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White Paper on Energy and Global Warming

Sierra Club Northeast Florida Group

The pace of changes due to global warming has picked up. It has become even more urgent that we know what is driving those changes, what is ahead for us, and how we might craft a response adequate to the problem. In particular, we need to consider where our energy will come from if not from fossil fuels.

Our World Is Changing

If the earth were an onion the breathable atmosphere would be as thick as its skin. The atmosphere is made up of gasses which have accumulated in the long history of the earth as well as newer gasses which humans have made and released.

Some of the gasses in the atmosphere let in more of the sun's energy than they let out. When the energy passes through the atmosphere to the earth, it is typically in highly energetic, short wave length packets. These packets heat the earth, which radiates energy back out toward space. But this radiated energy is in relatively low energy, long wave packets. Greenhouse gasses let in the high energy packets but trap some of the low energy radiations.

If there were no greenhouse effect the earth would be a snowball. Most forms of life on earth depend on the greenhouse effect and have from the beginning. We can observe the greenhouse effect on other planets with a substantial atmosphere even remotely like our own.

The most common greenhouse gas is water vapor. It stays aloft for up to a few years before returning as rain or snow. The amount of water vapor in the atmosphere of the earth as a whole is roughly in balance with the temperature, which it has helped regulate. The seasons have their heat and cold as the sun shines directly or at a slant. The temperatures vary in a range determined by the water vapor in the air, for the most part.

The earth turns continually in a bath of heat from the sun. Almost all forms of energy on earth come directly or indirectly from the sun. (The major exception is energy from nuclear interaction on earth, whether manmade or in the earth's core, where it occurs naturally and provides geothermal energy.)

We get the energy to move about our lives from the food we eat, which is passing on the energy it derived from the sun. Ancient life forms, vegetable and animal, returned to the earth and under the right conditions, in the expanse of time, became coal, oil, and natural gas—the fossil fuels. When these are burned they return the carbon of which they were composed to the atmosphere. The carbon goes up in the form of CO2.

Carbon dioxide, CO2, is a tiny part of the earth's atmosphere. It now is 388 parts per million of the air we breathe. But that is half again as much as was in the air before the industrial revolution. Much of it will remain in the air for centuries, heating the planet all that time.

So one effect of burning fossil fuels is to add CO2 to the atmosphere—much of it permanently, on human time scales. CO2 is a potent greenhouse gas. As it traps the outgoing heat radiation from the earth, it makes the atmosphere hotter. When that happens the air can hold more water vapor—which increases its greenhouse effect.

The result is that the ancient balance of temperatures is altered. Since the industrial revolution began the earth has gotten .8 degrees centigrade hotter, on the average.

We would hardly notice the difference on our own. That is only about a degree and a half Fahrenheit. But the earth has noticed.

The number and intensity of forest fires has increased. So, according to most studies, have the number and intensity of hurricanes. Heat and increasing acidity (from the new CO2 dissolving in the oceans) have already doomed 40% of our coral reefs, nurseries of ocean life. As 95% of the earth's glaciers have begun to melt, the oceans have begun to rise—slowly, now, but more and more quickly, both from the melting of land-based ice and from the way water expands when it is heated. Thermal expansion is about half the sea level rise now but is due to be overwhelmed by melt water from the ice sheets at the poles of the earth. Greenland and the West Antarctic are already showing signs of instability. Low-lying coastal areas everywhere in the world are likely to be under water by the end of this century, and some are likely to go under in our lifetimes—even if we are not young.

People are already suffering from the drought, storms, and fires. As the climate changes our world food production is dropping, and people are starving. But other life on earth is suffering too, in the oceans and everywhere else. The general extinction rate is thought to be a thousand times more than the background rate, the rate we normally expect.

Methane, nitrous oxide, and other gasses arising from human activity add to the greenhouse effect. Some, like methane, remain in the air for only a few years. Others are long-lived, like CO2 or the fluorocarbons. CO2 is not the most potent. Methane is 23 times as powerful in its greenhouse effect. Some of the fluorocarbons are ten thousand times as potent and last in the atmosphere for centuries. But their release is measured in tons, and CO2 in gigatons (billions of tons). Because our production of CO2 has been so vast we usually convert the other greenhouse gasses into carbon equivalents.

Roughly half the carbon we release is taken up by the oceans and other systems such as forests, though their capacity to store carbon is diminishing. Much of the rest remains in the atmosphere. The fossil fuels we have already burned will continue to change the world into the far future.

So far as we know we have it in our power to preserve the world in something like its current state. But unless we act quickly to moderate the amount of greenhouse gasses we are putting into the air the world will become more and more unlivable. At some point feedbacks such as the buildup of methane from the melting of the permafrost will take over and we will be powerless to stop it. We must change our lives, and begin now, whether we want to or not.

We, Too, Must Change

When the topic of global warming arises the discussion usually turns to what we are driving and whether we are using the right light bulbs. Those things are important because cumulatively they can have a real impact on how much carbon we add to the atmosphere. But they are not the key. That would be how we produce our energy. If everyone on earth drove hybrids, used compact fluorescent bulbs, and bought energy star appliances—and still used coal and natural gas to produce most of their electricity—we would still be headed for serious trouble. On the other hand, if we produced our energy by means which did not put out greenhouse gasses, and were still pigs about the amount of energy we used, we would be in good shape. Once the sun or the winds are producing our energy we can use as much as we can manage to produce and not endanger the earth. No matter how much we conserve, coal, oil, and natural gas put us in danger.

The major exception to the danger posed by fossil fuels comes from the possibility of capturing and storing the carbon produced. That has not been done on a large scale, and is unlikely to be done in the future. It is expensive and inefficient to capture and to store greenhouse gasses, even where we know how to do it. Finally, we produce such a vast amount of carbon when we base our energy use on fossil fuels that storage becomes impossible to imagine.

We do not consider carbon capture and storage to be a serious option for large scale energy production. In fact, it is a way for us to continue business as usual while we talk about and research the technology. A great many of the suggestions for energy reform fit into that category.

While we research nuclear fusion as an energy source, adding to the tens of billions of dollars and decades we have already spent researching this option, we continue to burn coal, oil, and natural gas. While we talk about hydrogen fuel cells as an automotive fuel source, knowing that it is unlikely we will be able to produce, store, distribute, or use it in any practical or renewable way on an appropriate scale, we continue to burn gasoline. While we plant 30% of our corn crop to make ethanol, knowing as we do that it saves no carbon because we produce as much carbon planting, processing, and transporting the fuel as we would if we just burned gas, we burn gas.

Finally, while we talk about nuclear power, we know that we could not build enough plants to serve our needs, that we could not sustain the expense involved if we tried, and that we would be left with radioactive byproducts and waste we still had no idea of what to do with if we succeeded.

Yet the latest research shows that we must achieve near zero greenhouse gas emissions if we wish to live on this planet. Luckily, we know how to achieve that. It will not be easy. But it will be rewarding in many ways, economically, culturally, and spiritually. It will mean a change which spreads to most of our daily life. At the end, and along the way, too, we will know that we are becoming more at home on the earth.

Our Viable Options for Energy Sources

We must cease building any fossil fuel plant which emits greenhouse gasses. Further, we must decommission such existing plants. We must derive our power from renewable sources.

Nuclear energy operates at all by externalizing costs—especially those of waste and liability. But when those costs are externalized they do not go away. They simply disappear from the company's cost and profit calculations. We will still pay them, now and for all our future. Nuclear power is not a viable option. Luckily, we have other options.

No one energy source will do for all times and places. To achieve near zero emissions, we may choose among the developed technologies of renewable energy: solar, wind, geothermal, hydroelectric, tidal, and wave power.

Florida Power and Light is using Ausra Corporation to build a 300 megawatt solar plant in south Florida which intends to produce energy for a price competitive with fossil fuels. The project will in the next few years produce 2000 megawatts in several plants.

Wind power in Texas and other favorable locations is competitive in cost with fossil fuels. Nanosolar and Coolearth Solar corporations have begun to produce solar power for about what we are paying for power now. Infinia will this year begin to market an economical household-sized Stirling solar thermal power system. Geothermal power can use existing turbines to produce power, and geothermal energy is potentially available anywhere, though some locations are more favorable than others. Florida is surrounded by waves and tides.

It is commonly objected that many renewable energy sources—solar, wind, tidal, and wave power—are intermittent. The concentrating solar thermal technology in the Ausra project uses heated liquid which can be stored to produce power when the sun is not shining. The other power sources can use technologies appropriate to their storage needs. Geothermal energy, which produces steadily, could provide a base load. Hydroelectric power is also steady. Still, we may find that we must get used to brownouts and even rolling blackouts unless we can find a way to balance our energy needs. Balancing supply and demand will pose a great challenge to our utilities, and they will need to be supported in new ways as power management from several fluctuating sources becomes even more a part of their task.

All power sources suggested here have difficulties. Geothermal power and tidal power require large startup funds. Wind turbines change skylines and threaten birds. Hydropower can be destructive to the environment, perhaps in some cases unacceptably so. Solar power requires a lot of ground, though some of the solar technologies permit double land use, and concentrating solar technology has a smaller footprint.

No difficulties should be allowed to trump our need to shift to renewable power sources and a sustainable culture. We are headed for the cliff. We must change direction.

The transition to renewable energy will be dislocating. Many occupations, and whole industries, will disappear. But new ones will arise. Sir Nicholas Stern, Britain's leading economist, estimates that the conversion will cost 1% of the world's economic effort. If we do not convert we are headed for what amounts for a permanent worldwide depression, a loss of 5-20% of our wealth this century. But the conditions will sooner or later become so severe that our economies themselves will not survive.

We may console ourselves that fossil fuels, already rising in cost, will become prohibitively expensive in the lifetime of any power plants we would build. The final bottom line, though, is not economic. The earth cannot tolerate the climate change we are generating.

Where We Must Go

We are headed for a different earth, one way or another. On the other side of a successful transition to renewable energy we will find our material lives changed in almost every aspect, and our cultural life as well.

The cheapest power is that we do not use. We can conserve energy and ease the transition to renewable energy. Refitting our houses and re-equipping our kitchens should keep us busy for awhile.

If our leading climate scientist James Hansen is right and we must take carbon out of the system to avoid dangerous change, charcoal is the primary candidate. When you burn any organic matter at a relatively low temperature by controlling the oxygen input you produce charcoal. If you bury that you are taking its carbon out of the system for thousands of years—and you are permanently increasing the fertility of the land where you bury it. The process is called terra preta, biochar, or agrichar, and was first discovered in the Amazon where it has been in use for hundreds of years. If farms around the world were induced to produce biochar they would benefit and we could sequester billions of tons of carbon.

Some greenhouse gas emission sources are a challenge to imagine eliminating. Cement contributes 5-10% of global emissions (but half that when produced using renewable energy); shipping contributes 4.5%, and air travel 2.5%.

Geopolymeric cement is even stronger than Portland cement, uses commonly available materials, and has much lower greenhouse gas emissions. Because it requires lower temperatures it uses less energy to produce. Economies of scale should make it competitive with Portland cement in cost. We will, however, need to convert cement production facilities worldwide.

We must find some way to travel by sea and air without emitting carbon. Wind power and solar in combination might do for the oceans; lighter than air travel might be more in the future of air travel than in the past, or perhaps algaic or cellulosic ethanol can provide carbon-neutral fuels for aircraft. Finally, though, we may find that we do less transport and less travel than now, whether by ship or by air.

Auto travel is easier to imagine. Compressed air and electric autos can derive their energy in the form of electricity from any of the renewable options. Certainly we will turn to more public transportation. We may even find that personal motorized transportation is not so necessary as we thought, or that longer trips can be left to public systems.

Trades people are going to need our support if we do move to public transportation. A plumber cannot take the necessary gear on a bus. Also, we are going to have to invest in clean commercial transportation for the exchange of goods necessary to our economy.

If we are going to make war, we will need to do so without emitting carbon. Nothing gets a pass on the approaching energy transition. Our personal lives and our collective habits are due for a great revision.

The internal combustion engine running on fossil fuels will probably have to disappear (unless our hopes for algae and switchgrass as fuel sources work out). Electric and rotary lawnmowers are in our future—so long as we have lawns. It may be that lawns themselves are due for a transformation. Most of us now face a water shortage arising partly from climate change. Lawns also generate pollution from the fertilizers, pesticides, and herbicides which we spread on the grass and greet again in our oceans and streams.

We have every reason to welcome the transition to renewable energy and a sustainable culture. Our lives have been impoverished by much of what we thought was making us richer. There is a delight to be had from living in harmony with the earth's resources. We may look back on our previous way of life as isolated.

Finally, there is no away to throw anything. We are going toward an awareness of how our actions impact everything around us. We shall live more consciously, and, perhaps, more joyfully. The earth has told us that it is time for that, and will accept nothing less than our full effort and our full attention.