IMPACTS OF REDUCING USE OF CARBON FUELS

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Contents

1. The Role of Carbon Based Fuels

Carbon based fuels (CBFs) have provided the primary energy source for human development and survival since the dawn of humanity. Harnessing fire was one of the first technological advances of early humans, and one that is often cited as critical to separating Homo sapiens from the rest of the animal kingdom. Many cultures have created myths around the acquisition of fire making technology. CBFs have been the source of energy throughout that time. In addition to fire, animal power was of course significant. Animal power has included human labor as well as the domestication of other animals, to assist in hunting, and in bearing our burdens.

However, CBFs were the ultimate source of energy, even for animal power. The organic matter we consume is oxidized in our bodies to yield energy. The oxidation process in animals is a slow, controlled one. In contrast, the oxidation process that occurs during combustion is more rapid and vigorous, yet fundamentally the same. Bonds between carbons or carbon and hydrogen are broken. The carbon then bonds with oxygen to form Carbon Dioxide (CO_2). In both kinds of oxidation processes, much of the energy is released in the form of heat. Thus, CBFs have fueled development, the building of societies, and even building and running our own bodies.

It is possible to reduce CBF dependence by more efficient and prudent use (conservation) and by substituting alternative fuels in our machines. There can be no alternative fuel for our bodies, however. In the affluent world, we may be able to reduce our consumption of food, by eating less, and perhaps by eating foods lower on the food chain. Considering food as a fuel has direct bearing on fuel for machinery, insofar as food and biomass fuel stocks may be seen to compete for land and carbon resources.

Direct combustion of biomass (typically firewood) provided light to see by, heat for warmth and cooking, and a means for tool making throughout the thousands of years of human existence. Only within the last three hundred years has biomass been displaced as the primary energy provider for many people in affluent countries. Even today, approximately half of the world's population is firewood and charcoal dependent.

In the 17th Century, England and some other portions of Western Europe began to face issues of deforestation due to the use of wood as a fuel and as a construction material. More or less out of desperation, people there discovered that coal could replace and indeed outperform firewood. There is good evidence that the transition to coal was crucial to the Industrial Revolution. A simple calculation demonstrates this. By 1900, Great Britain consumed 200 million tons of coal per year, with an estimated raw energy content of four quadrillion Btu's. Assuming typical forest growth rates and energy content of green wood, it would have required a forest area of 400 000 square miles to renewably supply that much biomass. Since the British Isles occupy a total of only 150 000 square miles, it is clear that there could be no sustainable firewood use for that context.Although there have been those who suggest that biomass consumption is intrinsically renewable and that England's firewood use was sustainable, simple calculations of energy use in early industrial England reveal that only a forest substantially larger than England itself could possibly have provided those levels of energy consumption sustainably.(Ebenhack, pp.239)

2. The Need to Reduce the Use of CBFs

Carbon based fuels have and continue to provide much of the energy used for industrialization. Whether used by developed countries as a main source of energy, or by lower income countries for basic heating and cooking, CBFs are the energy sources of choice. At the end of the 20th century, the global averages for primary fuel sources were approximately:

Primary Fuel	Average Global Usage (%)
Oil	47%
Coal	29%
Natural Gas	17%
Renewables	6% (combined usage of all 'renewables')

Table 1 - DOE/EIA International Energy Outlook 1997 pp.22

Of the six percent of world energy consumption that is classified as 'renewable' some proportion is biomass. Since much of the biomass consumption is outside of the marketplace, or in the informal market, estimates of total biomass consumption are considered to be very rough. Reducing the use of CBFs worldwide understandably has

far-reaching implications. Merely stabilizing the amount used worldwide would be a tremendous undertaking. Total global energy consumption is estimated to have increased by an average of a little over two percent per year over the period from 1970-1995. Commercial fuel use (excluding firewood and charcoal) grew at about one percent per year. However, the overall rate of increase has been declining over that time period. Additionally, some of the increase noted has been in non-combustion sources, especially nuclear power. (International Energy Outlook 1997, pp 17-22) During the same general time period, the population was growing at a rate of approximately one point seven percent per year. Most of the population growth, though, occurred in the less affluent nations (Our Common Future, pp.101).Thus, some portion of the growth in energy consumption is simply a function of the growing numbers of people who need energy… but not all of it.

The issue of Enhanced Global Warming (EGW) has raised some doubt concerning the continued unrestrained use of CBFs.The scientific community has proposed such CBF reduction undertakings. Carbon dioxide is considered the main anthropogenic gas leading to EGW.CO_2 is given off when CBFs are oxidized (burned).

Source, Providing 1 Million Btus of Energy	**CO_2 Emitted**
Direct Combustion of Natural Gas for Heat	118 pounds
Gasoline and Fuel Oil	190 pounds
Direct Combustion of Coal	210 pounds
Electricity from Natural Gas	388 pounds
Electricity from Oil	628 pounds
Electricity from Coal	694 pounds
Direct Combustion of Firewood	~1000 pounds

Table 2 – Relative Carbon Dioxide Emissions for Different Energy Sources
WRI 1992 pp.58, except firewood approximated by authors by open fire efficiencies

The amount of CO_2 in the atmosphere has been steadily increasing since the Industrial Revolution. Today there is approximately 30 percent more CO_2 in the atmosphere than before the 1800s (Andrews pp.164). Continued unrestrained use of CBF's will exacerbate the problem further. Even if action is taken promptly, the atmospheric CO_2 concentration is not expected to drop or even stabilize in the near term. In part, this is due to sinks being lost, especially through deforestation. (Forests take up carbon from the atmosphere to make plant mass, thus providing a sink or storage of global carbon. In fact, all growing plants provide carbon sinks.)

The theory behind the mechanism responsible for Enhanced Global Warming is generally accepted among the scientific community. However, the ultimate outcome of EGW is highly disputed. The actual feedback loops involved, and their mechanisms are poorly understood. For example, one theory holds that as concentrations of CO_2 increase the global temperature will also increase. This should cause more water to evaporate from the land and sea that could cause more clouds to form from increased moisture in the atmosphere. Increased cloud cover increases the earth's albedo (the amount of incoming solar radiation that is immediately reflected back to space) thereby

reducing insolation and reducing earth temperatures. This theory is one example of a negative feedback loop mechanism since it tends to counteract the effects of global warming and return the earth to a fairly steady state (e.g.'see figure 1' below).

Other theories counter to this hold that a positive feedback mechanism will occur (e.g.'see figure 2' below). There is research that suggests even moderate increases in global temperature could begin to thaw the Siberian permafrost, which has a tremendous amount of methane locked away in the icy ground. Methane is a strong greenhouse gas with 21 times the greenhouse gas forcing potential as CO_2 and therefore could help to accelerate the EGW effect. There is also some evidence that increased atmospheric moisture will not lead to more cloud formation, just a higher ambient humidity since cloud formation depends on many other factors outside of atmospheric moisture levels. This is an example of a positive feedback mechanism because a small increase in global temperatures starts in motion a mechanism that will tend to accelerate global warming.

The Global Climate Model is not yet sophisticated enough to discern with much certainty which mechanism will actually occur. However, the authors, and the majority of the scientific community including the Union of Concerned Scientists (www.ucsusa.org) believe that the severity of the consequences of EGW warrant action in the face of uncertainty. Some argue that even moderate reductions in CO_2 emissions through regulation could have dire economic repercussions for industrialized nations.These issues have led to indecisiveness amongst governing agencies, and regulated CO2 emissions are currently non-existent in the US. The authors believe that at the very least a no regrets reduction of CO2 emissions should be implemented. Reducing unnecessary carbon dioxide emissions and incorporating a modest amount of conservation exemplify this. This could be achieved by implementing a policy whereby an evolving energy mix is used. The Kyoto protocol is the first international initiative that attempts to limit the amount of global CO2 emissions. Extensive analyses of the implications of this protocol have been performed by various scientific and governmental agencies using models. A review of these detailed analyses explain some of the connections between the economy and CBFs. Most analyses consider fuel switching and emissions trading to be the primary means to reduce CO2 emissions, as opposed to conservation measures. Due to the flood of research on the effects the Kyoto Protocol could have on the American economy and energy infrastructure, addressing the impacts of reducing the use of CBFs can be best accomplished by using reduced CO2 emissions as a proxy. This is a reasonable assumption, because burning of CBF's produces virtually all anthropogenic CO2 emissions.

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Biographical Sketches

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