



GLOBAL CLIMATE CHANGE

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trations have increased in the atmosphere from about 280 parts per million (ppm) in the year 1750 to 379 ppm in 2005, exceeding any level of natural concentration in at least the past 650,000 years. Carbon dioxide emissions increased by 80% between 1970 and 2004. These increasing concentrations trap more of the heat emitted by the earth’s surface; like a blanket, they cause a gradual warming of the earth.

CLIMATE CHANGE DEFINED

Climate change, global warming, and the greenhouse effect are related but distinct concepts.

Climate: *Climate* means the overall (average) patterns of heat, cold, precipitation and wind over time; it is distinct from *weather* in that it reflects trends rather than conditions at any particular point in time. For example, the fact that it is raining today is weather; if the number of rainy days and the amount of rain over time have increased, that indicates a change in climate.

Greenhouse effect: The earth’s surface, warmed by the sun, heats the atmosphere above it. Some of the heat energy escapes into space, while some is absorbed into the atmosphere. A portion of this captured energy is radiated back to the earth’s surface. This absorption by gases is known as the *greenhouse effect* because - as in a greenhouse (although the mechanism is different) - the net effect is a warming of the earth. Without the natural greenhouse effect, the earth’s average temperature would be below freezing.

Greenhouse gases: The atmospheric gases that absorb outgoing radiation from the earth include both natural and synthetic compounds. The most significant gases are water vapor and carbon dioxide, but also include methane, nitrous oxide and chlorofluorocarbons.

As a result of human activities – primarily the burning of fossil fuel in power plants and vehicles, as well as deforestation – carbon dioxide concen-

Relative contributions of greenhouse gases from various activities in the U.S. are:

Electricity Generation:	32%
Transportation	28%
Industry	20%
Agriculture	7%
Commercial	7%
Residential	6%

(Ref: Pew)

Most of the contributions come from industrialized nations, with plenty of power plants and cars. The seven largest emitters are the United States, the European Union, China, Russia, Japan, India and Canada.

Global warming has the potential to create global and regional **climate change**, involving changes in temperatures and precipitation. These two terms are used interchangeably to reflect the influence of human activities on the warming of the earth and the resulting changes in climate.

SCIENTIFIC CONSENSUS

While researchers debate or find uncertainties about individual elements of the science of global climate change, there is overall scientific consensus that human-induced climate change has happened, is happening, will continue to happen, and that most of the effects are not desirable.

Intergovernmental Panel on Climate Change (IPCC): Since climate change is a global problem, the United Nations Environmental Panel and the World Meteorological Organization established

the IPCC in 1988 to assess 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.” This panel provides periodic summary reports on scientific knowledge regarding the extent and effects of climate change. The latest report was written by 450 scientists from 130 countries, with 800 contributing authors and 2500 expert reviewers. The IPCC is recognized as the most authoritative scientific voice on global warming. In December, 2007, the IPCC and former Vice President Al Gore were jointly awarded the Nobel Peace Prize “for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change.” IPCC reports are used as source material throughout this document.

OBSERVED CLIMATE CHANGES

The latest series of IPCC reports issued in 2007 indicate numerous changes already observed as a result of global warming (Ref: IPCC).

- The average global surface temperature increased by 1.3°F in the past 100 years. The increases are greater at extreme northern latitudes (e.g., the Arctic). Land regions have warmed faster than the oceans. Eleven of the last twelve years are among the twelve warmest years since global records were begun in 1850. The average temperatures in the Northern Hemisphere during the second half of the 20th century were higher than any other 50-year period in the last 500 years, and likely the highest in the past 1300 years.
- Sea level has risen a total of 3.5 inches since 1961, with contributions from thermal expansion (water expands as it warms) and melting glaciers and ice caps.
- Total snow and ice cover has decreased. Arctic sea ice area has shrunk by 2.7% per decade since 1978, with larger decreases in summer of 7.4% per decade.
- Precipitation increased significantly in some parts of the world (including eastern North America) and declined in others; areas af-

ected by drought have increased since the 1970s.

- Hot days, hot nights, and heat waves have become more frequent; cold days and nights have become less frequent. The frequency of heavy rainfalls has increased, as has the incidence of extreme high sea levels (i.e., storm surges).
- Many natural systems are being affected by the increased temperatures; for example, ground instability from melting permafrost, earlier arrival of spring, and northward expansion of plant, insect and animal ranges.
- Intense hurricanes have increased in the North Atlantic.

Although the earth’s temperature and climate have sometimes been affected by natural factors, the IPCC has determined that *most* of the warming observed recently is due to human influences.

FUTURE IMPACTS

The IPCC has also summarized assessments of future trends. Complex computer models are used to predict future changes in temperature, precipitation, sea level rise and other climate variables based on various inputs. Scientists have a high degree of confidence in these computer models because they are based on accepted physical principles and because they reproduce observed features of current climate and past climate changes. The models are most accurate on large scales (e.g., continental) but less accurate on smaller scales.

When making future predictions using computer models, scientists use a range of variables based on assumptions about the future. For example, a key input is how much carbon dioxide and other greenhouse gases will be emitted in the future. Greenhouse gas emissions could increase by anywhere from 25% to 90% by 2030 in the absence of strong emissions-reduction efforts.

The result of a series of model runs will be a range of expected impacts, e.g., a range of possible temperature increases within the 21st century. This range results from uncertainties in future estimates of socio-economic conditions. For example, to

project the range of greenhouse gas emissions, the modelers consider such variables as the future world population, whether developing countries will achieve the wealth of the industrialized world, and how efficiently energy will be used.

The IPCC report indicates that the following future changes are likely to occur:

- Depending on the emission scenario, computer models predict that temperatures could increase 2°F to 11.5°F, with the “best estimate” range of 3°F to 7°F, by 2100. Because of the inherent inertia of the earth’s climate systems and the long life of carbon dioxide in the atmosphere, temperatures would still rise about 1.1°F in the 21st century even if greenhouse gas concentrations stabilized at year 2000 levels. Temperatures in the United States are projected to be higher than this global average.
- Sea level will continue to rise, with models predicting a rise of seven to 23 inches by 2100, barring unexpected abrupt events associated with the Greenland and Antarctic ice caps. Sea-level rise would worsen flooding, storm surges, and erosion of coastlines; islands are some of the most vulnerable areas. Coastal flooding is likely to affect many millions of people, possibly causing large migrations. In the U.S., vulnerable areas include the Southeast and Mid-Atlantic coasts, and low-lying areas such as North Carolina’s Outer Banks, Florida’s coast, and much of Southern California (Ref: Pew).
- Rising temperatures will warm land masses and extreme northern latitudes the most, producing reduced snow cover, thawing of permafrost, and decreases in sea ice. Some projections indicate Arctic late-summer sea ice could disappear by the end of the 21st century, endangering species such as seals and polar bears which depend on sea ice. The U.S. Fish & Wildlife service has proposed listing polar bears as “threatened” to help protect the species from melting ice and other threats.
- The frequency of hot extremes, heat waves, and heavy precipitation is likely to increase. A heat wave in Europe in 2003 killed 53,000 people.
- Precipitation is expected to increase in high latitudes and decrease in most sub-tropic land regions. Water availability will increase in some locations and decrease in some dry and semi-arid regions (including the Mediterranean basin, western United States, and southern Africa). This impact is projected to affect between 75 and 250 million people in Africa alone by 2020. Lack of precipitation likely will increase the risk of wildfires.
- Glaciers and snow cover will continue to melt; many cities depend on runoff for their drinking water.
- There is a significant risk of increasing species extinction with increasing temperature. For example, an estimated 20% to 30% of all species will be at increased risk of extinction if the temperature increases by an additional 2.7°F to 4.5°F.
- The intensity of hurricanes and cyclones is likely to increase.
- As more carbon dioxide is dissolved in sea water, oceans are expected to become more acidic, which could have negative impacts on marine shell-forming organisms (such as coral reefs). Formations such as coral reefs help protect coastal communities from high waves (e.g., tsunamis).
- The health of millions of people is expected to be affected by increasing malnutrition, the spread of infectious diseases, and extreme weather.
- Food production will decrease in some areas (up to 50% in some African countries by 2020). On a longer term, warmer temperatures could affect agricultural production in the Southeast U.S. and the southern Great Plains (Ref: Pew).
- According to the Nobel Foundation when it awarded the Nobel Peace Prize to Al Gore and the IPCC:
“Extensive climate changes may alter and threaten living conditions of much of mankind. They may induce large-scale migration and lead to greater competition for the earth’s resources. Such changes will place particularly heavy burdens on the world’s most vulnerable countries.

There may be increased danger of violent conflicts and wars, within and between states.”

Social, economic, agricultural and health consequences of climate change will most significantly impact the world’s poorest regions, as well as the most vulnerable citizens (the poor, children, and the elderly) throughout the world.

Beyond projections that focus on gradual changes, there is the concept of a *tipping point*, in which smaller-scale changes cause escalating impacts as some changes reinforce other changes in spiraling *feedback loops*. These scenarios are possible, but are not given the same likelihood as “best estimates” by the IPCC. For example, one oft-cited disaster scenario is the possibility of the complete melting of the Greenland and West Antarctic ice sheets. According to the IPCC, if global average temperatures are sustained over “millennia” above 3.4°F to 8.3°F compared to pre-industrial levels, the Greenland ice sheet could melt completely, which would raise sea levels about seven meters (23 feet) globally. However, some of the factors affecting ice melt are not fully understood, and even partial loss of ice sheets could lead to significant sea-level rise; the IPCC concludes that “more rapid sea level rise on century time scales cannot be excluded.”

ADAPTATION AND MITIGATION

Adaptation to Climate Change: Since the temperature of the earth has already risen somewhat and will continue to go up even if greenhouse gas levels are stabilized, some level of adaptation to the effects of climate change will be necessary. Many possible methods for adaptation are listed in the IPCC report by sector:

- Water: Expanded rainwater harvesting; water storage and conservation techniques; water reuse; desalination; improve water use and irrigation efficiency.
- Agriculture: Adjust planting dates and crop variety; crop relocation; improve land management.
- Coast infrastructure: Relocation of population; seawalls and storm surge barriers; dune rein-

forcement; protect existing natural barriers; create wetlands as buffers against rising sea levels.

- Human health: Heat-health action plans; emergency medical services; safe water and improved sanitation.

Many of these measures have benefits beyond responding to climate change: For example, improving water use and cropland management has health and economic benefits.

Relying on adaptation to respond to climate change has limits because some nations have a lower adaptive capacity, and financial, social and environmental resources may already be stretched. And it’s a continuous game of catch-up: As society adapts to changes in one decade, the impact on the earth may continue to worsen, perhaps until a point of permanent, irreversible change is reached to which society cannot adjust, if nothing is done.

Mitigation of Climate Change: The IPCC concludes that “unmitigated climate change would, in the long term, be likely to exceed the capacity of natural, managed and human systems to adapt.” Therefore, the total amount of greenhouse gases must be reduced to lessen the predicted impacts of climate change as well as reduce the risks of reaching a potential tipping point. Stabilizing carbon dioxide concentrations at 350 to 400 ppm would require a reduction of 50 to 85% in emissions by 2050, holding the global temperature rise to 3.6°F to 4.3°F above pre-industrial levels.

Reducing greenhouse gases will also have many associated benefits: e.g., reductions in energy use and cost, dependence on foreign oil, and other pollutants that have a direct impact on human health.

Estimates for costs associated with stabilizing carbon dioxide emissions range widely; the IPCC presents an estimate of slowing average annual global growth of gross domestic product by 0.12% through 2050. Regardless of the actual numbers, the longer society waits to reduce emissions, the more it will eventually cost to adapt and, belatedly, to mitigate.

Many of the potential mitigation techniques are available for implementation today; many others are expected to be available by 2030 with advances in technology. The IPCC lists mitigation methods in the following areas.

- *Energy supply:* e.g., improved efficiency; switch from coal to gas; nuclear power; renewable heat and power (hydropower, solar, wind, geothermal and bioenergy).
By 2030: Carbon Dioxide Capture and Storage (CCS); advanced nuclear power; advanced renewable energy (e.g., tidal and wave energy, solar photovoltaics).
- *Transport:* More efficient vehicles; hybrid vehicles; cleaner diesel vehicles; use of biofuels; rail and public transport systems; non-motorized transport (cycling and walking); land use and transport planning.
By 2030: Second generation biofuels; higher efficiency aircraft; advanced electric and hybrid vehicles.
- *Buildings:* Efficient appliances, lighting, heating and cooling devices; improved insulation; solar heating and cooling
By 2030: Integrated design of commercial buildings, including intelligent meters that provide feedback and control; solar photovoltaics integrated into buildings.
- *Industry:* More efficient electrical equipment; material recycling and substitution; process-specific technologies.
By 2030: Advanced energy efficiency; CCS.
- *Agriculture:* Improved crop and grazing land management to increase soil carbon storage; restoration of degraded lands; improved livestock and manure management to reduce methane emissions; improved nitrogen fertilizer application techniques to reduce nitrous oxide emissions; dedicated energy crops to replace fossil fuel use; improved energy efficiency.
By 2030: Improvements of crop yields.
- *Forestry:* Reforestation; forest management; reduced deforestation
By 2030: Tree species improvement to increase biomass productivity and carbon sequestration.

- *Waste:* Landfill methane recovery; waste incineration with energy recovery; composting of organic waste; recycling and waste minimization.

The report also notes that “changes in lifestyle and behavior patterns can contribute to climate change mitigation across all sectors.”

SOCIETAL RESPONSE

International, national and local effort is needed to set limits on greenhouse gas emissions, invest in researching the science of climate change and the technology for solutions, and set efficiency standards for vehicles, buildings, and appliances.

International Response: The first assessment report of the IPCC was issued in 1990. The United Nations subsequently created the United Nations Framework Convention on Climate Change (UNFCCC) at the Rio Earth Summit in 1992 to start negotiations on a worldwide agreement to limit greenhouse gases. This convention eventually led to the adoption of the *Kyoto Protocol* in 1997, which required signatory parties to reduce emissions. Reduction targets varied by country, and were six to eight percent below 1990 levels for the largest emitters by the end of the agreement in 2012. Developed countries are assigned specific emission targets; developing countries have monitoring and reporting requirements, but no mandatory reductions.

In 1997, the U.S. Senate passed a resolution by 95 to 0 stating that the U.S. would not enter into an agreement that harmed the economy and that did not require “meaningful involvement” by developing countries. The current U.S. administration announced in 2001 that it would not sign the Kyoto Protocol, citing expense and the lack of requirements for developing nations. The agreement became enforceable in 2005 with the signature of 55 countries; 175 countries have now ratified it. The U.S. and Australia were the lone hold-outs among developed nations; Australia signed the agreement in December 2007 after a change in administration.

The Developing Nations Dilemma: The Kyoto Protocol did not assign emissions reduction targets to developing countries because the developed

nations had the highest historic and current emissions of greenhouse gases. Per-capita emissions in developing countries are still relatively low: China has emissions that are 20% those of the U.S. on a per-capita basis, and India only five percent. Industrialized countries developed their wealthy economies without limitations on emissions; developing countries argue they should have the same opportunity. On the other hand, China and India are already significant economic competitors with the U.S., and overall emissions of greenhouse gases from developing countries will eclipse those from developed countries by 2018 (Ref: Pew).

The UN held a summit in Bali in December 2007 to begin planning for an agreement to follow Kyoto, which expires in 2012. The U.S. rejected inclusion of binding commitments for industrialized nations, preferring voluntary targets. The resulting document is a roadmap for negotiations to be completed by 2009; items to be negotiated include emissions targets for industrialized countries, potential softer targets for major developing countries, transfer of clean technology to developing countries, halting deforestation, and helping poorer nations adapt to impacts of climate change such as rising sea levels and reduced crop yields.

Individual nations: To comply with the Kyoto Protocol, European countries created a market-based approach. In the “*cap-and-trade*” approach, a nation-wide cap is placed on greenhouse gases, and allowances can be traded. Apart from Kyoto, China is working on improving energy efficiency and expanding renewable energy.

United States’ Response: The U.S. has five percent of the world’s population, yet emits 25% of the world’s greenhouse gases. Our per-capita emissions are twice those of the European Union and Japan, and five times the world average. The stated goal of the U.S. is a voluntary reduction of 18 percent in U.S. greenhouse gas *intensity* (the ratio of emissions to gross domestic product) between 2002 and 2012. By this measure, greenhouse gas emissions will still increase by 12% in this timeframe as the economy grows; by contrast, European Union emissions are expected to remain flat or decrease (Ref: Pew).

Some steps are being made: President Bush signed a bill in 2007 that will increase vehicle fuel mileage to 35 mpg by 2020, a 40% increase over the current standard of about 25 mpg, and the first increase in 32 years. The bill also mandates an increase in fuel ethanol and calls for improved efficiency standards for light bulbs, home appliances and commercial buildings. The U.S. spends \$1.7 billion a year on climate change research, half the total global expenditures.

Numerous bills in Congress would address climate change. In December 2007, the Lieberman-Warner Climate Security Act cleared the Senate Environment and Public Works Committee. The bill would address greenhouse gas sources accounting for 80% of U.S. emissions, and require a reduction of 70% by 2050. Several bills have also been introduced that would adopt a “cap-and-trade” approach. Advocates including Al Gore have called for a “*carbon tax*” to establish a strong incentive for reductions in the use of fuels and emissions of greenhouse gases.

Many businesses in the U.S. and throughout the world are also taking action. Increasing energy efficiency can yield significant savings and improve profits. Reducing greenhouse gas emissions can also enhance a corporation’s public reputation. Many companies see government action as inevitable and imminent, and want to deal proactively with any new potential system. By engaging the issue, they have an opportunity to influence climate-change legislation. Some companies also see the business opportunities in making green products. For example, the Sierra Club and United Steelworkers believe that companies in Ohio can be positioned to create hardware components for alternative energy (e.g., wind turbines), creating up to 23,000 new jobs.

State and Local Response: In the absence of strong Federal action, individual states, counties and cities are setting emission reduction goals and developing action plans to reduce greenhouse gas emissions. State, local and even individual actions provide a foundation for future actions and proof that effective action can be taken. At least 28 states have climate action plans; some states are also promoting the use of renewable energy and improving energy efficiency (Ref: Pew).

Ohio: Ohio is fifth among the states in overall energy consumption. The state is a signatory observer, but not a full participant, in the Midwest Greenhouse Gas Reduction Accord. This allows Ohio to participate in the development of a mid-western “cap-and-trade” system for emissions, but does not agree to the regional regulatory goals and emission reduction targets set by the accord. According to Ohio Governor Strickland, the governor’s new electricity plan addresses the threat of global warming while also pursuing a variety of clean coal and electricity deregulation and production goals: “Coal has been, is, and will be an integral part of Ohio’s economy. By using clean coal technology, we can take steps to reduce the carbon impact of coal. Carbon sequestration offers us that opportunity. By injecting carbon dioxide deep into the Earth instead of sending it into the atmosphere, we can significantly reduce the effect of coal on our climate. Under my plan, we will pursue pilot and demonstration projects to fully measure the potential benefits of carbon sequestration.”

Hamilton County: In September 2007, Hamilton County became the 13th county in the nation to sign the Cool Counties Climate Stabilization Agreement, an initiative calling on counties to reduce greenhouse gas emissions by two percent per year, or 80 percent by 2050. There are now about 25 counties involved. The Cool Counties roadmap calls for action in seven key areas: energy efficiency, renewable energy, greening county vehicle fleets, land use, transportation, water conservation, and education outreach. Hamilton County is currently conducting an emissions inventory to serve as the baseline for cutting emissions.

Cincinnati: Nearly 800 cities including Cincinnati have signed the U.S. Mayors’ Climate Protection Agreement, launched by Seattle in 2005. The goals of the agreement are for cities to meet or beat the targets suggested for the U.S. in the Kyoto Protocol (seven percent reduction in 1990 greenhouse gas emissions by 2012), to urge state governments to adopt similar goals, and to urge the U.S. Congress to establish a national emission trading system. The City of Cincinnati set energy efficiency goals of reducing the city government’s electricity demand by four percent in one year and ten percent in four years. Mayor Mallory has also established a Climate Protection Planning Process,

consisting of a Steering Committee and citizen task teams to identify specific ideas for reducing greenhouse gases. The five task teams (which include LWVCA participation) are: Land Use; Waste Management; Energy; Transportation; and Advocacy. The Steering Committee will report to City Council in April or May 2008.

Even before this effort, the City had been pursuing energy-efficiency measures, including replacing traffic lights and walk signs with high-efficiency LED units; modernizing streetlights; generating electricity using solar power at Eden Park; and constructing new City facilities to green building standards. Cincinnati also offers tax incentives for construction of high-efficiency buildings.

Individual Response: While the scale of climate change is huge, individual actions collectively can contribute to the solution. Beyond the fundamental League policy response of advocating for local, national and international leaders to take action, individuals can begin the process of reducing carbon dioxide emissions, demonstrating to political leaders that voters take the issue seriously and helping drive market forces. Because we all create greenhouse gasses through daily activities, Americans have an opportunity to have a direct impact on reducing emissions.

The following list contains a number of ideas individuals can pursue to reduce greenhouse gas emissions. Not every idea will apply to everyone. But applying a few of these ideas will begin the process whereby – collectively – we can reduce greenhouse gas emissions. Future *LWVCA Voter* articles will discuss some of these in more detail.

Housing

- Replace light bulbs with Compact Fluorescent light bulbs (CFLs)
- Purchase Energy Star appliances and high-efficiency heating and cooling equipment
- Seal and insulate your home
- Recycle, and buy recycled products when available
- Reduce and reuse
- Use water efficiently – especially hot water (e.g., shorter showers, low-flow showerheads, wash clothes in colder water, use full dishwasher)

- Hang-dry laundry
- Turn off lights and computers when not in use
- Adjust your thermostat lower in winter, higher in summer; use a programmable thermostat
- Reduce standby power loss “vampires” by turning electronics off at the power cord
- Get a home energy audit and implement findings

Transportation

- When shopping for a car, choose more fuel-efficient models (such as hybrids)
- Improve fuel mileage: Accelerate and decelerate smoothly, reduce idle time, keep tires inflated properly, remove excess weight from vehicle, keep your car tuned, avoid drive-throughs
- Reduce vehicle miles: Use public transportation; car pool; combine trips; walk or bike
- Telecommute to work

Other:

- Implement energy efficiency where you work
- Advocate energy efficiency at places you shop, worship, attend school and play
- Consider buying carbon offsets
- Travel efficiently: Reduce air and car miles where possible; look for hybrid rental cars; practice energy efficiency in hotels; consider carbon offsets
- Food choices: Eat less meat; buy closer to home
- Bag your groceries in a reusable cloth bag
- Plant trees
- Minimize packaging on purchases; limit use of plastic water bottles
- Purchase green energy

CONCLUSION

Scientists have concluded that the earth is heating up in response to human activity since the industrial revolution, that global climate change is occurring, and that it is certain to continue into the future. Although there are some uncertainties associated with how quickly the earth will warm and what the exact effects and timing of those effects will be, it is virtually certain that this climate change will have significant negative effects if we do not drastically reduce greenhouse gas emissions. Even though the worst of these changes may not occur in our lifetimes, what we set in

motion now will have irreversible impacts on future generations.

By reducing the emissions of greenhouse gases – primarily from our energy usage – we can reduce the amount of future warming and associated effects, and we can reduce the risk of potential disasters. Strong action is needed at every level – international, national, state, local and individual.

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