# Geosciences and Energy Policy

***Position Statement.*** Development of a comprehensive energy policy that significantly reduces greenhouse gas emissions is essential for the future economic vitality, environmental well-being, and health and security of the citizens of the United States as well as other nations. Geoscientists locate, quantify, and help develop energy resources, and, along with professionals in other disciplines, assess and mitigate the impact of energy-resource development, operations, and use on the environment. Accordingly, input from geoscientists must be an integral part of all energy policy deliberations.

***Purpose.*** This position statement summarizes the importance of the geosciences in developing fundamental data upon which sound energy policy should be based and the contributions geoscientists can make to the framing of energy policy. Most energy sources have important and distinct geologic factors that should be considered when analyzing the life-cycle impacts related to exploration, extraction, development, operations, human consumption, waste disposal, decommissioning, and reclamation.

The use of abundant and cheap fossil fuels has contributed to the emergence of the United States as an economic power and has raised the standard of living for much of the developed world. This use, however, represents an energy business model that must change. We now know that anthropogenic greenhouse-gas emissions, including those from fossil fuel combustion, have a profound impact on global climate, with effects on local and regional ecosystems and public health. In addition, over the last few years, other energy sources have become economically competitive with fossil fuels.

The challenge for energy policy makers is to develop a plan that will provide cost-effective improvements for the efficient and sustainable use of Earth's energy resources, reduce carbon emissions, and provide secure and affordable energy to the world's developing economies as well as the developed nations of the world. The knowledge and expertise of geoscientists take on added importance as countries and industries worldwide adapt to climate change and work to reduce carbon emissions.

## RATIONALE

The Geological Society of America (GSA) adopted a Position Statement on Climate Change in 2006 that recognized that anthropogenic emissions of carbon dioxide ($CO_2$) and other greenhouse gases have been the primary cause of global warming since 1880, and that this warming has significant impact on humans and global ecosystems[1]. Revisions and updates to the GSA Position Statement on Climate Change in 2010, 2013, and 2015 are consistent with the findings of the National Academies of Science, Engineering, and Medicine[2] and position statements of professional societies that deal with geoscience and climate change, such as the American Geophysical Union[3], American Meteorological Society[4], American Chemical Society[5], American Association for the Advancement of Science[6], and the Geological Society of London[7].

As the human population continues to surge beyond 7 billion, and developing and emerging countries transition to consumer-based economies, global demand for energy is predicted to grow significantly through 2040, as seen in Figure 1.

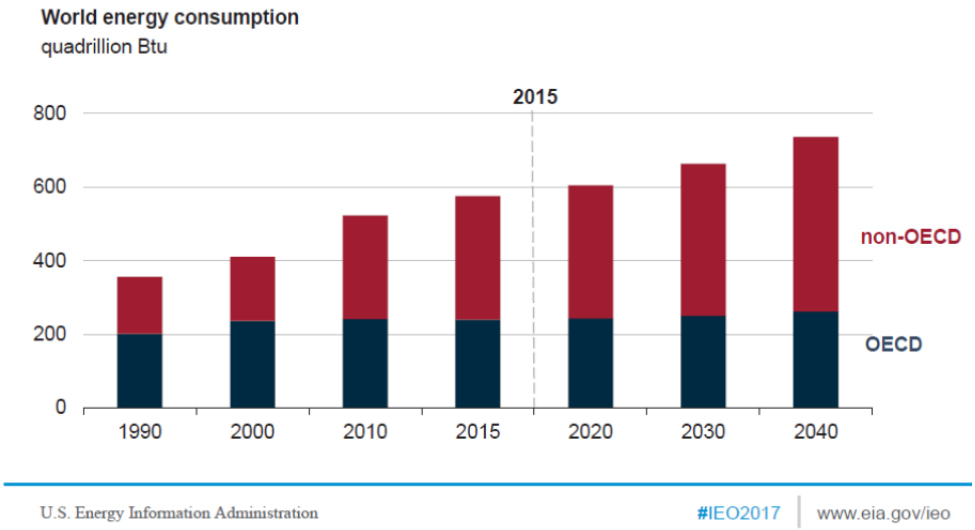


Figure 1.
World Energy Consumption 1990–2040, Reference Case. Source: EIA International Energy Outlook 2017. Organization for Economic Co-operation and Development (OECD) member countries include most European countries, Australia, Canada, Chile, Korea, Iceland, Israel, Japan, Mexico, New Zealand, Turkey, and the United States (www.eia.gov/forecasts/ieo/world).

In addition to supplying fuels for transportation, electric power, and industrial and residential heating, petroleum and coal resources also provide the energy and basic chemical feedstocks for the manufacture of the steel, plastics, and textiles that support our modern standard of living, and the fertilizers and pesticides needed to feed a growing global population.

The energy sources for projected energy use through 2040 as estimated by the U.S. Energy Information Agency are indicated in Figure 2.

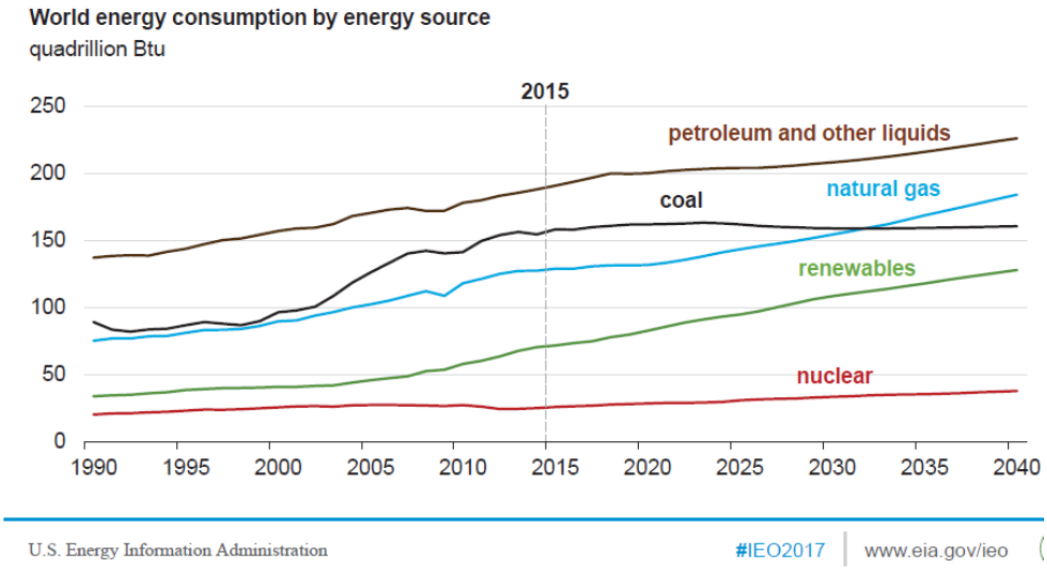


Figure 2.
World Energy Consumption by Energy Source 1990–2040, Reference Case (www.eia.gov/forecasts/ieo/world).

According to the U.S. Energy Information Administration (EIA) "2017 International Energy Outlook," fossil fuels will continue to provide as much as 77% of total world energy consumption by 2040, declining from 84% in 2012. But in real energy terms, this implies a 40% increase in fossil fuel burning over those 28 years as a result of the increase in total energy demand. Petroleum liquids consumption will decrease from 33% of global marketed energy in 2015 to 31% in 2040, but in absolute terms it is projected to increase from 95 million barrels per day (b/d) in 2015 to 113 million b/d in 2040, primarily as a transportation fuel as a function of increased demand in China and India. Natural gas consumption is projected to

increase 43% from 2015 to 2040, principally as a fuel for electric power generation and for industrial use. Worldwide coal production is expected to increase 3% from 2015 to 9.4 billion short tons by 2040. However, coal, which supplies about 40% of electric power generation today, is projected to decrease to 31% of electric generation by 2040, due to increased use of natural gas and renewables for power generation. Renewable energy resources, including hydro, are projected to grow from 20% of total global electric power generation in 2010 to 31% in 2040. Nuclear power, which emits no direct greenhouse gases, but has serious public acceptance challenges, is projected to also increase. The mix of energy sources and their magnitudes that are predicted to meet current and growing energy demands will greatly influence the economy, environment, national security, and public health of the world's citizens. These projected energy sources needed to fulfill future energy demands will increase the rate of $CO_2$ emissions. The $CO_2$ emissions from the burning of fossil fuels constituted 65% of the overall anthropogenic greenhouse emissions in 2010 (Fig. 3, "Fifth Assessment Report" [AR5] of the United Nations Intergovernmental Panel on Climate Change [IPCC])[8].

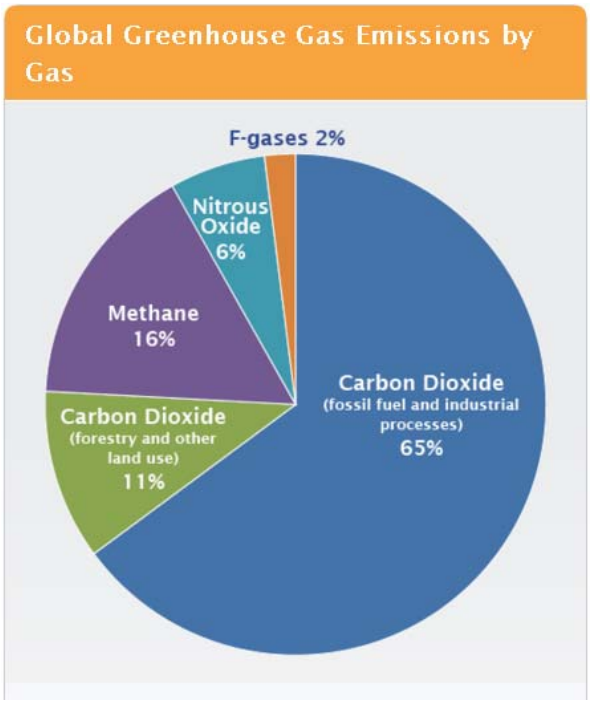


Figure 3.
Global Greenhouse Gas Emissions by Gas Source. Source: IPCC (2014; www.ipcc.ch/report/ar5/wg3/) based on global emissions from 2010. Details about the sources included in these estimates can be found in the "Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change."

The historic increase in anthropogenic $CO_2$ emissions since the late nineteenth century and the cumulative amount of anthropogenic $CO_2$ emissions are illustrated in Figure 4 and show the dominant contributions from fossil fuel burning.

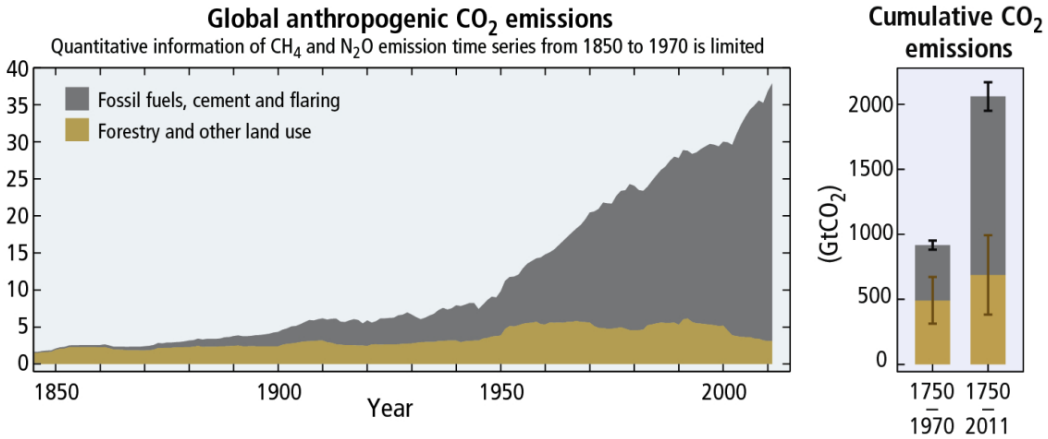


Figure 4. Global Anthropogenic CO2 Emissions. Source: "Climate Change 2014 Synthesis Report," IPCC 2015, p. 3.

Human-sourced emissions of $CO_2$ and other greenhouse gases have strongly impacted those earth processes that regulate the terrestrial climate, ecosystems, and seawater composition (e.g., pH). The IPCC "Climate Change 2014 Synthesis Report" (p. 8)[9] states:

> *Continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems. Limiting climate change would require substantial and sustained reductions in greenhouse gas emissions which, together with adaptation, can limit climate change risks.*

The United States, together with 173 other nations, initially signed the UN Paris Agreement on Climate Change[10] on 22 April 2016, and there are now 195 signatories. Under the terms of this agreement, the signatories have committed to reducing their carbon output "as soon as possible" to do their best to keep global warming "to well below 2 °C." The short summary above of $CO_2$ fluxes from the past 100 years and the associated rise in atmospheric $CO_2$ and projected energy use for future demand are incompatible with requirements for reductions in carbon outputs.

## The Policy Challenge

There is a clear policy rationale and a United Nations mandate to reduce global carbon and other greenhouse gas emissions in order to mitigate the impact of climate change. However, forecasts by the United States Energy Information Agency[11], the International Energy Agency[12], and industry forecasts, such as those published by ExxonMobil[13] and BP[14], all indicate a significant increase in fossil fuel consumption through 2040. The challenge for policy makers and scientific innovators is to find a way to reduce carbon emissions and accelerate the transition to renewable energy without adversely impacting global standards of living.

GSA has recommended in its position paper on climate, that

> *Strategies for reducing greenhouse-gas emissions should be evaluated based on their impacts on climate, on costs to global and national economies, and on positive and negative impacts on the health, safety, and welfare of humans and ecosystems.*[15]

In its 2016 pamphlet titled "Geoscience for America's Critical Needs," the American Geosciences Institute stated the importance of energy and the role of the nation's geoscientists as follows:

> *Energy supports economic growth, national security, and all the elements of daily life—food, water, transportation, communication, and entertainment. The United States' historically robust and secure energy systems have contributed to our high quality of life. Geoscientists find and develop earth and ocean-sourced energy, such as oil, natural gas, coal, uranium, and geothermal. They also find and develop the raw materials needed for renewable energy sources, such as cement and metals for dams, and rare earth elements for wind turbines and solar installations. In addition, geoscientists help determine suitable locations for energy infrastructure, including refineries, transmission lines, dams, and wind farms.*

Geologists who work in the petroleum, coal, uranium, and geothermal industries, engineering geologists, hydrologists, geochemists, oceanographers, meteorologists, and climatologists all play important parts in evaluating and implementing the development of all forms of energy. It is the geoscience community that also assesses the impact of energy development on water resources, ecosystems, air quality, and climate. Geoscientists understand the dynamics of Earth's natural processes and are able to reconstruct climates from the past with their atmospheric $CO_2$ levels, and the associated sea-level stands, ecosystem diversity and distribution, and sea-water composition. For those reasons, geoscientists can assess how human activities can influence nature, and which activities are environmentally sustainable. Accordingly, geoscientists have an essential role to play in energy policy.

Earth scientists can provide a balanced and realistic perspective in the oftentimes contentious debate about the pros and cons of fossil fuels versus renewable energy, and the scope and timing of the transition to energy resources that reduce greenhouse gas emissions. Resolution of the energy issues that are presently being debated will have significant economic, strategic, environmental, health, and security consequences. Input from geoscientists is critical to informing the public and policy makers about the consequences of different options.

GSA supports scientific knowledge as a guide to public decisions about the exploration, exploitation, and stewardship of finite energy and mineral resources.

## RECOMMENDATIONS

- GSA recognizes that all forms of energy production will be required to meet global energy demand through this century and that no form of energy is perfectly secure or completely devoid of potential negative impacts. However, in order to mitigate negative climate change impacts, GSA encourages policy makers to mandate reductions in carbon and other greenhouse gas emissions through appropriate regulation and legislation that fully considers the economic and security impacts of such mandates, and to facilitate the responsible transition away from fossil fuel energy resources by supporting renewable energy and climate research.
- Research on energy sources and on the environmental, economic, health, and social impacts and benefits of their development is vital. Continued monitoring and research are necessary to improve forecasts of climate change and impacts to geological and ecological systems.
- Given the dynamic nature of energy markets, state, federal, and global energy policies must be developed in a way that is adaptive to circumstances and innovations, and continuously updated to reflect changing conditions. Geoscientists need to be at the forefront of discussions so that science-based energy policies can be formulated and implemented. The continued responsible development of all forms of energy resources, and the advancement of emerging energy sources, will ensure reliable supplies for the future.
- Global coal resources are abundant; however, the continued use of coal for electric generation will not be possible without continued improvement in technologies to reduce carbon dioxide, sulfur dioxide, nitrous oxides, mercury, and particulate emissions. GSA supports continued research into clean coal technologies, carbon gasification, and carbon capture and storage to consider how best to reduce $CO_2$ emissions from coal.
- Nuclear power generation emits no carbon. GSA recommends that a national nuclear waste storage solution be developed, and that the U.S. Congress approve the construction and operation of this solution. The recycling and reuse of spent fuels from nuclear power plants should be explored, and the U.S. should determine where and if these opportunities exist, and when and how to implement the process. Research into power technologies such as fusion and thorium-based fission must continue.
- Wind and solar power projects require the permitting and construction of new power transmission corridors, because the optimum sites for wind and solar generation are often remotely located from existing transmission infrastructure. GSA recommends that state and federal regulatory bodies support the permitting of these transmission corridors to facilitate a growing renewable energy portfolio. The geoscience community can provide an assessment of the environmental impact of such transmission corridors and find and develop the natural resources necessary for energy infrastructure construction.
- The high-temperature geothermal energy resource, the heat of the Earth, is enormous. The current challenge is extracting energy from hot rocks in an economic and sustainable manner. In the U.S., this means using new technologies and development models to expand nationwide from the current base of conventional geothermal electricity generation in California and Nevada. The geoscience community's broad expertise is needed to make direct deep use (DDU), Enhanced Geothermal Systems (EGS), Super-Hot rock energy, and other geothermal innovations viable and scalable renewable energy sources. GSA supports continued research into the commercialization of hot dry rock geothermal energy.

- GSA recognizes that energy efficiency and conservation is one of the most effective, scalable, and near-term solutions to reducing greenhouse-gas emissions from fossil fuels. Much progress has been made recently in mandating increased fuel efficiencies for automobiles, for increased efficiencies in electric appliances, in home insulation, in lighting, and much more. Without energy efficiency measures developed and deployed since the early 1970s, the U.S. would today consume significantly more energy every year than the 100 quads we currently consume. However, more can be done. GSA recommends that state and federal legislative bodies implement policies through regulation and incentives to further increase fuel efficiencies for all forms of transportation; enhance insulation and "smart" electric power and distribution technologies in homes, schools and other public buildings, offices, warehouses, and manufacturing facilities; improve lighting systems; and incentivize and implement comprehensive recycling programs that are evaluated on the basis of overall societal cost.
- GSA recognizes that the United States has the potential to become energy independent through responsible development of all forms of energy. This would have profound beneficial economic and security consequences. GSA supports efforts to make America energy independent as the nation transitions to an economy with low greenhouse-gas emissions.

*Adopted October 2017*

## ABOUT THE GEOLOGICAL SOCIETY OF AMERICA

The Geological Society of America, founded in 1888, is a scientific society with more than 25,000 members from academia, government, and industry in more than 100 countries. Through its meetings, publications, and programs, GSA enhances the professional growth of its members and promotes the geosciences in the service of humankind. GSA encourages cooperative research among earth, life, planetary, and social scientists, fosters public dialogue on geoscience issues, and supports all levels of earth science education. Inquiries about the GSA or this position statement should be directed to GSA's Director for Geoscience Policy, Kasey S. White, at +1-202-669-0466 or kwhite@geosociety.org.

## REFERENCES AND INTERNET LINKS


1. GSA Position Statement on Climate Change: http://www.geosociety.org/documents/gsa/positions/pos10_climate.pdf
2. National Academies climate information: http://nas-sites.org/americasclimatechoices/
3. Climate position statement of the American Geophysical Union: http://sciencepolicy.agu.org/files/2013/07/AGU-Climate-Change-Position-Statement_August-2013.pdf
4. Climate position statement of the American Meteorological Society: https://judithcurry.com/2012/08/27/ams-statement-on-climate-change/
5. Climate position statement of the American Chemical Society: https://www.acs.org/content/dam/acsorg/policy/publicpolicies/sustainability/globalclimatechange/climate-change.pdf
6. Climate position statement of the AAAS: http://www.aaas.org/sites/default/files/migrate/uploads/aaas_climate_statement1.pdf
7. Climate position statement of the Geological Society of London: http://www.geolsoc.org.uk/~/media/shared/documents/policy/Statements/Climate%20Change%20Statement%20Addendum%202013%20Final.pdf?la=en
8. *Fifth Assessment Report (AR5)* of the United Nations Intergovernmental Panel on Climate Change (IPCC): http://www.ipcc.ch/report/ar5/
9. IPCC Climate Change 2014 Synthesis Report: http://www.ipcc.ch/report/ar5/syr/
10. United Nations Paris Agreement on Climate Change: http://newsroom.unfccc.int/paris-agreement/
11. United States Energy Information Agency International Energy Outlook 2017: http://www.eia.gov/outlooks/ieo/
12. International Energy Agency: http://www.iea.org/statistics/
13. ExxonMobil Outlook for Energy: http://corporate.exxonmobil.com/en/energy/energy-outlook
14. BP Statistical Review of World Energy: http://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html
15. GSA Position Statement on Climate: http://www.geosociety.org/documents/gsa/positions/pos10_climate.pdf

## Opportunities for GSA and its Members to Help Implement Recommendations

To facilitate implementation of the goals of this position statement, the Geological Society of America recommends the following actions:

- GSA members should seek opportunities to communicate effectively the role and importance of geoscientists to society in locating, evaluating, and developing all forms of energy resources and assessing the impact of energy resource development and operations on the natural environment.
- GSA members should make clear to national, state, and local governments, community groups, local decision makers, and the general public the link between fossil fuel use and climate change, and the importance of reducing carbon and other greenhouse gas emissions by transitioning to renewable energy resources.
- GSA members should emphasize the importance of including geoscientists in the process of developing and implementing energy policy, as it is the geoscience community that understands Earth's natural processes, Earth's capacity to produce energy from fossil and renewable resources, and the impact of energy use on the environment.

**The Geological Society of America**

- Can provide members with readily accessible print, Web, and personnel resources that support geoscientists' communications with decision makers regarding the value of the geoscience community in developing energy policy.
- Can raise awareness of the role of geology and government in mineral and energy resources by publishing articles and conducting symposia, technical sessions, and workshops at annual and sectional meetings on these subjects.
- As GSA members rise to the challenge of informing the public and decision makers about energy, climate, and energy policy, it is important that members' positions and recommendations be supported by objective and reliable energy and climate data.

Some of the best sources for energy statistics include the following:

1. U.S. Energy Information Agency (EIA): http://www.eia.gov
2. International Energy Agency (IEA) http://www.iea.org/statistics/
3. Petroleum Services Association of Canada (PSAC): http://www.psac.ca/business/industry-statistics/
4. International Energy Forum (IEF): https://www.ief.org/resources/energy-outlooks.aspx
5. ExxonMobil Outlook for Energy: http://corporate.exxonmobil.com/en/energy/energy-outlook
6. BP Statistical Review of World Energy: http://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html

Comprehensive information about climate change can be found at the following sources:

1. National Academies: http://nas-sites.org/americasclimatechoices/
2. NASA: https://climate.nasa.gov/
3. National Oceanic and Atmospheric Administration: http://www.noaa.gov/climate
4. U.S. Environmental Protection Agency: https://www.epa.gov/climatechange
5. University of Maine Climate Change Institute: http://climatechange.umaine.edu/about/overview
6. United Nations Intergovernmental Panel on Climate Change: http//www.ipcc.ch