

What Can We Do about Climate Change?

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Everyone grumbles about the weather, but nobody seems to do anything about it. —attributed to Mark Twain

Many Friends have heard about climate change, and some have begun living different lifestyles in response. Yet, many of us wonder if our personal actions are of much significance compared with the global need, and ask, “what can Friends contribute?”

Friends can lead by example. Friends’ historic commitments to the right sharing of world resources and to living with integrity require us to examine our personal lifestyles, and make changes accordingly; there is no other moral choice. Friends’ historical belief in racial and gender equality existed long before the abolitionist, suffrage, civil-rights, and women’s-rights movements. Quakers were in the forefront of those social-change movements, serving as leaders and role models for others. Friends, as a corporate body, are somewhat late in joining the environmental movement, but we nevertheless bring an historical boldness in working for social change based on traditions of integrity, community, and simplicity. Bold changes are needed once again.

Energy, Carbon, and Climate

In 1896, Swedish chemist and Nobel Prize winner Svante Arrhenius recognized that combustion of fossil fuels, which releases carbon dioxide (CO₂) into the atmosphere, would warm the planet, because CO₂ is a greenhouse gas—it traps heat that the earth radiates out to space. Fifty years ago, human activities released about two billion metric tons of carbon into the atmosphere each year. Today, global anthropogenic (human-caused) CO₂ emissions are approximately eight billion metric tons of carbon per year. If we continue on this “business as usual” path and the world does not make reduction of carbon emissions a priority, human-generated CO₂ emissions may double in fifty years. Because of feedback effects and delayed responses, Earth has only begun to respond to the CO₂ that we have already added to the atmosphere and oceans—it will continue to warm even without further CO₂ emissions.

The most recent report by the Nobel prize-winning Intergovernmental Panel on Climate Change (IPCC) predicts that business as usual will increase global average temperature by about 3.4 degrees Celsius (°C), relative to 1980–99, by the end of the 21st century, with a likely range of 2.0 to 5.4°C. In comparison, global average temperature has increased about 1°C (1.8 degrees Fahrenheit) since 1850, and 0.5°C since 1980.¹

For the past 2 to 3 million years, our planet has been cooler than typical, with permanent ice caps waxing and waning about every 100,000 years. We are now living in a warm interglacial period, so a rise in global temperature greater than about 2°C will result in climate conditions that last occurred before the genus *Homo* first appeared. The planet can cope with warmer climates. After all, for much of geological time, Earth was substantially warmer than today. But many species, including humans, may not be able to adapt to such rapid climate changes.

Some of the consequences of climate change have already begun to appear. Many glaciers are retreating and summer Arctic ice cover is shrinking. Since 1993, the global average sea level has risen nearly twice as fast (3.1 mm per year) as in previous decades. Heat waves have become more

frequent, and the number of intense hurricanes in the North Atlantic has increased. Spring is arriving earlier in northern latitudes, and some bird species are out of synch; they are trying to raise their young when food is not available. According to the IPCC, “approximately 20-30% of species assessed so far are likely to be at increased risk of extinction if increases in global average warming exceed 1.5-2.5°C, relative to 1980-1999.” Public health officials in many areas are beginning to plan for increased incidence of infectious diseases and heat stress.

A Multi-Solution Approach

It is not too late to minimize the amount of future warming. CO₂ accounts for nearly one-half the warming caused by anthropogenic emissions of soot and greenhouse gases. To hold the future global average temperature increase to 2°C, global CO₂ emissions need to be controlled.

In an influential and widely cited study, Stephen Pacala and Robert Socolow showed that we already have the technology to meet the world’s energy needs for the next 50 years while first halting, then reversing, historical increases in CO₂ emissions.² Their key insights are:

- 1) No single solution solves the CO₂ problem.
- 2) The portfolio of commercially available technologies is large enough that not every mode of carbon reduction has to be used.
- 3) Different countries may choose different sets of actions, depending upon needs, resources, and priorities.
- 4) Don’t expect revolutionary technology to solve the immediate problems.

Pacala and Socolow introduce the idea of a carbon “wedge,” any change that reduces carbon emissions by a 20 million-ton increment each year for 50 years in comparison to business-as-usual practices. At

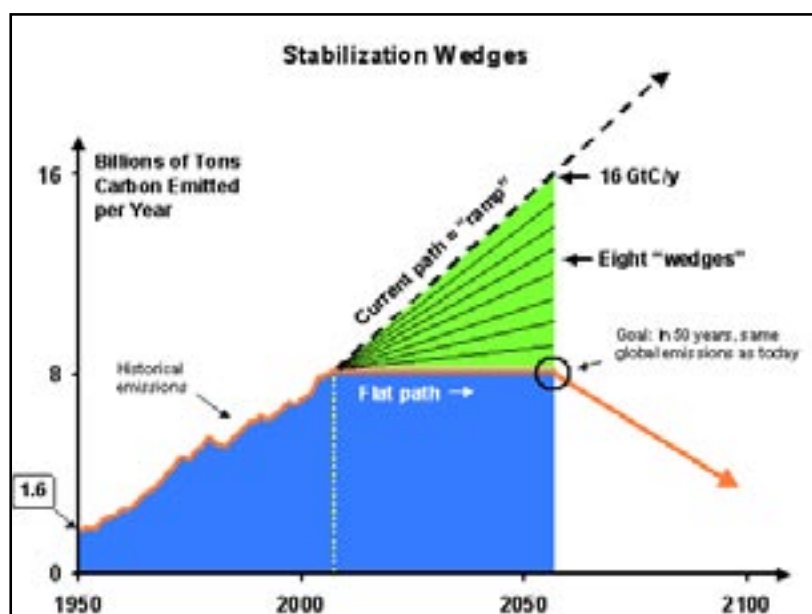


Figure 1. CO₂ stabilization wedges. <www.princeton.edu/wedges> Reprinted by permission.

Quaker Eco-Bulletin (QEB) is published bi-monthly by Quaker Earthcare Witness (formerly FCUN) as an insert in *BeFriending Creation*.

The vision of **Quaker Earthcare Witness (QEW)** includes integrating into the beliefs and practices of the Society of Friends the Truths that God's Creation is to be held in reverence in its own right, and that human aspirations for peace and justice depend upon restoring the Earth's ecological integrity. As a member organization of Friends Committee on National Legislation, QEW seeks to strengthen Friends' support for FCNL's witness in Washington DC for peace, justice, and an Earth restored.

QEB's purpose is to advance Friends' witness on public and institutional policies that affect the Earth's capacity to support life. QEB articles aim to inform Friends about public and corporate policies that have an impact on society's relationship to Earth, and to provide analysis and critique of societal trends and institutions that threaten the health of the planet.

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- Explain why the issue is a Friends' concern.
- Provide accurate, documented background information that reflects the complexity of the issue and is respectful toward other points of view.
- Relate the issue to legislation or corporate policy.
- List what Friends can do.
- Provide references and sources for additional information.

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the end of 50 years, each wedge accounts for one billion metric tons of carbon not added to Earth's atmosphere (*Figure 1, p. 1*). They propose first stabilizing global carbon emissions with available technologies and then reducing emissions by employing more advanced technologies that will take longer to develop. Since this study was published four years ago, the calculations have been updated to account for recent emission increases and the lack of action between 2004 and 2007.³ According to the update, capping world CO₂ emissions now requires eight wedges, compared with the 2004 estimate of seven wedges. Moreover, many climate scientists now believe that it is necessary to reduce CO₂ emissions to avert the most severe effects of climate change. Stabilizing emissions is a start, but it won't be enough to keep temperatures from rising past the 2°C threshold. But delay is harmful. If the world waits another five years to tackle emission reductions, simply capping CO₂ emissions at 2004 levels could require 10 wedges.

The Choice is Ours: Selecting the Wedges

Pacala and Socolow identified 15 carbon wedges, each of which would prevent one billion metric tons of carbon emissions by 2054. They identified a technology as a wedge only if it was commercially available now or could be ramped up in scale very soon. Accomplishing any one of these will require major efforts. Table 1 shows the wedges arranged by types of energy production and consumption.

Table 1. Wedges (Pacala and Socolow, 2004, 2007)			
Type of Energy Consumption	Type of Energy Production		
	Energy Efficiency and Resource Conservation	Renewable Energy	Nonrenewable Energy
Transportation	1) 2X* vehicle mpg \$ 2) Halve VMT \$	7) 30X ethanol \$\$ 8) H ₂ (wind) \$\$\$	11) Synfuels (CCS) \$\$ 12) H ₂ (CCS) \$\$\$
Electricity	3) 25% better \$ 4) CFPP efficiency \$	9) 40X wind \$\$ 10) 700X solar \$\$\$	13) Natural gas \$ 14) CCS at CFPP \$\$ 15) 3X nuclear \$\$
Biostorage	5) Protect forests \$ 6) Agricultural practices \$		

*X = expansion of current conditions by factor indicated, mpg = miles per gallon, VMT = vehicle miles traveled, CFPP = coal-fired power plant, H₂ = hydrogen, CCS = carbon capture and storage
Relative costs of options are reproduced from <www.princeton.edu/wedges> and are intended as general approximations: \$ = low cost, \$\$ = moderate cost, \$\$\$ = high cost

Energy Efficiency

Energy use, especially in North America, is so inefficient that there are huge opportunities to reduce CO₂ emissions through efficiency improvements, at very modest cost.

Transportation. Two wedges are achievable from changes in transportation. Doubling the average vehicle fuel-use efficiency from a hypothetical business-as-usual world average 30 mpg at mid-century to a readily-attainable 60 mpg is one wedge (Table 1, wedge 1). Cutting the average vehicle miles traveled in half by traveling less, providing better mass-transit alternatives, and changing commuting patterns, provides another wedge (wedge 2). Doubling fuel efficiency and cutting vehicle miles in half together yield 1.5 wedges (being careful to avoid double-counting). Complete elimination of the remaining carbon emissions from vehicles could be achieved using carbon-neutral types of ethanol production and plug-in hybrids. Additional carbon savings could be achieved from increased efficiency in rail transport and by shifting from air travel to more efficient modes of transit.

Electricity. Increasing efficiency in consumption and production of electricity offers opportunities for two wedges. One efficiency wedge (wedge 3) comes from reducing energy use in buildings (much of which involves electricity) by 25 percent. More than one wedge is possible if energy-use improvements exceed 25 percent. This option is low-cost, and very doable.

A second electricity efficiency wedge (wedge 4) is available if mid-century coal-fired power plants produce twice as much electricity by operating at 60 percent efficiency compared to the present 32 percent. If electricity continues to be produced from coal-fired plants, which appears likely as long as coal is inexpensive, doubling the energy output per unit of coal consumed will allow generating capacity to grow without increasing CO₂ emissions. China and India currently account for 45 percent of world coal use, and in each of the two countries coal is the overwhelming energy source for electricity production, so they will certainly continue to use coal.

Resource Conservation

Storing carbon in plants and soils (biostorage) potentially provides two wedges. One carbon wedge could be achieved by stopping all deforestation by mid-century (wedge 5), compared with a business-as-usual future in which the rate of deforestation is half that of today. A second biostorage option is conservation tillage. Annual plowing accelerates carbon emissions from soils, whereas drilling seeds into soil without plowing, using cover crops, and practicing erosion control all prevent carbon losses from soils. Such practices, known as conservation tillage, now occur on about one-sixteenth of the world's croplands. They could produce one wedge if extended to all agricultural soils (wedge 6).

Renewable Energy

Transportation. A 30-fold increase in ethanol production is one wedge (wedge 7). Hydrogen-fueled vehicles could be one wedge, either wedge 8 or wedge 12, depending on what fuel is used to generate the hydrogen. But there is no gain in displacing petroleum twice. To be a carbon savings, either ethanol or hydrogen must be produced without using fossil fuels substantially in their production. Ethanol from crops is likely to be cheaper than hydrogen, because a hydrogen fuel system requires a new infrastructure. But, ethanol should be produced from non-food crops.

Electricity. Wind energy provides one wedge, if it expands to 30 times today's capacity (wedge 9). The cost of wind-generated electricity is comparable to other low-cost sources of electricity today. Wind energy is expanding at the rate of about 30 percent per year. Depending on how long this rate can be sustained, wind yields at least one and possibly two or more wedges.

Solar electricity, from photovoltaic (PV) systems, is not cost-competitive at present, but is still expanding as fast as wind energy, about 30 percent per year. If sustained, PV creates one or more wedges (wedge 10). A second approach for generating electricity from the sun, concentrating solar power, has been tested at development and pre-commercial facilities for over twenty years; if costs were halved, it would be commercially competitive. Another full wedge may be achieved by passive solar design of buildings, insulation, solar water heating, and heat pumps, all of which are commercially available now.

Other renewable sources of electricity may develop before mid-century. Examples include the production of electricity from waves and tides, neither of which is yet at the stage of commercial production.

Fossil-Fuel Strategies

Natural Gas. One wedge could be provided by replacing 1400 coal-fired plants with natural gas, which would result in four times the current capacity of natural-gas fired power plants (wedge 13). The carbon savings results because natural gas yields twice as much energy per ton of carbon emitted as coal does. Substituting natural gas for coal is inexpensive, but supplies of natural gas may be limited and can be difficult to deliver to markets. The infrastructure needed to expand natural gas production and delivery includes large numbers of new pipelines and terminals for loading and unloading liquefied natural gas.

Carbon capture and storage. The technologies for carbon capture and storage are used commercially today, but not for reducing CO₂ emissions. The petroleum industry injects CO₂ into oil fields to enhance petroleum yields. One wedge could be achieved by installing carbon capture and storage at approximately 80 percent of the existing coal-fired power plants today (wedge 13), requiring 100 times as much geological storage of CO₂ as the petroleum industry now practices. The U.S. could demonstrate leadership by requiring all new coal-fired power plants to employ carbon capture and storage.

Transportation. Hydrogen and synthetic fuel produced from coal, called "synfuel," are two fuels used as substitutes for petroleum in the operation of motor vehicles. Employing carbon capture and storage

at plants producing hydrogen and synfuel could provide two wedges (wedges 11 and 12). Hydrogen production is one of the most expensive strategies available, due to the costs of building a new infrastructure for distribution. Synfuels, while less expensive, are still costly.

Nuclear Power

Nuclear fission reactors produce electricity with very low emissions of CO₂. Estimates of nuclear fission capacity vary from one wedge obtained by tripling today's global nuclear energy capacity (wedge 15) to two or more wedges if even more nuclear reactors are built.

While some see increased nuclear energy capacity as essential to reducing CO₂ emissions, the problems associated with nuclear energy today are no different than they were 30 years ago. The technologies for enriching uranium and operating fission reactors are well developed, but no permanent waste repositories exist. Tripling nuclear fission reactors will triple waste disposal needs and generate thousands of tons of plutonium. Reprocessing involves additional difficulties and the potential for proliferation of nuclear weapons is a major disadvantage of expanding nuclear energy.

The Path Forward

A pathway for stabilizing carbon emissions exists. Energy efficiency, resource conservation, and renewable energy sources could provide two wedges from transportation, four wedges from electricity production and consumption, and two from other sectors. A solar electricity wedge is attainable with PVs, concentrating solar power, or a combination of the two. Another solar wedge is possible from increased efforts to incorporate passive solar heating and water heating into building designs. For fossil-fuel strategies, one wedge can be obtained by doubling conversion efficiencies at coal-fired power plants, but that same wedge, or more, could also be developed through various combinations of efficiency, substitution of natural gas for coal, and implementation of carbon-capture-and-storage. An eighth wedge is possible from biostorage as a combination of changes in forestry and agriculture. Together, the categories potentially provide all eight wedges needed to stabilize global CO₂ emissions by mid-century.

CO₂ emissions stabilization could be accomplished without relying on current-generation nuclear technologies. With further research, more advanced nuclear fuel cycles may become commercially viable in the future. Such advanced fuel cycles would be attractive if they generate negligible waste and are resistant to weapons proliferation. At present, the available nuclear technologies have serious deficiencies and are very expensive when full life-cycle costs are considered. Current international agreements and cooperation to monitor nuclear technologies and materials are inadequate. The InterAcademy Council concluded that nuclear power could contribute only if major concerns related to capital cost, safety, and weapons proliferation are addressed.⁴ In our view, rapid expansion of nuclear power is a strategy best left for the future.

Control of CO₂ emissions should be supplemented by more vigorous efforts to control anthropogenic emissions of other air pollutants that contribute to global warming. For example, eliminating diesel exhaust would improve public health and reduce soot, which contributes to warming by nearly 20 percent as much as CO₂. Efforts to reduce concentrations of other air pollutants, including methane, ozone, and halocarbons, will also mitigate global warming.

The path forward relies on energy efficiency, renewable energy, improved management of forests and farmland, and reductions of air pollutants, in addition to CO₂. This pathway does not require a rapid expansion of nuclear energy, or wide-scale development of hydrogen or synfuels.

Our proposed path is not radically different from analyses carried out by the International Energy Agency (IEA).⁵ According to the IEA, energy-related CO₂ emissions will rise from seven billion tons of carbon in 2005 to eleven billion tons carbon in 2030 under

the business-as-usual reference scenario but could be held to nine billion tons if governments implement various control measures. The IEA indicates that 80 percent of the avoided CO₂ emissions could be achieved through energy efficiency, with renewable energy sources and nuclear energy each accounting for about half the remaining emission savings. Nuclear energy accounts for 10 percent of the avoided CO₂ emissions through a 40 percent expansion of world capacity. A more challenging IEA scenario further cuts 2030 CO₂ emissions to six billion tons carbon through widespread deployment of carbon capture and storage.

Stabilizing Carbon Emissions Is Not Enough

Eight wedges is a good start, but more than eight will probably be needed before mid-century. According to the latest IPCC assessment, holding the future temperature increase to 2°C 2050 will likely require CO₂ emissions that are 50 to 85 percent below 2000 levels. These emission reductions would limit the temperature increase to 1.5 to 1.9°C relative to 1980-99 and result in an ultimate sea-level increase of 0.4 to 1.4 meters.

Whether eight wedges or more, the developed world must reduce its emissions over the next 50 years. Stabilizing global emissions requires that developed countries reduce their emissions, while developing economies grow toward equality. Developed and developing countries each account for roughly half of global CO₂ emissions. Developed countries, with industrial, carbon-based economies and high-consumption lifestyles, cannot tell developing countries not to grow. At the same time, developed countries cannot eliminate their CO₂ emissions completely. Capping global CO₂ emissions at current levels means that developed economies must reduce emissions equivalent to increases occurring in developing countries—and both need to decouple economic growth from CO₂ emissions.

Eventually, CO₂ emissions must be reduced to an equilibrium level that could be safely absorbed by the world's forests and oceans. Forests in North America have been regrowing since the mid-1800s and currently absorb about 30 percent of the North American fossil-fuel emissions of CO₂,⁶ but the future capabilities of North American forests to continue absorbing CO₂ are largely unknown.

Confronting Unlimited Growth

Total carbon emissions (E) are a product of four contributing factors: the total population (P), the consumption per person (C), energy required per unit of consumption (J), and carbon emissions per unit of energy (R).⁷

$$E = P \times C \times J \times R$$

Each of these factors contributes to total emissions. The wedges considered so far reduce CO₂ emissions through energy efficiency (J) or carbon intensity (R), the last two factors in the equation. If all four factors are reduced, the overall reduction is greater.

Population. As observed by Pacala and Socolow, one additional wedge is possible if world population stabilizes at eight billion instead of nine billion.⁸ Increasing population, while not the only cause of climate change, makes solutions more difficult.⁹

Consumption per person. Carbon reductions are possible through lifestyle changes. For the developed world, opting for lifestyles with lower rates of consumption is an option. Indeed, consumerism raises profound ethical and moral questions.

Energy required per unit of consumption. Improved energy efficiency is likely to go beyond what we have described. For example, green design has been embraced by architects with extraordinary enthusiasm.

Emissions per unit of energy. Innovation will create new technology choices sooner rather than later. The options considered by Pacala and Socolow intentionally included only commercially available technologies, but the need for CO₂ reductions is likely to stimulate innovative carbon-free energy solutions much sooner than mid-century. There is no need to wait until 2050 to begin using new technologies!

What Friends Can Do

Religious communities can help frame the ongoing political discussion about climate change in moral, not just technocratic or economic, terms. As Quakers, we can work to build a world system that will make later decisions easier and establish personal habits of living creatively and simply. We can do our share. The future will be shaped by our choices.

Every global-scale action begins somewhere. Americans can make an especially significant contribution in travel. From 1980 to 2006, the U.S. population increased by 32 percent, but vehicle miles traveled within the United States increased by 101 percent.¹⁰ Further, Americans made eight million trips overseas in 1982, compared with 27 million overseas trips in 2004, an increase of 240 percent.¹¹ We can travel less often and still experience lifestyles no worse than those that we enjoyed twenty years ago, and we can travel more efficiently.¹²

But, try suggesting traveling less or taking public transportation to someone you know—you may get an interesting response. It is difficult to live differently. Yet, now that we understand how damaging CO₂ emissions are to the planet, and how much we in the U.S. affect climate change, how can we not make changes in our lifestyles? As Friends, we expect that we will “walk our talk.” We can:

- Support policies promoting CO₂ control through energy efficiency, renewable energy sources, improved forestry and agricultural practices, and innovation;
- Travel fewer miles, more efficiently;
- Practice resource conservation in your home and place of work;
- Increase the efficiency of appliances, heating, cooling, and lighting your home;
- Let people know what you are doing, and why;
- Support research into new technologies and adopt them when they become feasible;
- Support creation of nonviolent international decision making that fairly shares power, burdens, and opportunities;
- Work for global nuclear disarmament and a strong, globally trusted control system for nuclear materials and processes.

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