charged with adopting rules to administer the program. It also created a special revenue fund with fees and penalties to support the program.

SJ 20 Carbon reduction timeline. Tabled in House Natural Resources/ Sen. Mike Cooney

Urged Congress to enact a mandatory and science-and-market based limit on overall limits of greenhouse gas emissions and to provide incentives for development of energy efficiency and renewable energy programs.

LC 1469 Carbon Dioxide as pollutant. Not introduced//Requested by Rep. Ron Erickson

Revised the definitions of "air pollutants" under the Clean Air Act of Montana to include CO₂. Required the BER to establish CO₂ emission levels.

Other climate change programs

There are new efforts developing to examine various aspects of the climate change issue. Here is a snapshot of a few Montana-based programs:

The **Big Sky Carbon Sequestration Project**, led by Montana State University, is one of the U.S. Department of Energy's seven regional partnerships. Researchers are developing a framework to address carbon dioxide emissions and are working with stakeholders to create a "vision for a new, sustainable energy future."²³

The **National Carbon Offset Coalition, Inc.**²⁴ is made up of seven Montana nonprofit corporations. It allows landowners, corporations, tribes, and state and local governments to participate in a market-based conservation program. The program is geared at reducing the impacts of greenhouse gases and explores the concept of transferring carbon sequestration units as a new commodity.

²³ www.bigskyco2.org

²⁴ www.ncoc.us

Montanans for a Healthy Climate²⁵ is a nonprofit organization focused on protecting Montana's outdoor heritage. The **Montana Climate Challenge**²⁶ is operated through the **National Wildlife Federation**. The organization **GlobalWarmingSolution.org** is made up of 35 member organizations representing 320 groups from throughout the United States is based in Missoula. Other conservation-based organizations like the **Montana Environmental Information Center**²⁷ and **Montana Trout Unlimited**²⁸ offer climate change information.

The **Montana Coal Council**, the **Montana Petroleum Association** and the **Western Environmental Trade Association**²⁹ each recently featured programs on climate change issues.

Regional efforts include the **Rocky Mountain Climate Organization** and the **Western Regional Climate Action Initiative**.³⁰

²⁵ www.mthealthyclimate.com

²⁶ www.mtclimatechallenge.org

²⁷ www.meic.org

²⁸ www.montanatu.org

²⁹ www.montanacoalcouncil.com; www.montanapetroleum.org; www.weta-montana.org

³⁰ www.rockymountainclimate.org; www.westernclimateinitiative.org