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GLOBAL CLIMATE CHANGE AND CATHOLIC RESPONSIBILITY: FACTS AND FAITH RESPONSE[1]

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[1] In late September, 2005, after the final draft of this paper was prepared, one of us, Monika Hellwig, suddenly died. In light of this tragic turn of events, the other two of us (W.M.B. and G.B) would like to dedicate this paper to Monika's memory. She truly was an accomplished author and theologian, an ardent advocate for Catholic intellectual freedom, a dedicated mother, and, for the two of us, a wonderful colleague, friend, and fellow parishioner at St. Rose of Lima church.

ABSTRACT:

The scientific evidence is now overwhelming that human activity is causing the Earth's atmosphere to grow hotter, which is leading to global climate change. If current rates of greenhouse gas (GHG) emissions continue, it is predicted that there will be dramatic changes, including flooding, more intense heat waves and storms, and an increase in disease. Indigenous peoples and the poor will be most severely affected, as will Earth's wild animals and plants, a quarter of which could become extinct in fifty years. We urgently need to switch to renewable (non-GHG emitting) energy sources, and try to live in a simpler, more sustainable way. In this article, a renewable energy expert, a biochemist, and a theologian have come together to describe the situation in which we find ourselves, and present ideas for a solution that is incorporates Catholic social teaching.

INTRODUCTION

Modern day Catholics and other Christians are bombarded by an overwhelming array of social issues. In the relatively short span of two decades, a new issue has arisen that may have enormous social consequences. While public debate focuses on social legislation and changing cultural norms, meteorological processes are underway that may profoundly alter the global economy as well as worldwide social and cultural conditions. The result of these processes, a phenomenon called global climate change (global warming), is barely on the radar screen of the "person in the pew." Yet its direct and indirect adverse effects are already being observed. What can be done to bring the reality of global warming and its predicted dire consequences home to Catholic communities? What responses do our Catholic faith and Catholic social teaching require of us?

The U. S. Conference of Catholic Bishops (USCCB) has taken up the issue and, with reference to well informed scientific opinion, has offered a preliminary teaching on the subject[2]. This teaching has drawn little evident media attention and scarcely a ripple of interest among ordinary Catholics. There is, for example, no apparent practical guidance regarding the construction of new churches that

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[2] *Global Climate Change: A Plea for Dialog, Prudence and the Common Good* (Washington, D.C.: The United States Conference of Catholic Bishops, 2001). Available at: http://www.nccbuscc.org/sdwp/international/globalclimate.htm

recognizes their role as models for sustainable living. Concern for global climate change among Catholics seems limited either to those whose technical expertise has drawn them to sift through the confusing assortment of related facts, claims and opinion, or to those who already have a deep concern for the environment. At the parish level, there is often silence.

Recently, the authors of this paper organized and participated in a symposium titled: "Global Climate Change: Facts and Faith Response." More than fifty people from Catholic parishes in the area attended. At the symposium, three panelists (including two of us) presented compelling evidence that: 1) the global climate is changing significantly due to cumulative human activity; 2) consequences could include severe ecosystem disruption and massive species extinctions; and 3) the adoption of "climate-friendly" technologies based on renewable energy have the potential to significantly reduce the GHG emissions that cause global warming. A fourth panelist (also one of us) offered the theological perspective that Jesus' commandment "love your neighbor," rooted as it is in Hebrew scripture, demands that we take steps now to prevent global warming and its dire consequences for the poor of the Earth. This paper incorporates the content of the four talks, and extends from them. It emphasizes some of the main points of scientific fact and Catholic social teaching that should be considered in order to promote an active, dynamic faith response to global climate change.

SOME KEY CONCEPTS

It will be helpful at the outset to define some of the key concepts that are discussed in this paper, namely: global warming, climate, climate change, global climate change and nonlinear response. *Global warming* refers to the progressive gradual rise of the Earth's average surface temperature that is being caused by an increase in concentrations of GHGs (mainly CO_2 and methane) in the atmosphere. *Climate* is defined as the composite of the long-term prevailing weather patterns in a particular place; it includes, for example, variations in temperature, precipitation, and wind patterns. *Climate change* refers to changes in the climate as a whole in a particular region; as such, it considers how all of the elements of weather, not just temperature, change. *Global climate change*, then, refers to the changes in all of the interconnected weather elements for all of the regions of the Earth.

It is predictable that global warming will cause climate change. But the particular way in which warming affects climate varies across the globe. The change in climate experienced by a particular geographical region may be completely different from the changes experienced by other regions. Moderate climates may become more extreme and extreme climates more moderate. Wet climates may become drier and drier climates wetter. Colder climates may

become warmer and warmer climates colder.[3] In other words, the response of global climate to the Earth's warming is *nonlinear*. Different regions are and will be affected differently. Nonetheless, climate models do suggest general trends, including a more rapid warming of polar and Arctic zones compared to temperate and equatorial zones, for example. In addition to directly raising sea levels, the melting of polar ice sheets and Arctic permafrost caused by warming is predicted—through positive feedback loops—to accelerate overall global warming trends.

Regarding the issue of the *nonlinear response* of climate to warming, some scientists predict that if GHG emissions are not quickly brought under control, a certain threshold or "tipping point" might be reached beyond which further efforts will be futile. In this scenario, there would be a dramatic shift in global

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[3] One example of the way in which global *warming*, when filtered through the prism of the global climate system, can cause localized *cooling* is the effect that warming might have on deep ocean water currents. These currents, which bring warm surface water north toward Great Britain and other northern countries, and return cold water south, are now 30% slower than they were fifty years ago. With enough warming, this "conveyer belt" of currents could come to a complete halt, plunging northern Europe within decades into a frigid climate that is on average 11°F colder than it is now. [Juliet Eilperen, "Deep-Water Currents Slowing, Report Says," *The Washington Post* (December 1, 2005): A16].

climate upon exceeding the threshold. Many existing climate patterns would be disrupted simultaneously. The Earth's climate possibly would be permanently changed, and it might take thousands of years—if ever—for climate to return to its normal, pre-threshold equilibrium. Just where the all-important threshold lies is an open question. Some experts note, however, that for vulnerable communities such as the Inuit peoples of the Arctic and the citizens of the tiny South Pacific island atoll nation of Kiribati the threshold is already being approached.[4] How well a post-threshold climate of this sort experienced on a global scale would support life as we know it is also completely unknown. The fact that this kind of scenario is being entertained, however, points to the seriousness of the issue. It is a clarion call to immediate action.

THE REALITY OF GLOBAL CLIMATE CHANGE[5]

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[4] See Juliet Eilperin, "Debate on Climate Shifts to Issue of Irreparable Change: Some Experts on Global Warming Foresee 'Tipping Point' When It Is Too Late to Act," *The Washington Post* (January 29, 2006): A01; and Doug Struck, "Inuit See Signs In Arctic Thaw: String of Warm Winters Alarms 'Sentries for the Rest of the World'," *The Washington Post* (March 22, 2006): A01.

[5] Unless otherwise indicated, the material in this section comes from the presentation of Dr. Michael MacCracken, chief scientist at the Washington, D.C.-based *Climate Institute*, at the St. Rose of Lima Catholic Church (Gaithersburg,

THE COMPOSITION OF THE ATMOSPHERE IS CHANGING. The "greenhouse effect" refers to the effect of the Earth's atmosphere in trapping heat from solar radiation. (See Figure 1) Since 1750, the atmospheric concentration of carbon dioxide (CO_2), the primary GHG, has increased by over 30%[6] (See Figure 2), reaching a value higher than any it has had in at least the past several million years. Although the atmosphere is miles thick and more than twenty-five thousand miles in circumference, it is nevertheless finite. Life-supporting gases such as oxygen and carbon dioxide that enter at one point are transported elsewhere by wind and convection. The atmosphere also traps heat from the sun, and its effectiveness in doing so depends on its chemical and optical properties, which in turn depend on its chemical composition, especially on the concentrations of certain carbon compounds such as CO_2, methane (CH_4) and

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MD) symposium titled "Global Climate Change: Facts and Faith Response," held on May 10, 2005, that was mentioned in the Introduction. For more information on global climate change science, see: Michael MacCracken, "The Science of Climate Change," available at: http://www.climate.org/PDF/Mike%20MacC%20YALE-032504.pdf

[6] "International Panel on Climate Change (IPCC) observations of greenhouse gas and radiative forcing changes since 1750." Available at http://ess.geology.ufl.edu/ess/Notes/070-Global_Warming/IPCC_GH_observ.htm

chlorofluorocarbons. Solar radiation penetrates the atmosphere at a rate that may vary over the short term but is essentially constant over centuries and millennia. Heat is radiated away from the Earth's surface up into the atmosphere, and it is the balance between heat lost and heat gained that determines the temperature of the air, land and water in the "eco-sphere," the thin layer that supports life (Fig. 1).

The atmospheric warming effect of CO_2 present in the atmosphere because of the burning of fossil fuels is amplified by the warming effect of methane (CH_4), another GHG. Methane is produced through the decay of garbage and sewage, the growing of rice, the raising of cattle and sheep, and leakage from coal mines and natural gas pipelines. Altogether, intensification of these anthropogenic processes has increased the atmospheric CH_4 concentration by over 150% since pre-civilization times. In addition, industrial and agricultural activities have significantly increased the concentration of nitrous oxide, N_2O, a non-carbon GHG. To make matters worse, escaping chlorofluorocarbon compounds used in refrigeration and industry also intensify the natural greenhouse effect.

The effects of an increasing CO_2 concentration on the climate were first suggested during the 19th century, and have been under intensive scientific study for the past few decades. In 2001, the most comprehensive international scientific summarization of available observations and climate model simulations

concluded that most of the warming over the past several decades is a result of the combustion of fossil fuels (i.e., coal, petroleum, and natural gas).

GLOBAL CLIMATE IS CHANGING. Since the mid-19th century, the cumulative increase in the annual average temperature measured at thousands of locations around the world has been roughly 1°F. Associated with this increase has been an increase in the temperatures of ocean waters, the melting of Arctic sea ice and mountain glaciers, a 6-to-8 inch rise in global sea level, an increase in intense rainfall events, and pole-ward shifts in the habitat ranges of most species that have been studied. The human-induced increases in the concentrations of CO_2 and other GHGs (Fig. 2) are the only plausible explanation for this set of climatic and environmental changes. According to computerized climate models, stabilizing the global climate will require more than just limiting our global carbon diet to current levels of consumption; it will ultimately require reducing GHG emissions to far below current levels. Worldwide use of coal, oil, and natural gas is leading to the emission of roughly 6.5 billion metric tons of carbon per year; another billion or so tons is being released as a result of land cover change, mainly deforestation in tropical regions. Emissions of soot and of CH_4, N_2O, and other GHGs add an additional 20-25% to the warming influence of the CO_2 emissions, while the emissions of SO_2 reduce this additional increment by about half. Carbon dioxide emissions have the greatest warming influence and persist in the atmosphere for centuries. This means that, even if we stopped all GHG production today, global warming with its accompanying climate change

would continue for decades before abating. Plausible scenarios of future changes in population, economic input, and energy technologies project that CO_2 emissions, if not constrained, will increase from present levels by a factor of 2-4 during the 21st century, doubling or tripling the atmospheric concentration of CO_2 relative to its pre-industrial level. Keeping emissions roughly constant would only slow the increase in concentrations and would require sharp reductions in emissions by industrialized nations to balance the planned increases by developing nations.

UNPRECEDENTED CLIMATE CHANGE IS PREDICTED. Using the best climate models, an increase of CO_2 emissions by a factor of 2-3 over the 21st century is projected to lead to an increase in the global average of annual-average surface temperatures of roughly 3-5°F. Greater emissions would lead to even more warming; for example, an increase in emissions by a factor of 4 would lead to temperatures that are about 5-7°F higher. Compared to the global average, the warming will be greater over land than over the ocean, greater in mid-to-high latitudes compared to low latitudes, greater in winter than in summer, and greater in drying areas than in moist areas. The magnitude of these effects is projected to be even greater during the 22nd century. Limiting global warming to about 3°F above current levels for the indefinite future will require that emissions during the 21st century remain about constant and then decrease significantly during the 22nd century; limiting warming to 3°F in the mid-latitudes will require even greater reductions.

As global average temperatures increase, all aspects of the climate will change. Evaporation and precipitation will both increase, but not to the same degree in each region; as a result, patterns of soil moisture and the availability of water resources will change. The related changes will be regionally complex and associated with shifts in storm tracks, intensification of tropical cyclones and convective rains, a higher snow line leading to less spring snow pack, further shrinkage of mountain glaciers, reduced coverage of winter snowfall and sea ice, more rapid evaporation of soil moisture leading to more frequent drought, less extensive permafrost, and a much higher heat (or discomfort) index in urban areas.

Shifts in the timing and patterns of monsoons and natural oscillations such as El Niño/La Niña cycling are expected. These shifts are likely, in turn, to disturb, possibly discontinuously, the established circulations of the atmosphere and oceans that determine weather patterns and ocean currents, creating unusual and unexpected sequences and intensities of events. The massive Greenland and West Antarctic ice sheets are particularly at risk. Already there are signs that they are losing mass (breaking off and melting) near and around their edges. Moreover, recent reports indicate that the glaciers of Greenland and Antarctica are flowing to the sea and melting much faster than expected. The combined effect of the meltwater from these two phenomena together with the simple expansion of ocean waters as they warm, are predicted to cause a rise in sea level of one to two feet or even more during the 21st century.

ECOSYSTEM DISRUPTION AND SPECIES EXTINCTION

It is likely that indigenous peoples and the poor, who are more directly dependent on the land and for whom relocation as an intact community is more problematic, will be most severely affected by the flooding, more intense storms, longer heat waves, and increased pestilence and disease that are expected to accompany global climate change.[7] (Witness the recent devastating effect of hurricane Katrina—a climate change-induced natural disaster—on the poor of the city of New Orleans and the Gulf Coast region.) Other groups of people may be somewhat insulated from direct effects by geographical location, or by a better economic ability to adapt. Yet, indirect effects may touch nearly everyone by causing global economic depression, or even global economic collapse.[8]

Suffering along with indigenous peoples and the poor of the world will be the 1.25 million species of living creatures—24% of all in existence today—

[7] See Juliet Eilperin, "Climate Shift Tied to 150,000 Fatalities: Most Victims Are Poor, Study Shows," *The Washington Post* (November 17, 2005): A20.

[8] See Jared Diamond, *Collapse: How Societies Choose to Fail or Succeed* (London: Penguin Books, 2005).

predicted to become extinct by 2050 if temperatures rise as expected.[9] The scale of this possible future extinction event will rival the great extinctions seen only five other times in the 4.5 billion-year history of Earth. What will set this extinction apart from the others, however, is that it will have been caused by a single species—*Homo sapiens*.[10]

GLOBAL WARMING IS AFFECTING ECOSYSTEMS NOW. Ecosystem disruption is already evident today in the "fingerprints" of global warming on

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[9] Chris D. Thomas et al., "Extinction Risk from Climate Change," *Nature* 427 (January 8, 2004): 145-148. See also: Guy Gugliotta, "Warming May Threaten 37% of Species by 2050," *The Washington Post* (January 8, 2004): A1.

[10] We have often heard the phrase "extinction is forever." But, does this truth really enter our consciousness? When a species goes extinct, it will never again be seen on the face of the Earth. And, while a certain low-level rate of extinction is normal, the rate we will be seeing with global warming could be ten-thousand-fold higher than this background rate. The wholesale loss of species will not only diminish the radiant expression of God's Love within creation (as St. Thomas Aquinas might say) but, equivalently, will also severely reduce biodiversity, upon which the health of the planet—and our own health—depends. Moreover, we must ask, as has Bill McKibben in *The End of Nature* [(New York: Doubleday, 1989)], Do we humans really want to be virtually alone on the Earth?

plants and animals in North America and elsewhere in the world.[11] These fingerprints include: the northward migration of North American animals from their former habitats into ones occupied by native species, causing disturbance in both places;[12] the decimation of coral reefs in the Caribbean;[13] the rapid decline and extinction of amphibian (frog and salamander) species worldwide since the

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[11] Terry L. Root, Jeff T. Price, Kimberly R. Hall, Stephen H. Schneider, Cynthia Rosenzweig and Alan Pounds, "Fingerprints of Global Warming on Wild Animals and Plants," *Nature* 421 (January 2, 2003): 57-60.

[12] One example of this is seen with the North American red fox, whose range has shifted northward into that of the Arctic fox, a less aggressive and therefore more vulnerable species. Another is seen with the spruce budworm; in this case, changing climate could decouple its population cycle from that of its avian and parasite predators. This could cause its population to explode, leading to extensive damage of spruce and balsam fir forests. See Douglas B. Inkley et al., "Global Climate Change and Wildlife in North America," *Wildlife Society Technical Review 04-02* (December 2004)[herinafter "Global Climate Change and Wildlife"]; and Juliet Eilperin, "Climate Change Affecting Species, Study Shows," *The Washington Post* (December 15, 2004): A17.

[13] Toby A. Gardner, Isabelle M. Côte, Jennifer A. Gill, Alastair Grant and Andrew R. Watkinson, "Long-Term Region-Wide Declines in Caribbean Corals," *Science* 301 (August 15, 2003): 958-960.

1980s;[14] the plummeting of krill (a crustacean similar to shrimp) populations in the Southern Ocean, adversely affecting the entire food chain in the region;[15] and the tragic decline of polar bears in the Arctic due to loss of winter sea ice with rising temperatures.[16] (See Fig. 3) These are only a few examples; many more are described in two recent reports, one by the Pew Center on Global Climate

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[14] See Simon N. Stuart et al., "Status and Trends of Amphibian Declines and Extinctions Worldwide," *Science* 306 (December 3, 2004): 1783-1786; Juliet Eilperin, "Worldwide Report Says Amphibians Are In Peril," *The Washington Post* (October 15, 2004): A3; J. Alan Pounds, "Climate and Amphibian Declines," *Nature* 410 (April 5, 2001): 639-640; and Joseph M. Deisecker, Lisa K. Belden, Katriona Shea and Michael J. Rubbo, "Amphibian Decline and Emerging Disease," *American Scientist* 92 (March-April 2004): 138-147.

[15] Angus Atkinson, Volker Siegel, Evgeny Pakhomov and Peter Rothery, "Long-term Decline in Krill Stock and Increase in Salps within the Southern Ocean," *Nature* 432 (November 4, 2004): 100-103.

[16] See "Impacts of a Warming Arctic," *Arctic Climate Impact Assessment*, Cambridge University Press (November 16, 2004), available at www.acia.uaf.edu; and Juliet Eilperin, "Study Says Polar Bears Could Face Extinction," *The Washington Post* (November 9, 2004): A13.

Change[17] and another by The Wildlife Society.[18] In thinking about ecological disruption, it is important to realize that ecosystems are very complex, and so the effects of changing climate will be broad, devastating, and, to a large extent, unpredictable. Moreover, due to co-extinction,[19] it is likely that current estimates are on the low side.

WHY WILL GLOBAL WARMING BE SO DEVASTATING? One reason why global warming will be so damaging to ecosystems stems from the fact that different organisms within an ecosystem respond differently to environmental cues for the timing of important life cycle events such as leafing and flowering, egg laying, larval development, and migration. The environmental cues themselves might be different—for example, some organisms might use day length, while others might use temperature—or the degree of response to a particular environmental cue, say, temperature, might be different. As a result of these differences, when temperatures rise and precipitation and evaporation

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[17] Camille Permesan and Hector Galbraith, "Observed Impacts of Global Climate Change in the U. S.," *The Pew Center on Global Climate Change* (November 2004). Available at: http://www.pewclimate.org

[18] "Global Climate Change and Wildlife."

[19] Lian P. Koh, Robert R. Dunn, Novjot S. Sodhi, Robert K. Colwell, Heather C. Proctor, and Vincent S. Smith, "Species Coextinctions and the Biodiversity Crisis," *Science* 305 (September 10, 2004): 1632-1634.

patterns change as a result of global warming, there is an *uncoupling* between the normally closely interacting species within the ecosystem, placing them out of phase with each other. Examples include butterflies and the plants on which they feed, and birds and the seeds and insects they eat.

A second reason why global warming will be so devastating to ecosystems is that many ecosystems have already been weakened by other factors such as habitat fragmentation, invasive species, and pollution. We can see these phenomena around us today. Yet, their effects will be more extensive in the future with the additional stress of higher temperatures. Consider, for example, habitat fragmentation. Some species in an ecosystem might be biologically capable of migrating northward in response to higher temperatures, thereby surviving. (Others, due to their biology, will not be able to do this, and will perish). But, suppose that a highway or a suburban housing development has fragmented the habitat, blocking northward migration. In this case, the species, though biologically able to move, cannot, and likely will become extinct. By the same token, an invasive insect or plant, or a stream polluted with herbicide, might degrade some populations of species in an ecosystem, further compromising the integrity of the ecosystem as it struggles to cope with climate change. This will have a cascading effect, leading to more extinction. Thus, it is not just climate change, but climate change in conjunction with other exacerbating forms of environmental degradation that makes the situation so dire.

It is important to emphasize again that the ways these ecological factors all interact are complex and, like the response of climate itself to warming, are nonlinear.[20] Beyond a certain threshold, as ecosystems are stretched beyond their breaking points due to the combined impact of human-induced habitat degradation and climate change, even small changes in environmental conditions will trigger rapid, nonlinear changes in ecosystem dynamics. The effects will be large and potentially irreparable. Again, as with climate change itself, a "tipping point" may be reached beyond which the ecosystem can no longer function as an integrated whole. The consequence of exceeding this threshold will be massive die-offs and extinctions of plant and animal species as the ecosystems of which they are a part can no longer hold together.[21]

Of course, another important reason why global warming will be so devastating is the *rapidity* with which temperature is increasing; it is happening

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[20] See Virginia R. Burkett et al., "Nonlinear Dynamics in Ecosystem Response to Climate Change: Case Studies and Policy Implications," *Ecological Complexity* (2005): 357-394.

[21] Note that it is not merely coincidental that both global climate and ecosystems—two apparently very different kinds of systems—exhibit the property of having a "tipping point." Why? Because this property is latent in all complex, nonlinear systems. If pushed beyond a certain limit or threshold, such systems can change dramatically and irreversibly.

so fast compared to the time scale on which environmental changes have occurred during recent evolutionary history that organisms cannot adapt. Instead, they simply will become extinct.

HARD ENERGY CHOICES

Neither the world's energy economy, nor the climate's response to it is in equilibrium now. The global climate is changing, and so must our energy outlook. Over the short span of less than one hundred years, we have used approximately half of the planet's readily accessible oil. At the same time, nuclear power evokes fear of terrorism rather than visions of purely peaceful uses. Meanwhile, in recent decades, many new renewable energy sources and applications have come into use. But choices between new and old energy sources are typically made in reference to current market structures and economic opportunities for currently dominant industries . And, although in recent years environmental impact has been more frequently considered, in reality, environmental impact is usually given little weight in economic analysis. A fundamental fact is that the world's existing energy infrastructure, based as it is on fossil fuel consumption, has been enormously costly to create; consequently, it has both a high economic value and a significant impact on the global environment. It currently accounts for as much as 10 percent of the gross domestic product in countries like the United States. Other relevant facts include:

- More than eighty percent of the energy used by the planet's population comes from burning carbon based fuels. The remaining 10-20% of the global energy used comes from renewable resources, which mostly involve converting abundant sunlight directly to heat and electricity, or converting wind, falling water or other indirect forms of solar energy such as biomass to more useful forms such as electricity and fuel.
- Timely concerted action by the nations of the world to limit global warming is unlikely. Currently, 30% of the several billion people on the planet use very little carbon-based fuels, and many others use only moderate amounts compared to the level of consumption of the average American. For the average global citizen to use significantly less, those who currently use far more than their share would have to use a lot less, and people who now use less than their share would never be able to use as much as the average American uses today. The most obvious approach to curbing GHG emissions would involve fewer people using much less energy per person. But, the trend is in the opposite direction, both in the developing world—think of China with its recent unprecedented growth in manufacturing and demand for fossil fuel—and in the United States, where energy use is increasing at relatively high rates. The U. S. government has concluded, and announced, that the impact on the nation's economy of curbing our GHG emissions would be unacceptable, and that it will not agree to international restrictions for curbing such

emissions, e.g., the Kyoto Protocol. Already responsible for the production of 25% of global GHG emissions, the U. S. intends to continue on its present path toward increased consumption of carbon based fuels. This position has moral repercussions for which citizens of a democracy like ours bear collective responsibility.

- Waiting for radically new technology is not a solution. In the U. S., rather than promoting a re-examination of our energy generation and consumption habits, which is perceived to be unpopular, some politicians take the dubious approach of promoting technological solutions to the global warming crisis that allow us to continue our reliance on coal. These include technologies, still in the exploratory R&D stage, that involve carbon sequestration[22] whereby GHGs are trapped and immobilized at their source. But, truth be told, there is no radically new climate-friendly technology breakthrough on the horizon that can be deployed quickly, cheaply and easily. To be sure, our engineers and scientists can posit scenarios in which technology comes to the rescue. However, such schemes have drawbacks: they inherently require significant investment for which no market justification currently exists, their deployment

[22] Carbon Sequestration website of the Office of Science and the U. S. Department of Energy. Available at: http://cdiac2.esd.ornl.gov/

timescales are very long, and they are receiving virtually no commercial attention.

RENEWABLE ENERGY IS ESSENTIAL. Renewable energy sources, which include solar, wind, hydroelectric, geothermal, biomass and bio-fuels, are those whose use does not result in a net increase in GHGs in the atmosphere. Over the past 30 years they have graduated through R&D steps to full commercial availability and fairly widespread use. The average annual global growth rates of two of the largest renewable energy industries, namely solar and wind, have ranged from 30 to 50% over the past decade[23], with annual purchases of renewable energy projects and products currently in the range of $30 billion.[24] Within the United States, growth rates are lower because U. S. policies do not effectively encourage the use of non-fossil and non-nuclear sources. In this regard, it is important to emphasize that renewable energy is not inherently costly. Nonetheless, the renewable energy industry is heavily taxed and, at the

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[23] Such high growth rates, occasionally achieved in the very early years of an emerging industry, are practically unprecedented for mature industries. Thus, conventional forecasting predicts slower growth for wind and solar industries in the coming decade as they begin to mature .

[24] See: Eric Martinot, "Renewable Energy Information on Markets, Policy, Investment and Future Pathways." Available at: http://www.martinot.info/markets.htm#figure3

same time, is not supported by tax relief to the same extent that the politically powerful nuclear and fossil fuel energy industries are.

Roughly 80% of global energy *supply* now comes from (commercially purchased) carbon based fuels. On the other hand, roughly 80% of the current global energy *demand* is for residential, commercial and industrial applications; transportation accounts for the remaining 20%. In the United States, transportation's share is significantly higher, i.e. around 30%. The U. S. demand for petroleum, which, unlike other fossil fuels such as natural gas and coal, is mostly used for transportation, is expected to grow somewhat faster than the demand for other fuels. (See Figure 4) Likewise, demand for electricity, which can be obtained from nuclear and renewable energy as well as from various carbon-based fuels, is also expected to grow faster than overall energy demand. Given this scenario, the critical requirement for the successful replacement of carbon-based fuels with renewable sources is that it must not just keep pace with, but actually significantly out-pace, the anticipated increase in demand for electricity and transportation fuels.

If we are willing to make the choice, the increased future demand for both electricity and transportation fuel can be filled using existing renewable energy sources. Renewable sources compatible with current electricity generation technologies include hydroelectric (falling water), wind, geothermal (underground heat sources), and solar. These sources are sufficiently abundant

that almost all future U. S. electricity needs could be served by using them to feed into grid systems that are already in place.

In an increasingly globalized energy economy dominated by multi-national energy companies, people want to take action but at the same time feel powerless to do so. Fortunately, solar energy, the most climate-significant renewable energy option, is best deployed on roofs of homes, and it is well documented that localizing energy production in this way tends to motivate overall reductions in energy use as the consumer becomes more conscious of his or her energy usage. The investment required by a homeowner is a good one, having the same cost/benefit relationships as his or her investment in the home itself. In many parts of the US, companies are springing up that provide competent, convenient installation services for both solar hot water and solar electricity. As an example, California now has a state sponsored program that will result in a million new installations over the next ten years, and many other states are following suit. As an outcome of local advocacy, many communities, colleges and universities around the US are committing to projects, codes and standards that promote sustainable building design and use of indigenous renewable energy. For example, The San Diego Unified School District decided in 2005 to re-roof 15 of its schools and 3 of its administrative buildings with a

total of 1 million square feet of solar electric roofing material, to "help protect our regional economy and quality of life."[25]

Other home-based renewable energy devices that lower electricity consumption include "ground source" heat pumps, which use less electricity because they pump heat from an underground geothermal source. In rural areas, home-based wind turbines can be used to power pumps and offset grid electricity purchases. As mentioned above, using renewable electricity sources does not produce GHG emissions. However, for certain forms of renewable energy, the ecological impact can be significant, especially when deployed broadly in an effort to meet an increasingly higher proportion of electricity needs. Although solar panels placed on homes have no known negative ecological effect, the siting of large hydro-electric power plants on the major rivers of the world has had profound effects on regional eco-systems and on the poor and indigenous populations who live along their banks. These environmental and social issues were either ignored or were not understood in the past. Now that they are well understood, it is imperative that ecologists and representatives of power companies work together closely to seek acceptable solutions.

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[25] Richard Louv, "Solar schools help shape our future", *San Diego Union-Tribune* (March 22, 2005). Available at: http://www.signonsandiego.com/news/metro/louv/20050322-9999-lz1e22louv.html. Last accessed: April 20, 2006.

Between the extremes of benign solar home systems and environmentally-damaging hydro-electric dams are large wind and solar farms. These also require careful siting, design, and analysis to minimize their potentially negative ecological effects.[26]

While bio-fuels such as ethanol and bio-diesel are technically classified as sources of renewable energy and sometimes are considered to be "carbon neutral," the combustion of bio-fuels does, of necessity, release CO_2 into the atmosphere. Under only one scenario could the cycle of bio-fuel production–and-combustion be considered closed and carbon-neutral: that is, if one ignores the consumption of fossil fuels that is currently inextricably tied to it. It is true that the CO_2 that will be released when bio-fuels are burned has already been taken up (via photosynthesis) by the "energy crops" such as corn or sugar cane currently grown as bio-fuel feedstocks. But, using current practices, consumption of fossil fuels is required to plant, fertilize, and harvest these crops. Moreover, producing bio-fuels at a rate equivalent to the rate at which fossil fuels are produced would require a dramatic expansion of the amount of agricultural land used. The ecological impact of such an expansion could well be imagined:

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[26] See Justin Blum, "Researchers Alarmed by Bat Deaths from Wind Turbines," *The Washington Post* (January 1, 2005): A01. Working with ecologists to insure proper siting of wind turbines will be critical as power companies more heavily invest in wind energy.

broader dispersal of pesticide residues, increased soil erosion, and more fertilizer-laden agricultural run-off making its way into streams, lakes and estuaries. New technologies are coming on stream that significantly mitigate this problem. They use cellulosic (non-crop) feedstocks such as wood and grass, and offer major land use and GHG reduction advantages over currently prevalent bio-fuels technologies. "Corn ethanol production reduces GHGs by 18-29%, while cellulosic ethanol production results in an 85-86% reduction."[27] Likewise, "grain biofuels give less energy services per hectare/year than lignocellulosic crops – due primarily to lower effective yield per hectare."[28]

TIME IS NOT ON OUR SIDE. In order to supply the world's existing energy needs completely with renewable energy, the population of the planet would require ten times as much renewable energy as it is getting now. Moreover, future needs will be greater unless extraordinary efforts are made to stop wasting as much energy as we currently do. Currently, most of the production of renewable energy comes from hydroelectric and biomass

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[27] Michael Wang, "Updated Energy and GHG Emissions Results for Fuel Ethanol, 15th International Symposium on Alcohol Fuels, San Diego, CA, September 26-28, 2005

[28] Eric D. Larson, "Lifecycle Analysis of GHG Impacts of Biofuels for Transport, Presentation at the World Bank's Energy Week Conference, Washington, DC, March 7, 2006

conversion, with some contribution from solar and wind. In general, renewable energy supply has not kept pace with global energy demand, but the reasons for this are specific to the source. For example, with hydroelectric, the most economically-favorable sites for conversion plants (on rivers) have already been exploited; as a result, installation of additional plants is largely at a standstill. (See the discussion above about the negative ecological impacts of large hydroelectric dams on rivers.) On the other hand, growth in biomass energy is somewhat higher but, due to competing land use interests, is still not able to keep pace with demand. Finally, as mentioned earlier, the solar and wind industries are experiencing a relatively high level of annual growth. However, since they are still very small, it will be some time before they can catch up with demand. In fact, at current growth rates, it will take 10 to 15 years for the solar and wind industries to achieve annual production and installation rates that would, over a period of decades, stabilize GHG concentrations at three times pre-industrial levels, i.e. 750 parts per million CO_2. Stabilization, even at this level, will require a massive investment in renewable energy; however, such an investment is certainly within the capability of global financial systems.

An even greater acceleration in renewable energy use would be required to stabilize GHG concentrations at only twice pre-industrial levels, i.e. around 550 parts per million CO_2. To get an idea of what stabilization at two to three

times pre-industrial levels would require, according to Aitken et al.[29], "even stabilizing emissions at twice *today's* level [i.e. 2.7 times pre-industrial levels] would require 450 megawatts of new renewable [e.g., wind] capacity to be installed every day for several decades to come." Since a 450 megawatt wind energy power plant costs around $400 million, this would result in total expenditures in the range of several trillion dollars over several decades. The cost of stabilizing CO_2 concentration at the lower and less-damaging level of 550 parts per million would be proportionately higher.

ENERGY CONSERVATION IS IMPERATIVE. Energy efficiency can significantly reduce the required investment in renewable energy capacity and move closer the all-important day when renewable energy can begin to change the GHGs emissions curve from one of growth to one of decline. For each market sector, there is a handful of high-impact ways of saving energy. Hybrid vehicles offer double or triple the fuel efficiency of the average vehicle on U. S. roads. Compact fluorescent lights use only 25% of the energy of equivalent traditional lighting. For each high-impact choice there are dozens of other cost-effective

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[29] Donald W. Aitken, Donald et al., "The Climate Change Stabilization Challenge," *Renewable Energy World* (November-December, 2004): 56-69. See also Aitken, "The Renewable Energy Transition: Can It Really Happen," *Solar Today* (January-February, 2005). Available at: http://www.solartoday.org/2005/jan_feb05/RE_transition.htm.

alternatives to current wasteful practices. Energy efficiency measures, unlike energy supply infrastructure, do not require huge capital expenditures; in many cases they simply require education and attention. For example, most electricity and most carbon based fuels other than petroleum end up being used inside buildings, where simple measures like switching off lighting in unused areas and replacing worn out appliances (hot water heaters, refrigerators) with more energy efficient models can have dramatic effects, in many cases paying back the up-front cost in a matter of months or a year or two.

OTHER NATIONS ARE TAKING ACTION. If the U. S. is at one extreme, Germany is at the other, leading the world in the use of wind energy and second behind Japan in the use of solar electricity.[30] Germany expects to get 20% of its energy from renewable sources by 2020 and 60% by 2050. In parallel, it plans to improve energy productivity by more than 3% per year between now and 2020, and also lower the ratio of GHGs generated per unit of economic activity.[31] Meanwhile, the U. S. Energy Information Administration (an arm of the Department of Energy) estimates that the U. S. will increase renewable energy supplies from roughly 5% of its total in 2000 to only 7% or 8% in 2025. At the

[30] Ibid

[31] Ibid

same time, consumption of carbon-based fuels and emission of GHGs are predicted to increase much faster.[32]

Other industrial nations[33] and even some U. S. states[34] are making energy choices in response to climate change, for both economic and ecological reasons, that are dramatically different from those of the U. S. federal government. Whereas in the United States, energy prices are essentially unregulated at the federal level, in other industrialized countries, energy prices are regulated in ways that discourage waste. For example, in Europe, gasoline prices are kept as high as six to eight dollars per gallon in order to encourage conservation and fuel-efficiency. In the cases of England, the Netherlands and the Scandinavian

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[32] The website of the U. S. Energy Information Administration, a statistical agency of the Department of Energy (available at: http://www.eia.doe.gov/), posts major presentations and Congressional testimony. Included in these is Figure 4, from which the percentages are estimated.

[33] Niklas Höhne, Sina Wartmann and Wina Graus, "WWF Climate Scorecards – Comparison of the Climate Scorecards of the G8 Countries," *World Wide Fund for Nature* (July, 2005). Available at: www.panda.org/downloads/climate_change/g8scorecardsjun29light.pdf

[34] Policy Brief: "Learning from State Action on Climate Change," *Pew Center on Global Climate Change, In Brief, Number 8*, (2004). Available at: www.pewclimate.org/docUploads/States%5FInBrief%2Epdf

countries, higher prices are achieved by setting taxes at more than twice the underlying cost of the fuel.[35] The taxes collected are used to fund public transportation.

CATHOLIC SOCIAL TEACHING

Neither scripture, nor Catholic social teaching, nor the common moral sensibilities of humanity can be left unexamined in attempting to formulate a faith response to the above facts. Scientists began warning us about the causes and consequences of global warming several decades ago. Our generation failed a moral test when its political leaders chose not to respond with practical and effective policies. Now, as global warming proceeds unfettered, we as individual energy users face our own moral test, and our political leaders face an even more daunting moral test than before. Will wealthy nations protect the poor and powerless around the globe from the consequences of their (wealthy nations') previous failure, and will members of our political and religious communities do what they can to promote responsible energy use policies?

JESUS' COMMANDMENT—LOVE YOUR NEIGHBOR. Some well-meaning Christians believe that responsibility for the destruction of the Earth

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[35] Dean Calbreath, "U. S. reluctant to mirror Europe's high gas taxes", *San Diego Union Tribune* (May 29, 2005). Available at: www.signonsandiego.com/uniontrib/ 20050529/news_mz1b29gastax.html

caused over many generations by climate change is not our responsibility. They assume that as it is God's world, God will take care of it. The assumption behind this is that human responsibility before God is limited to matters already defined.

When Jesus was asked what was essential in human responsibility – what was the greatest commandment – his immediate answer was: to love God with one's whole heart and mind and resources, and one's neighbor as oneself.[36] He further insisted that love of God and neighbor are inseparable. When asked for a clear indication of the meaning of neighbor in this context, he replied with the story of the Good Samaritan. The thrust of the story is that in the context of the Love of God, neighbor is not limited to one's own family, ethnic group or nation. The neighbor is anyone whose need speaks to our ability to meet it. Moreover, the story assumes that we are responsible even when there is no rule to cover the situation, even when this is a situation not foreseen by the Ten Commandments, or the standard Christian catechism.

Today many of our poorest neighbors in the world are severely hurt by many aspects of production and consumption that we of the technically highly developed countries are enjoying every day. Crucial among these aspects is the clearly demonstrable climate change inexorably driven by the over-use of fossil fuels in our current patterns of energy consumption. As demonstrated in this paper, what is at stake is the most basic need of human beings, namely water

[36] Luke 10: 25 – 37; Mark 12: 26 – 34.

supply and land use. (This is because climate change will cause melting of glaciers and alter precipitation patterns, affecting both water availability and food production and, indirectly, land use.)

Without arable land and adequate water, people die. They die as surely as they would if shot, stabbed or bombed to bits. If we have any influence in the process, whether by our own patterns of consumption, our influence over others, or our participation in the political process by voting, lobbying, campaigning, or holding office, then those who are hurt by global warming die at our hands. It is as simple as that in God's eyes, though the process of acting to prevent it may be long, complex and tedious, requiring substantial sacrifices of our own comfort and convenience.

GUIDANCE FROM HEBREW SCRIPTURE. The response that Jesus gave was in fact drawn from existing Hebrew law and teaching that Jesus did not abrogate but rather confirmed. It is also enshrined in the highly significant Hebrew stories that Christians are taught to reflect on from their childhood onwards. There is the story of the Garden of Eden. God does not give human beings a wilderness but an ordered world that begins with land and with water rising from the Earth, a land fertile with growing things.[37] But human beings cannot do whatever they want with the world. The harmony that holds it all together is established by the creator's wisdom, by God's law. When people try

[37] Genesis 2: 5 – 14.

to usurp God's authority in the order of creation, the harmony of the garden falls apart, and they are exiles from Eden.[38]

The point of this story is repeated with different imagery in the story of the flood in the time of Noah,[39] a particularly apt image for global warming in which whole countries can expect to be submerged. Human evil can cause the land to be flooded so that there is no support for life. And in case we had missed the point, there is yet another story[40] of what happens when people usurp God's authority in the world – the story of the Tower of Babel. What happens is the confounding of tongues, the inability of people to work together for the common good.

Looking at the stories in this way may seem to be an anachronism, or at least stretching a point unduly. Yet the story of the Hebrews in the desert after the exile describes and emphasizes again and again what is evil in God's sight and what is right behavior. Thus, for instance:

> You shall not deprive the poor man of justice in his suit. Avoid all lies, and do not cause the death of the innocent and the guiltless…You shall not oppress the alien…in the seventh year you shall let (the land) lie fallow and leave it alone…it shall provide food for the poor of your

[38] Genesis 3: 1 – 19.

[39] Genesis 6: 9 - 7, 23.

[40] Genesis 11: 1 – 9.

people…on the seventh day you shall abstain from work so that …the home-born slave and the alien may refresh themselves.[41]

Clearly, Jesus built on this understanding that the love of God and neighbor has very practical consequences for the ordering of society and the resources of the world, and that they are not exhausted in so many specific commandments. Rather, they call on us to try at all times to understand what is happening in our world, and to consider how the justice of God calls on us to act. The truly radical teachings of the Sermon on the Mount[42] are not couched in terms of our contemporary economic and political structures. Nevertheless, anyone who reads them prayerfully and considers how they may apply to us cannot avoid making the larger societal applications on a worldwide basis. And this is precisely what the modern social encyclicals of the Catholic Church and the US bishops' pastoral letters have done.

Earlier Church teachings did not mention responsibility for global warming, because the current situation did not exist. Even when the damage was already being done, both the long-term trend and the relationship to the consumption of fossil fuels were not yet understood. Now that the relationship has become clear we have lost our innocence in the matter. We are responsible before God for what we are doing to our neighbors of the present and the future

[41] Exodus 23: 6 – 12.

[42] Matthew 5 – 7.

in the way we are using the world, and in the way our nation participates by its energy policies. For this last we are responsible because this is a democracy.

THE UNITY OF ECO-JUSTICE AND SOCIAL JUSTICE. Now that we know what we are doing to the poor of the Earth and to her creatures, the question for Catholic Christians becomes "Is this an acceptable situation?" Clearly, the answer is "no." But, conviction and passion for redressing both the ecological and social injustices will only come when we acknowledge that an important maxim of Catholic social teaching—that of the preferential option for the poor—extends to all of God's creation. Leonardo Boff has eloquently argued this, expressing the idea that social justice and ecological justice (eco-justice) are inseparable, with one demanding the other.[43] Similarly, John E. Carroll has described how the Sisters of Earth, a nationwide network of women religious communities who strive to live sustainably on the land, early on came to the conviction of the inseparability of these two forms of justice:

> How can we see the "cry of the Earth" and the "cry of the people" not as two separate cries, sometimes pitted against each other, but as two faces of the same living planet we call home …? Is it enough to make an option for

[43] Leonardo Boff, *Ecology and Liberation: A New Paradigm* (Maryknoll, NY: Orbis Books, 1995).

> the poor … unless we also make an option for preserving the Earth that sustains the poor and all other creatures?[44]

Should these not also be the questions we ask ourselves?

Once we acknowledge that the ecological crisis brought on by global warming is not acceptable, the question then becomes "What can we do about it?" In seeking an answer, we should recognize at the outset that the source of the crisis lies ultimately in our Western culture with its belief that we are separate from—above—nature and that it is our job to subdue her and bring her under our control.[45] Writes theologian Thomas Berry, "Both our religious and our

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[44] John E. Carroll, *Sustainability and Spirituality* (Albany: SUNY Press, 2004): 58.

[45] On this note, Lynn White, Jr., in 1967, argued that the blame for the ecological crisis lies not with Western culture, but with Christianity itself. He wrote: "Especially in its Western form, Christianity is the most anthropocentric religion the world has seen. …Christianity, in absolute contrast to ancient paganism and Asia's religions … not only established a dualism of man and nature but also insisted that it is God's will that man exploit nature for his proper ends." [L. White, "The Historical Roots of Our Ecological Crisis," *Science* 155 (1967): 1203-1207; hereinafter White, Historical Roots, *Science*]. He concluded that "…we shall continue to have a worsening ecological crisis until we reject the Christian axiom that nature has no reason save to serve man." [Ibid] Eric Doyle countered White's criticism of Christianity by saying that it is not "the essence of

humanist traditions are committed to an anthropocentric exaltation of the human. …We see ourselves as a transcendent mode of being. Only humans have rights. All other earthly beings are instruments to be used or resources to be exploited."[46] For this reason, Eric Doyle and others have argued, "[t]he ecological crisis cannot be solved by further use of science and technology,"[47] which are by-products of Western culture. Thus, although it is imperative in our current

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Christianity that has brought us to the crisis, but the blind selfishness of Christians which has prevented them from understanding the full implications of [the doctrines of creation and incarnation] and from determining the proper relationship between humanity and nature." [Eric Doyle, *St. Francis and the Song of Brotherhood and Sisterhood* (New York: The Seabury Press, 1981): 73.] In the end, White did find at least one redeeming quality in Christianity—that of Saint Francis of Assisi, who "tried to depose man from his monarchy over creation and set up a democracy of all God's creatures." [White, Historical Roots, *Science*] Interestingly, at the conclusion of his essay, White proposed that St. Francis be proclaimed the patron saint of ecology. In 1979, Pope John Paul II did just that.

[46] Thomas Berry, "Ethics and Ecology," a paper delivered at the *Harvard Seminar on Environmental Values* (April 9, 1996). Available at: ecoethics.net/ops/eth&ecol.htm

[47] Eric Doyle, *St. Francis and the Song of Brotherhood and Sisterhood* (New York: The Seabury Press, 1981): 72.

economic and social reality to switch as quickly and completely as possible to renewable energy sources such as solar, wind, and bio-fuel (see earlier discussion), doing so will not ultimately solve the problem. The reason is that we must also drastically reduce our overall consumption of energy, whatever its source. To do this, we will have to abandon our consumerist lifestyle and our old ways of thinking. This will require of us a dramatic conversion of heart, which will be possible only if we begin to see all of God's creatures—both human and nonhuman—as brothers and sisters, as did St. Francis, who believed that "… [t]he animals, the plants, and the elements all have intrinsic value as creatures loved by God."[48]

LIFESTYLE CHANGES. We Americans—who use five times more energy per capita than the average world citizen[49]—will have to say "enough," as Bill McKibben has suggested in his book *The End of Nature*.[50] We will have to adopt an attitude of restraint, humility, and prayerful solidarity with all who are suffering, including Earth's nonhuman creatures. Adopting a simple lifestyle will not only directly help the environment by reducing our ecological footprint; it also will place in us a mindset of solidarity with the poor and with nature. What might such a lifestyle involve? First, it might involve our taking some initial,

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[48] Ibid, 74.

[49] Erik Assadourian et al., *State of the World 2004* (New York: W. W. Norton and Co., 2004): 26.

[50] Bill McKibben, *The End of Nature* (New York: Anchor Books, 1989): 190.

practical steps such as recycling, using as few disposable items as possible, reducing household energy and water consumption, driving as little as possible in the most fuel efficient car possible, composting, eating very little meat, and actively promoting ecological awareness in the political and social arenas. We can form communities based on a desire to live sustainably, much as the Sisters of Earth and others have done. Beyond this, we can teach our children about the goodness, beauty and wonder of nature, and the intrinsic worth of each living and nonliving thing. We can tell them that our lifestyle choices directly impact Earth's creatures and the poor. Those of us who are involved with the liturgy of the Catholic Mass can help incorporate rituals celebrating the cycles and seasons of nature (summer and winter solstices, springtime, harvest time) into the Mass. Such rituals will remind us of our identity as humble dwellers of a sacred Earth. Finally, it will be important for Catholic theologians to work together with others to develop a meaningful ecological theology, much as Thomas Berry, Denis Edwards, Jürgen Moltmann, John Haught[51] and others are doing today. These

[51] T. Berry, *The Great Work: Our Way into the Future* (New York: Bell Tower Press, 1999); D. Edwards, *Jesus, the Wisdom of God: An Ecological Theology* (Eugene, OR: Wipf and Stock, 2005); J. Moltmann, *God in Creation: A New Theology of Creation and the Spirit of God* (Minneapolis, MN: Fortress Press, 1993); J. Haught, *The Promise of Nature: Ecology and Cosmic Purpose* (New York: Paulist Press, 1993).

efforts can further guide us as we seek prayerful solidarity with the world's human and nonhuman poor.

IF NOT NOW, WHEN? IF NOT ME, WHO? The facts are before us. The collective activity of billions of humans - especially the wealthiest few percent of the global population –is affecting the heat balance of the planet and changing the temperature of surface layer in ways that threaten the intricate web of life it sustains. This is a new set of circumstances confronting humanity. It is a situation that major religious traditions had not anticipated; as a result, the response by people of faith must come from the heart. It cannot be a by-product of settled doctrine. Moreover, this response-of-the-heart must be broad; it must come not just from Catholics and other Christians, or even from "people of faith," but from all people, or it will not be enough.

There is little or no active institutional "Catholic" response to our new reality. There are words, but there is no practical application of them by the institutional church. What this means for us laity is that we can put aside any hope for specific instructions. Instead, we need to look to the fundamental commandment of Jesus: Love God, and love your neighbor. God created life, and as scripture has it, "God saw that it was good." What folly or arrogance could cause us to trifle with what God saw as good? Moreover, what does the inherent goodness of God's creation tell us about how we should treat our neighbor?

A USEFUL METAPHOR. The Gospels reveal that Jesus did not place His hope in the human institutions of His day, be they political, economic or even religious. He taught instead what love of neighbor actually requires of each of us, as individuals and as members of a community, independent of what society's leaders may do. Lay Catholics can understand His teachings and interpret them (captured in contemporary Catholic social teaching) through the metaphor of "receiving a fish" versus "learning how to fish."[52] It is only a metaphor, but it nonetheless can help guide our faith response to the facts of climate change.

The network of global economic systems that sustains the growing numbers of humans on the planet gives us "fish" (food, shelter, transportation, comfort, entertainment, etc.) in return for money. We are increasingly taught, not how to engage in fishing, but how to make money to buy fish. Something is lost

[52] The reader will notice a similarity between this metaphor and the ancient Native American proverb that says: "If you give a man a fish, you feed him for one day. If you teach a man to fish, you will feed him for life." The difference between the two is that, whereas the proverb communicates the idea that we can help to empower others to live freely, our metaphor communicates the notion that if we begin to truly understand our actions and how they affect others, then we will be able to move toward a conversion of heart that will compel us to begin to act with justice toward others. The metaphor will be explained more fully below.

in this process. The consequences of how the actual "fishing" is done are hidden from us. As a result, we feel no responsibility for what we do not see.

On the other hand, the fishermen and women among us will understand how important it is to know the ecology of the fish's aquatic habitat (ocean, lake or stream) in order to catch fish. As we listen to them, we will begin to accept that we cannot all do just as we like if the fish's habitat is to continue to deliver its bounty. Over time, as this understanding and acceptance grows, we will begin to change, and an ethic will be established that calls upon a notion of *collective stewardship*. When we begin to understand the consequences of how we fish and how many fish we are taking, we are motivated to do as we would have others do, i.e. take what we need and put back what we don't need so that others now and in the future will have enough.

If the "fishing" metaphor is applied to energy and climate, then a couple of principles are apparent. First, we must acquire an *understanding*, not just of how to get money but also what chain of events is set in motion when we spend it in certain ways; with this understanding, we will be able to teach one another to "fish" properly. Second, we must *apply* our newly-learned ethic of collective stewardship to all of creation. In the present crisis, we must use it to compassionately change our habits of consumption and energy use in order to deflect the plague of suffering that global climate change—caused by us—would inflict on the Earth. Why?--Because our love and respect for our Creator and His creation and for our six billion human neighbors demand that we do.

These principles, true in Jesus' day, are still true today. As a practical matter, how can they be applied today by us, His followers? Our instinct is to look to the leaders of our day, be they governmental, corporate or religious. But these secular and religious leaders are bound by institutional habits that practically rule out the possibility of timely and effective concerted action, or doctrinal development. In fact, they look to us, the laity, for guidance regarding selection of priorities if not for inspiration. What seemingly matters most to them is not what we *think* – they are inclined more toward influencing our thoughts than seeking them out – but what we *do*, i.e. what we value as measured by our community participation and how we spend our money. In the end, as we decide on a course of action in response to global climate change we should, as in all things, follow Jesus. His message was not especially directed to the political or economic powers of His time. Rather, His call was to all people, to all who would follow Him—including (especially) us. He emphasized obedience to the Law of Love that is written on our hearts. By following His Law of Love, we have faith that we will be able to find a way to respond with justice to the present crisis.

CONCLUSION

Global warming and climate change have been underway for decades, and are gaining momentum. Their impact on ecosystems is predicted to be particularly profound, causing mass extinctions of one-quarter or more of the species currently living on the planet. Because global warming is caused by the build-up of GHGs in the atmosphere, and because GHGs, in turn, originate from

the burning of carbon-based fuels, the solution to the problem of global warming is clear: We must burn less carbon-based fuel, thereby reducing our carbon footprint. There are at least two ways we can do this. The quickest and most practical way is simply to use less energy. We humans waste far more energy than we use productively. Unfortunately, waste is common in countries like the U. S. where energy historically has been cheap and abundant, and where social and economic patterns assume, or even demand, the availability of cheap energy.

The second way for us to reduce our carbon footprint is to switch to renewable energy. There are now energy sources available that do not involve burning carbon-based fuels. These include solar, wind, geothermal, and lignocellulosic bio-fuels. We need to move as quickly as possible toward an economy that is powered primarily by renewable energy. This will require a stepping-up of the current growth rate of the renewable industry in the coming decades.

Energy conservation and renewable energy represent two practical ways to combat global warming. But we will not be driven to change our energy-consuming habits unless we also experience a conversion of heart. This is where the moral dimensions of the issue of global warming are particularly relevant. As Catholic Christians, we must ask: What is our responsibility in light of the fact that poor and indigenous peoples, and the ecosystems that sustain us all, will bear the brunt of the consequences of global warming? We need to ask ourselves: Should we waste as much as we do? What can we do about this situation?

This last question is reminiscent of the question that was asked of Jesus: "Who is my neighbor?" The answer to our question likely will be as difficult to swallow as was (and is) Jesus' answer. Both require that we invoke the radical commandment that we treat all, especially the most vulnerable, with love and compassion, putting their needs before our own. But to stop sinning, we must become *aware* of how our sin affects others. Likewise, to stop wasting, we must become *aware* of our waste and its effects. Jesus said we should ask God our Father to "give us this day our daily bread." It is a prayer for *sufficiency*, not for the "more" that apparently has become our idol.

We must cultivate, then, an *awareness* of how our actions affect others; only then will we have the conversion of heart that is required. How will this awareness take root in us?: When we realize that having a bigger home or a more powerful automobile wastes energy and, indirectly, causes harm to others; when we realize that energy is being wasted whenever a computer, a light, or a television set is left on in an unoccupied room—and that this hurts others. We will undergo a conversion of heart only when we understand that wasting food, for example, wastes the energy required to plant, harvest, process, transport, and cook the food. An integral part of our conversion will be the realization that we have *choices* and therefore can exercise stewardship: Efficient vehicles use 75% less energy than sport utility vehicles. In the home, efficient compact fluorescent lights use 75% less energy than incandescent lights, and simply changing thermostat settings a few degrees can reduce energy consumption dramatically;

Further, a home with solar electric panels and solar water heating panels can use 50% to 100% less carbon energy than a comparable home that does not .

It ultimately will be our love and compassion for others that will drive our awareness of how our actions affect others, and will prompt us to undergo a conversion of heart. As this happens, we will more willingly embrace our responsibilities and commit to living more simply within our needs, regulating our economic activity according to the spiritually-sustaining doctrine of *enough* versus the popular commercial doctrine of "more." What ultimately is important in these times is that we all do *something*, and that we do it purposefully and in solidarity with others. The (now generally accepted) recycling ethic was established in the U. S. in exactly this way. A broader ethic of environmental stewardship that also curbs our collective carbon appetite is desperately needed. Such an ethic would be fully consistent with traditional Catholic social teaching.

ACKNOWLEDGEMENT.

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FIGURE LEGENDS.

Figure 1: The Natural Greenhouse Effect. The Earth's atmosphere recycles most of the heat energy emitted by the surface, creating significant warming above and beyond what solar radiation provides. This process is important for sustaining life on Earth. In the figure, the width of the arrows is proportional to the amount of energy. Source: National Assessment Synthesis Team, "Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change." *Overview Report, U. S. Global Change Research Program* (Cambridge, U.K: Cambridge University Press, 2000). Available at: http://www.usgcrp.gov/usgcrp/nacc/default.htm

Figure 2: The atmospheric CO_2 concentration is now about 35% higher than it was during its pre-industrial times. The increase seen in the last 150 years is strongly correlated with anthropogenic emissions of CO_2. Source: Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory. Available at: http://www.eia.doe.gov/oiaf/1605/ggccebro/chapter1.html

Figure 3: Higher temperatures due to global warming are causing Arctic sea ice to break up too early in the spring. As a result, polar bears now have to forage on land, where food is less plentiful. Source: http://www.worldviewofglobalwarming.org/

Figure 4: Past and projected U. S. energy consumption (in quadrillions of Btu) by fuel type or energy source from 1970-2025. Source: Fig. 3 in "Annual Energy Outlook 2005," *Energy Information Administration, U. S. Department of Energy* (January, 2005). Available at: http://www.eia.doe.gov/oiaf/aeo/overview.html

Figure 1:

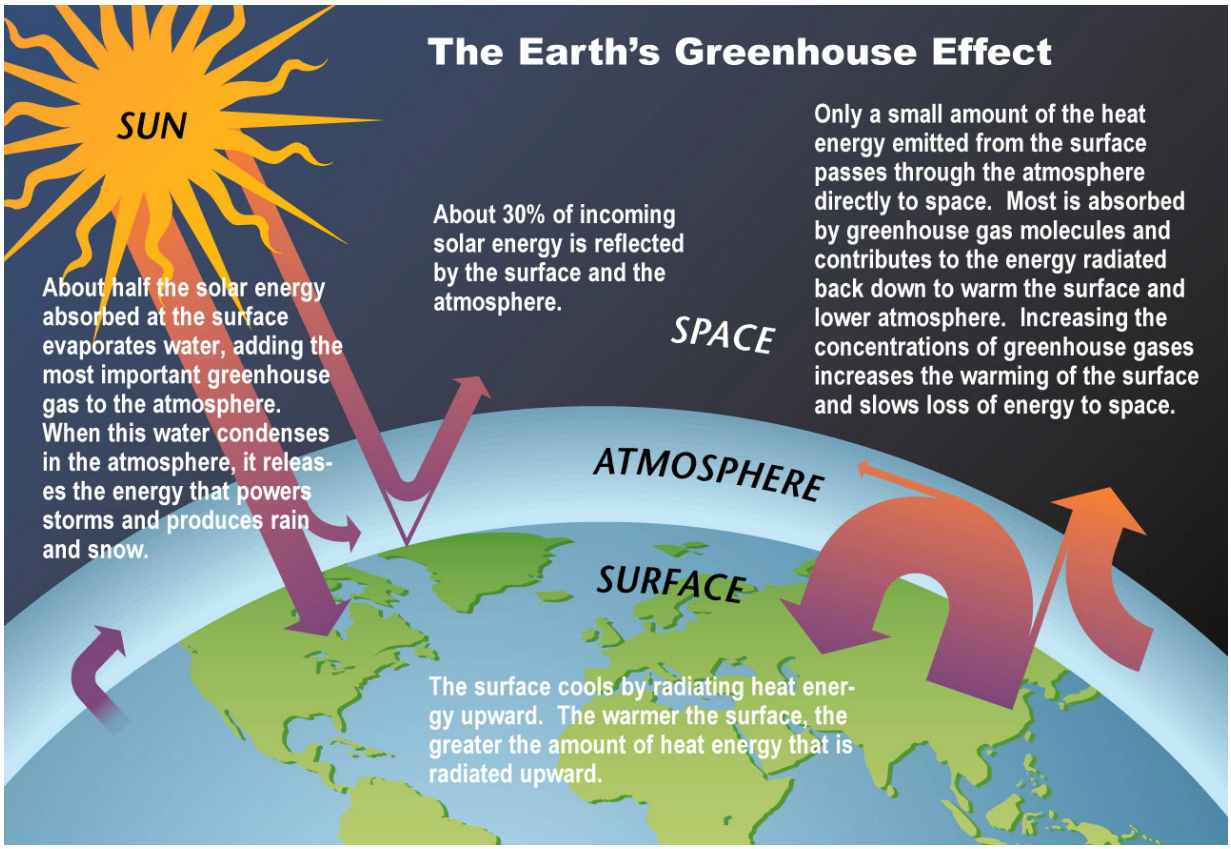

The Earth's Greenhouse Effect
SUN
About 30% of incoming solar energy is reflected by the surface and the atmosphere.
SPACE
Only a small amount of the heat energy emitted from the surface passes through the atmosphere directly to space. Most is absorbed by greenhouse gas molecules and contributes to the energy radiated back down to warm the surface and lower atmosphere. Increasing the concentrations of greenhouse gases increases the warming of the surface and slows loss of energy to space.
About half the solar energy absorbed at the surface evaporates water, adding the most important greenhouse gas to the atmosphere. When this water condenses in the atmosphere, it releases the energy that powers storms and produces rain and snow.
ATMOSPHERE
SURFACE
The surface cools by radiating heat energy upward. The warmer the surface, the greater the amount of heat energy that is radiated upward.

Figure 2:

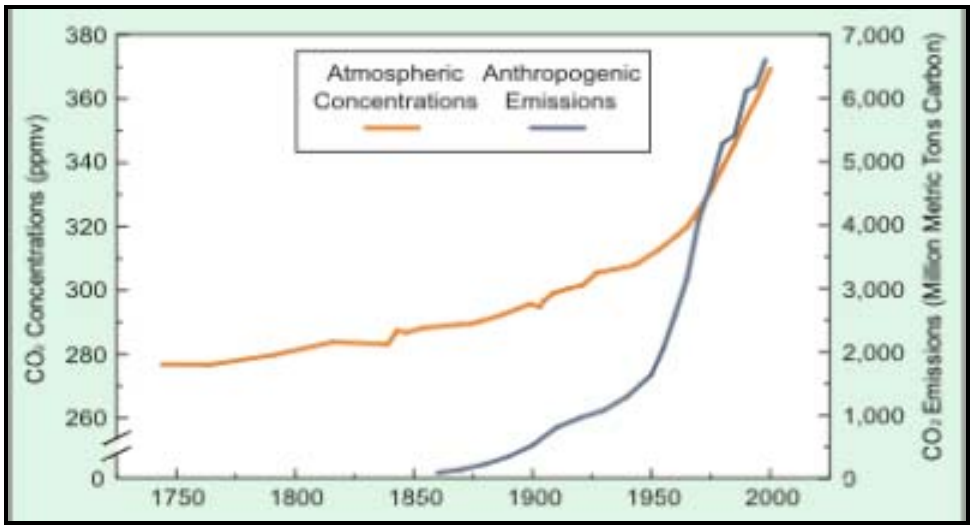
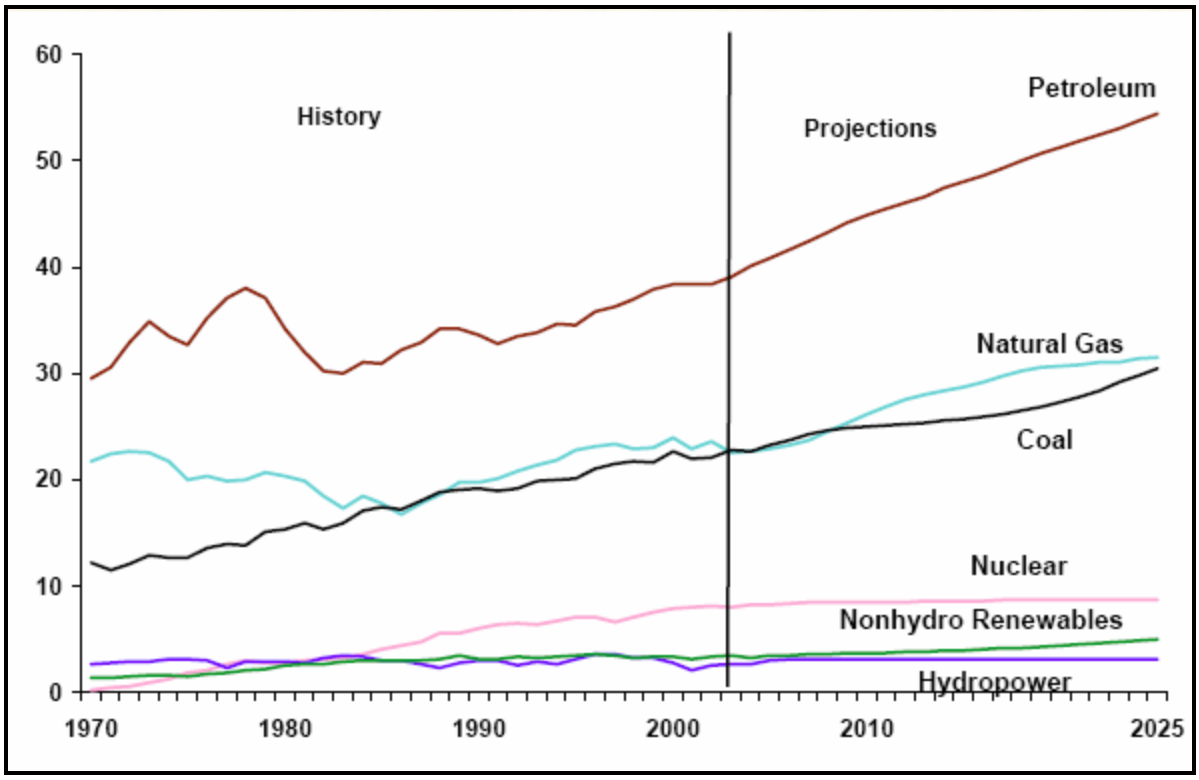

Atmospheric Concentrations
Anthropogenic Emissions
CO2 Concentrations (ppmv)
CO2 Emissions (Million Metric Tons Carbon)
380
360
340
320
300
280
260
0
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1750
1800
1850
1900
1950
2000

Figure 3.

Figure 4:


60
50
40
30
20
10
0
1970
1980
1990
2000
2010
2025
History
Projections
Petroleum
Natural Gas
Coal
Nuclear
Nonhydro Renewables
Hydropower