Energy & Climate – Where We Are

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Introduction

Five years ago, in the spring of 2008, oil prices reached $147 per barrel and there was a perceived energy crisis in the United States. The U.S. was the world's largest oil importer and consumer, and its own oil production and reserves were in long term decline. Today with rapid increases in oil and gas production and substantial upward revisions in proved reserves across North America, the United States is on the path to much greater energy self-sufficiency and security.

Since the 1970s, the U.S. has embraced successful programs of energy conservation and efficiency. Some of these have been mandated by government agencies, and many others have been driven by market forces simply seeking lower energy costs. Even with its economic and population growth over the past few decades, the U.S. has continued to implement conservation practices and buy products with more energy-efficient designs, thus reducing the per capita demand for energy. In 2005, The U.S. reached a high-point of oil consumption, and since then has actually decreased its annual oil use.[1]

Today, the greatest threat to U.S. energy security is not driven by increasing demand for imported oil. Rather, it is increasing government regulations based on a questionable environmental theory previously known as Global Warming, and then later changed to Anthropogenic Climate Change. So as we assess the theory of Anthropogenic Climate Change and its requirement of constraining carbon dioxide emissions, it is useful to review our nation's energy situation that this theory would impact.

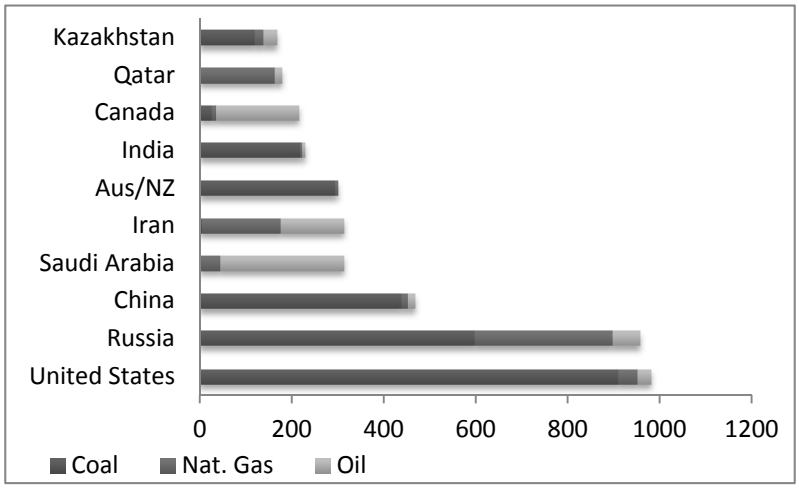
[1] The U.S. reached a high of 20.8 mbpd in 2005. *BP Statistical Review of World Energy 2013* (London: BP p.l.c., 2013), 9. Available online at: [www.bp.com/statisticalreview].

Energy Review

America: A Re-Emergent Energy Giant

By 2009, many energy experts and authors pointed out that America is an energy giant. This was contrary to the energy-dependent brand we arguably earned in the late 20th century. A simple, objective analysis reveals that the United States has the greatest abundance of available energy in the world. The chart below illustrates the actual energy reserves of the United States in 2009, dominated by its huge coal deposits.

Figure 1: 2009 total proved reserves expressed in billions of barrels of oil equivalent (BBOE).



	Coal	Gas	Oil	Total
Kazakhstan	119.0	17.7	30.0	**166.7**
Qatar	0	160.4	15.2	**175.6**
Canada	25.2	10.3	178.6	**214.1**
India	214.9	6.7	5.6	**227.2**
Australia	293.6	5.5	1.6	**300.7**
Iran	5.2	168.0	138.4	**311.6**
Saudi Arabia	0	44.8	266.8	**311.4**
China	435.4	14.2	16.0	**465.6**
Russia	597.2	297.7	60.0	**954.9**
United States	906.3	43.4	28.4	**978.1**

Source: Energy, Present and Future (Tulsa, OK: Strategic Energy Resources, 2010).

Ironically, in 2009 we were still underestimating our natural resources. Recent assessments of both proved and probable oil and gas reserves in the United States rival those of Mideast nations. For instance, not included in Figure 1 is the giant Bakken field in the north central U.S., which some estimate a total that more than doubles previous U.S. proved reserves. And when the oil reserves of Canada and Mexico are included, the numbers get larger. Natural gas has also experienced profound upward revisions as shale gas and coal bed methane formations add many trillions of cubic feet of proved reserves. On a BTU-equivalency basis, the U.S. energy endowments of economically recoverable fossil fuels are adequate for centuries.[2]

The Current Reality of Oil

Petroleum has been the primary source for transportation fuel for most of the past century – the century of the greatest amount of human material progress and advancement of civilization. It will be increasingly used as a transportation fuel for upcoming generations as other emerging economies become more advanced and mobile.[3]

This is not by accident. Petroleum has the most convenient molecular structure for energy storage – the hydrocarbon molecule.[4] And what is not

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[2] Consider the remaining probable, but "unproved" reserves that underlie the Arctic Coastal Plain; the outer continental shelf of Atlantic, Pacific, and Gulf of Mexico; remaining tight oil sands and shale; massive oil shale reserves in western states; and oil remaining in mature fields that can be recovered through enhanced oil recovery. See *U.S. Crude and Natural Gas Proved Reserves*, U.S. Energy Information Administration (Washington, DC: 2013). Available online at: [www.eia.gov/naturalgas/crudeoilreserves/?src=Petroleum-f6].

[3] *International Energy Outlook 2013*, U.S. Energy Information Administration, Transportation Sector Energy Consumption (Washington, DC: 2013). Available online at: [www.eia.gov/forecasts/ieo/ transportation.cfm].

[4] The terms "oil and gas," "petroleum," and "hydrocarbons" are used almost interchangeably. Author Daniel Yergin explains: "By generally accepted theory, crude oil is the residue of organic waste…that accumulated at the bottom of oceans, lakes, and coastal areas. Over millions of years, this organic matter, rich in carbon and hydrogen atoms, was collected beneath succeeding levels of sediments. Pressure and underground heat 'cooked' the plant matter, converting it into hydrocarbons – oil and gas." Yergin, *The Prize: The Epic Quest for Oil, Money and Power*, (New York, NY: Free Press, 1991), 795. Cited hereafter as: Yergin, *The Prize*.

used as a source of fuel is used for many other industrial purposes. Because of man's increasing understanding of petroleum chemistry, very little of petroleum goes to waste.

Not only has oil provided the fuel for planes, trains, automobiles and ships, but oil also provides the petrochemical substance for other inventions that have radically changed the way we live. Oil (and gas) gives us innumerable plastics and synthetics that have made our lives better. In health care alone, these materials are used to make the doctor's latex gloves, the nurse's polyethylene syringe, and the patient's polyvinyl IV bag. When we are finished extracting all the useful materials out of crude oil, we take the sticky remainder, mix it with sand and gravel and make roads out of it.

It is an inescapable reality that today's modern form of transportation runs on liquid fuels such as gasoline or diesel that comes from petroleum. Alternative fuels are available and have been available for many decades. Perhaps man will unlock the secrets of economically producing bio-fuels as he pursues it with the same intensity as he has pursued petroleum refining for the past century or so. Several alternative fuels offer promise, such as certain algae extracts, or oils generated from canola, or switchgrass as we investigate digestive enzymes needed to break down its woody lignin. But until then, we use oil and gas – which is really algae, and canola, and switchgrass, and other organic materials that nature has converted for us.

The Future Of Alternatives

Ethanol. There are a few promising alternative energy sources for transportation that are emerging. One alternative is ethanol. Man has been making ethanol for much of recorded history, and drinking it, so the process is well known. It actually takes a considerable amount of energy to process grains and sugars in order to distill ethanol (or any alcohol). The limiting factors of large scale ethanol production continue to be the amount of land it takes to grow the ethanol feedstock (lots of acreage for corn, sugar cane, etc.), the amount of energy it takes to gather the feedstock (lots of tractors), and the energy consumed in processing the feedstock into ethanol (lots of boiling). So, does it make sense to put more energy into growing and processing the feedstock than the end product is worth? It does if you are making fine sour mash whiskey at $50 for a fifth of a gallon, but maybe not if you are supplementing the fuel in your gas tank.

Biodiesel. Another alternative fuel is biodiesel which is converted from waste oils and fats into long chain alkyl esters. Biodiesel has been used to

blend with conventional diesel fuels, but must be done in limited amounts in order to minimize negative effects on engine seals and filters.

Man's ingenuity continues to find ways to cut the energy costs of ethanol and biodiesel production, and reduce the problems encountered in engines designed for conventional fuels. But we must ask if biofuels will be cost effective without government imposed production quotas, tax incentives or subsidies. Someday, when oil costs enough, they might.

Natural Gas. Another alternative motor fuel is compressed natural gas. Natural gas is cleaner burning than gasoline or diesel, and one can refuel at home with the proper set up. This fuel has the advantage of being compatible with current combustion engine technology, and natural gas is consistently less than the price of gasoline or diesel (now at $2.00 per gallon equivalent). But since natural gas is a gas, it requires a different tank and injection mechanism into the engine. Also, being gas, it is less energy dense than a liquid, and it does not achieve the same range between refills. Because of necessary modifications, natural gas vehicles cost more unless offset with government incentives. Natural gas vehicles seem to be very well suited for short and mid-range fleet-vehicle niches that have predictable refueling locations, like a car that is mostly used for commuting to work or a fleet of utility trucks that are parked in a motor pool every evening.

Perhaps, over time, natural gas vehicles will establish product niches, much like diesel trucks have proven best for long haul and heavy transport. Then manufacturers can push costs down based on economies of scale and technological improvements instead of government incentives.

Electric Vehicles. Electric vehicles seem to follow the pattern of natural gas vehicles. They have also demonstrated increasing market viability with the development of new battery technologies (lithium cells) and composite materials enabling lighter vehicle weight. They can be refueled (recharged) at home with the proper set up. Also like natural gas vehicles, they have relatively short range and limited commercial refueling options. Of course, the cost of refueling depends on the local cost of electricity, which ironically is cheapest when generated by fossil fuel fired generators.

Energy Agility

Fischer-Tropsch and GTL, CTL and BTL.

It is another irony that the best alternative to hydrocarbon based liquid fuels may be more hydrocarbon based liquid fuels—fuels that are synthesized from coal and gas. This alternative is often referred to as gas-to-liquids, coal-to-liquids, and biomass-to-liquids (GTL, CTL, BTL) and was first pioneered in the 1920s. The process converts the hydrocarbons into synthesized diesel or gasoline (or aviation fuel) using a process known as Fischer-Tropsch technology (F-T).[5]

F-T essentially takes coal or natural gas and breaks the molecules apart, then reassembles them into the right configuration for diesel, gasoline or jet fuel. With a significant amount of additional capital investment, it can do the same with biomass. The process is very complicated and the equipment is expensive, but no more so than an oil refinery. Like ethanol and biodiesel, the end product needs to be blended, but for different reasons. Of the three, gas-to-liquids is the easiest to achieve since the feedstock (natural gas) is already processed in the pipeline and ready to use, in fairly simple molecular form – pure methane.

The advantage of GTL is that it takes natural gas that is now abundant and cheap, and converts it into diesel or gasoline. It does not require you to buy a new car, or retrofit your house with a new refueling system, so consumers should love it. It does not require the automotive industry to re-tool, so Detroit should love it. It is as ultra-clean as natural gas, so environmentalists should love it.

Man must find an alternative to petroleum someday, but when? The answer is that the market will tell us. Market trends are simply a free people living in a free society interacting through a free market. This interaction is measured by the relative exchange price between petroleum and bio-derived

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[5] Fischer-Tropsch technology is named after Czech scientists Franz Fischer and Hanz Tropsch for their pioneering work in Germany to convert coal to liquid fuels in the 1920s and 1930s. The process breaks down a hydrocarbon feed stock, such as coal or natural gas, into CO and H_2, and then reforms these constituents into the desired hydrocarbon finished product ranges such as octane (gasoline) or cetane (diesel or aviation fuel). Colonel Hopper T. Smith, *Ace in the Hole: Fischer Tropsch Fuels and National Security*, (Washington, DC: National Defense University, 2010) 2-3. Cached online: [www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA526566].

(or other) fuels. So we'll change to some future alternative only when it is economically advantageous to do so, probably when the extraction costs of petroleum get much higher, or when we find the bacteria with the magic enzyme that ingests organic material and emits diesel at a competitive cost.

Necessities That Impact Electric Energy Generation

Electric energy generation is also a big issue when considering energy and the environment and many authors and experts have expressed a multitude of testimonies and opinions regarding how we generate electricity and the related environmental trade-offs. As we continue to grapple with how we generate electricity to power our homes, businesses and industry, we should consider some of the lessons to be learned and re-learned.

Solar is the ultimate energy source to harness. Nature has been doing that for millions of years, but our ability to do it efficiently is still very limited. Yes, it is true that the sun delivers more energy to the earth in one day than mankind can consume in a lifetime…and if only we could capture a small percentage of that energy, our electric generation needs would be met. And what could be cleaner than sunshine? A clean breeze, maybe. Wind is really sunshine too, or rather it is the effect of the sun as it warms part of the earth's atmosphere and hydrosphere causing it to expand (or evaporate) and move. Neither are concentrated, they are diffused. So we construct large gathering devices to collect energy from a windy ridgeline or a blistering hot desert basin and pipe it via miles of wire and cable to the electric grid and back to population centers where it can be used.

So far, wind and solar have promised the most and delivered the least. We continue to improve the energy gathering efficiency of wind turbines and solar panels. Yet even with these improved efficiencies, ratepayers are finding out that free sunshine and wind are not so cheap without government incentives. Why is this so?

Wind and solar are diffused forms of energy, and must be gathered and concentrated. As an example: In Oregon the Biglow Canyon Wind Generation Farm has been built. So has the Hermiston Natural Gas Power Plant. Both have the same generation capacity, about 450 megawatts, but their size differs:[6]

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[6] See site certificates at Oregon Department of Energy website: [www.oregon.gov/energy/Siting/Pages/HPP.aspx]

Biglow Canyon Wind Farm	250-450 megawatts (depends on wind)	25,000 acres
Hermiston Power Plant (Natural Gas)	472 megawatts (upgrading to 547 Mw)	17 acres

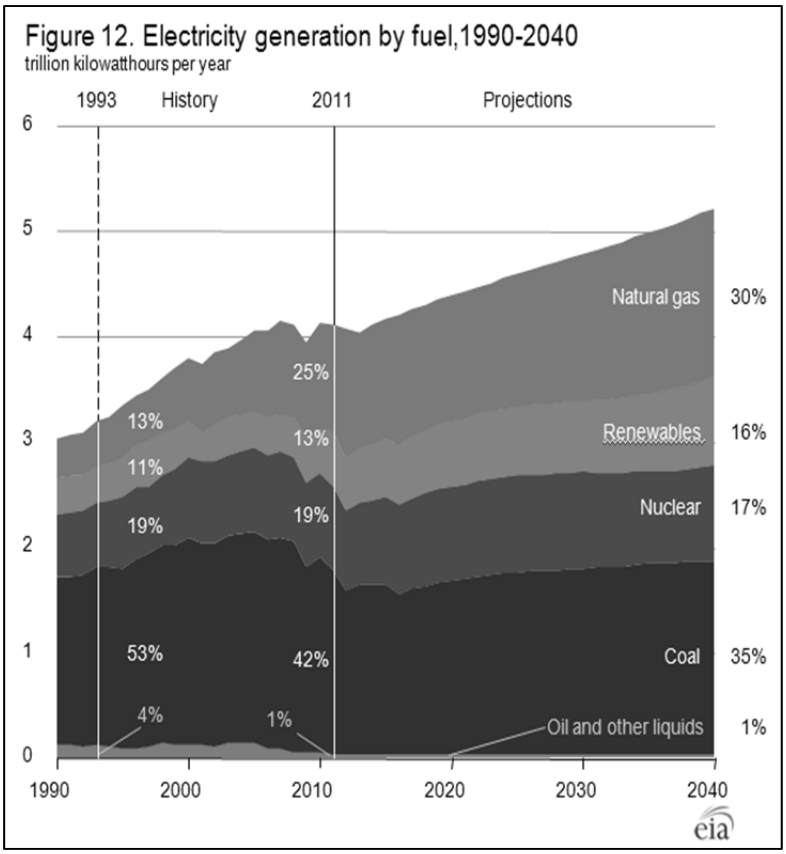
On windy or sunny days a lot of energy can be collected, but on still nights, not so much. Utility managers must constantly balance energy supply to meet energy demand. The fluctuations characteristic of wind and solar can create additional load balancing problems for a reliable electric energy grid. True, gas turbine generators can be kept in hot spinning reserve on the same grid to cover gaps in wind or solar generation, but then what savings or efficiencies have we really gained when duplicate generation capacity must be built to achieve necessary reliability? So, the ratepayers are paying for redundant generation capacity.

Would it not be nice if we had prepackaged chunks of concentrated solar energy available to use at our own convenience? And would it not be even nicer if we had these prepackages in solid, liquid and gaseous forms so we could use them for different energy purposes? Oh wait. We do. It is coal, oil and natural gas. These substances are in essence, stored solar energy. They are the result of plants soaking up a small percentage of solar energy over the surface of the planet and storing it, over millions of years, buried and transformed into hydrocarbon molecules.

Are hydrocarbons dirty? Actually, natural gas is comparatively clean. When pure methane burns it only creates water and carbon dioxide (CO_2), both of which plants need. Some say that CO_2 is a pollutant. But is the CO_2 exhaled by animals and emitted by decaying plant matter a pollutant? Yes, coal and oil are dirty due to impurities that typically accompany them in their natural state. As man has learned about these pollutants, he has adjusted how he utilizes these packages of stored solar energy and finds uses for the waste material which have become quite useful as herbicides, building materials, clothing fibers, and countless other byproducts.

Even considering the recent efforts to transition to cleaner electricity generation that we call “renewables,” coal generates the heaviest load and will for decades to come. In terms of BTUs, a cubic foot of coal beats a cubic foot of sunshine every time. The only thing that beats coal is its big brother, uranium.

Figure 2: U.S. Electric Energy Generation by Fuel through year 2040



Source: U.S. Energy Information Agency

A Word About Nuclear Power

Nuclear energy remains the cleanest and most efficient means of electric power generation available. It is also regarded by many as the most dangerous. But an objective analysis of nuclear power reveals that in terms of environmental impact, and safety to workers and the public, nuclear power has a superior record. The well-publicized Fukushima nuclear incident in 2011 provides a good example.

Approximately 18,500 people died due to the famous earthquake and tsunami in Japan in 2011, but despite fears of radiation contamination, there have been no acute radiation syndrome fatalities reported due to the Fukushima accident. Future cancer deaths from accumulated radiation exposures in the population living near Fukushima are predicted to be extremely low to none.[7]

The tsunami was of such magnitude that most infrastructure in the area was damaged. The Fukushima nuclear plant was a very early design that had not been refurbished or updated so consequently, it was vulnerable to total power failure. Today, many generations of experience with nuclear power generation has enabled the evolution of Generation III nuclear reactor technology. This technology incorporates improvements in design including fuel technology, better thermal efficiency, passive safety systems (fail safe, i.e., no "melt-down"), and standardized designs that reduce maintenance and capital costs.

Future reserves of nuclear fuel are extensive. Estimated world reserves of economically recoverable nuclear fuel – including uranium and thorium – for conventional nuclear plants vary, but are sufficient at current usage rates for at least several hundred years and perhaps considerably longer.

Critics of nuclear power have cited potential problems with radioactivity from waste material, but there is very little true "waste." Used fuel can be sequestered by safely storing below ground, and a cover of three feet of water absorbs the radiation. All the waste produced so far in the U.S. would only cover a football field about five yards deep. The used fuel can ultimately be reprocessed and incorporated into usable nuclear fuel.

Current policy within Europe regarding new nuclear plants is varied. Great Britain, Poland, and Finland are actively pursuing new nuclear plants. The Netherlands, Lithuania, the Czech Republic, Slovakia, Romania, and Bulgaria have facilities planned, but some are on hold. France and Germany have retreated from plans for construction of new nuclear facilities. Some European nations are pursuing nuclear power to reduce dependency upon coal and natural gas, particularly gas imported from Russia.

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[7] Brumfiel, Geoffrey (23 May 2012). "World Health Organization Weighs in on Fukushima."*Nature Journal*. Available online at: [blogs.nature.com/news/2012/05/world-health-organization-weighs-in-on-fukushima.html].

There is another source of nuclear energy beyond conventional reactors: the Fast Breeder Reactor (FBR). Conventional spent nuclear fuel can be reprocessed and used in FBR reactors (plutonium oxide mixed with uranium oxide). This second generation nuclear reactor technology would exponentially expand the power potential; i.e., the raw material supply would increase from several hundred years to tens of thousands of years. Thus nuclear power could be "stretched" by extending the first generation waste as a raw material for second generation fast reactors. Several challenges are presented by this method: these reactors would be more expensive than conventional reactors, and would produce a byproduct waste that is more easily processed into nuclear weapons-grade material. However, adequate security measures for the safeguard of weapons-grade material have been developed and in practice at U.S. military facilities across the country for over half a century.

Many nations have constructed and operated experimental FBRs, including the U.S., India, France, the U.K., Russia and Japan. It should be expected that as conventional fossil fuels reach peaks in the next 50 years, and economical reserves of uranium and thorium peak, that some nations will – no matter the objections of other nations – endeavor to develop and build fast reactors in order to provide electrical power generation. They may do this if they have no other energy alternatives. It would be good international policy for nations to share technology with each other to ensure safe and reliable reactors and methods for secure sequestering of used fuel, including ensuring non-proliferation to terrorists.

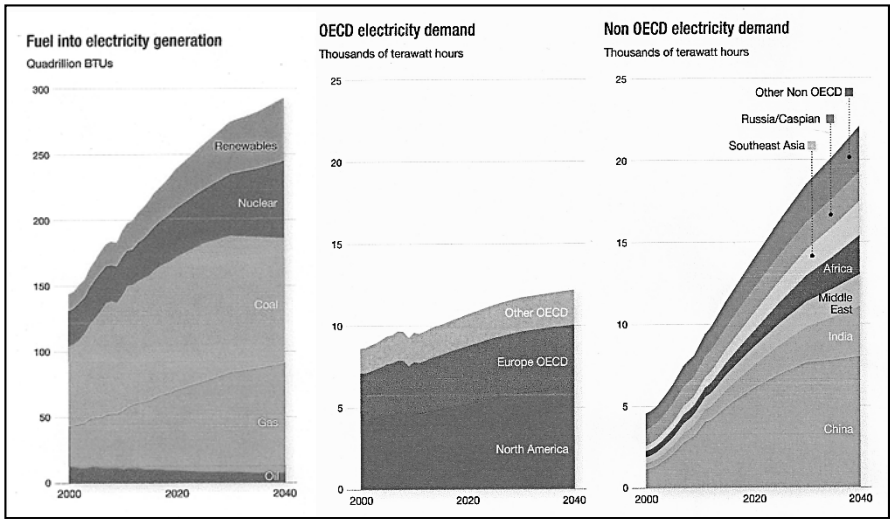
What the Emerging Industrial Powers Are Doing

While U.S. and European nations might be trending away from using coal and nuclear power for generation of electricity, the other emerging nations are not. They may not be quite as convinced of the hazards of CO_2 emissions, or they just may not care about warming it up a few degrees. But they do care about having access to energy to power their growing industries, and they intend to use coal, natural gas and nuclear power to do it.

While we shy away from permitting new coal fired plants, or developing new generation nuclear power capacity, China, India and other emerging economic powers are under no such restrictions. Within the next 3 decades, global demand for electric power will grow by 85%, or 4 times the

total that the U.S. uses.[8] This rapid growth is being driven by non-western economies (non-OECD nations).

Figure 3: Global Electric Energy Generation through Year 2040.



Source: ExxonMobil Energy Outlook 2013

Climate

The Anthropogenic Global Warming theory (AGW, i.e., "manmade global warming") consists of three elements:

1. Global warming is occurring;
2. An increase in atmospheric carbon dioxide from humans burning fossil fuels is the principal cause;
3. The resulting global warming will cause great harm.

In order for the AGW theory to be valid, all three elements must be true.

Proponents believe the above AGW theory is valid, while *skeptics* argue that climate variations are predominantly driven by natural forces, and

[8] *ExxonMobil Energy Outlook 2013*, 29-30 (ExxonMobil Corp: Irving, TX, 2013). Available online: [www.exxonmobil.com/ Corporate/files/news_pub_eo.pdf].

that the effects of CO_2 added to the atmosphere are not significantly harmful, and could even be beneficial.

From 1978 to 1998 there were twenty years of global warming along with a steady increase in atmospheric CO_2. This correlation was proclaimed by proponents as definitive proof of AGW. Then the warming stopped. For this, they have no adequate explanation. Kevin Trenberth, head of the Climate Analysis Section at the National Center for Atmospheric Research and lead author of many IPCC assessment reports, in an email to Michael Mann (author of the discredited "Hockey Stick") admitted:

> The fact is that we can't account for the lack of warming at the moment and it is a travesty that we can't. The CERES data published in the August BAMS 09 supplement on 2008 shows there should be even more warming: but the data are surely wrong. Our observing system is inadequate.

Trenberth had earlier commented on how many cold records were being broken. Since that email another four years of no warming have passed and AGW proponents still have no answers.

When scientists differ on an issue such as climate change, how can we know which opinions are valid, i.e., whom can we believe? How do we *know* that we know what we "know?" The answer lies in recognizing how science advances. Science advances by following the Scientific Method.

The Scientific Method employs empiricism, the principle of utilizing *observed* events as scientific evidence. Empirical evidence includes careful records of events that have occurred, and accurate data from repeatable experiments. Empiricism is based upon things that have happened. We learn how things work by observing them in action. Theory must be supported by observed events.

Empirical evidence *does not include* opinions, surveys, consensus, appeal to authoritative sources, forecasts, model predictions, unconfirmed theories, or speculation.

Empirical evidence requires careful records of events, and that implies consideration of a full dataset, not just a selected part of it. The "endpoint fallacy" results from arbitrarily choosing the start and end of a stochastic dataset, so that any desired trend can be demonstrated. One can do this with the stock market. The endpoint fallacy is popularly called "cherry-picking" data, where parts of a dataset are extracted while ignoring the rest. An

example of cherry-picking data is the utilization of only global temperature data from 1978 through 1998 to establish a correlation with rising atmospheric carbon dioxide, while ignoring what happened before and after. This example has been widely practiced in previous years as "proof" of AGW.

A majority opinion, even of scientists, is not a tenet of the Scientific Method because in the end, it is just opinion, and not empirical evidence. Recall that several hundred years ago the majority of physicians believed that bleeding a sick person could make them well. As recently as the 1960's, the theory of continental movement by geologic plate tectonics was rejected by most all university geology professors while a decade later it had become the official doctrine. In both cases, the original consensus of opinion was wrong. Majority opinion has never been consistent with the Scientific Method.

Nevertheless, the claim that the vast majority of scientists support AGW is unsupported by fact. Truly objective opinion surveys can be tricky because it is easy to craft questions to favor a desired bias. Most climate surveys are flawed and have been discredited. The best attempt has been by Dennis Bray and Hans von Storch, done several times, most recently in 2010. Those results were far from conclusive and more than anything else revealed the extent to which scientists are divided on the issue and their uncertainty about the reliability of data in support of AGW. But even if the majority of scientists in this survey had supported AGW it would only reflect their opinions, and opinion is not a tenet of the Scientific Method.

Neither is the notion of "settled science" consistent with scientific practice. Science is never settled, but constantly evolves, and with new discoveries the body of knowledge is revised accordingly.

Principal arguments supporting AGW

Principal arguments advanced in support of the Anthropogenic Global Warming (AGW) theory include the following:

1. CO_2 is a greenhouse gas and its increase causes global warming. This is proven by the strong correlation between the rise of global temperature along with that of atmospheric carbon dioxide.
2. Global climate models demonstrate credible evidence of AGW.
3. AGW has caused glaciers to melt and has decreased global ice volume.
4. AGW produces extremes in weather events.

5. The IPCC is the world's authoritative source on climate change, and their reports declare that most of the rise in global average temperature since the mid-20th century was "very likely" caused by human-generated greenhouse gas emissions.

Each of these arguments will be considered and examined based upon empirical evidence.

1. CO_2 is a greenhouse gas and its increase causes global warming. This is proven by the strong correlation between the rise of global temperature along with that of atmospheric carbon dioxide.

We often hear the phrase "heat-trapping greenhouse gases," (always referring only to carbon dioxide.) But greenhouse gases do not "trap" heat and CO_2 is not the only greenhouse gas, not even the most powerful one. In fact, many who make such quotes apparently have little understanding about greenhouse gases and how the Greenhouse Effect (GHE) works.

We human beings owe our existence to the phenomenon of the GHE. If it were not for the GHE the earth's surface would be 33 degrees Celsius colder, i.e., frozen. By retaining some of the sun's radiation energy in the atmosphere, the GHE raises the earth's temperature to a habitable range of around 15C.

Here's how it works. The sun's radiation is mostly in the ultraviolet range because of the sun's higher temperature. Some of this shortwave radiation is reflected back out to space, some is filtered out by the ozone layer, and some reaches the earth, warming the surface. The warmed earth re-radiates energy back upwards at a longer wavelength (because of the earth's lower relative temperature) and some of this radiation is absorbed by the earth's greenhouse gases in the lower atmosphere (troposphere). The absorption of some of the radiation by greenhouse gases causes them to warm, and they then re-radiate this energy, some out to space and some back to the earth. The GHE – a warming of the troposphere – is caused by this radiation absorption, warming, and re-radiation process by greenhouse gases.

The predominant greenhouse gases are water vapor, clouds, and CO_2. Water vapor (humidity) is responsible for about 85-90% of the GHE, clouds 7-10%, CO_2 3-5%, and other greenhouse gases less than 1%. Greenhouse gases only absorb radiation energy in certain wavelengths, not the entire spectrum. Otherwise no radiation would get through directly to earth. The reason water vapor dominates as a greenhouse gas is because it absorbs

radiation over a very wide span of the radiation spectrum, while CO_2 only absorbs in several relatively narrow bands. In most of earth's climate, CO_2 has little chance to act as a greenhouse gas because water vapor has already done so, i.e., the CO_2 makes little difference because water vapor is already doing the job. Also, those CO_2 absorptive bands correspond to radiation that is emitted at temperatures that are outside the normal temperatures found on earth, i.e., there isn't a great deal of radiation coming from very hot and very cold temperatures that are rarely created on earth. Consequently, CO_2 is only highly active as a greenhouse gas in places that are very cold, very high, and very dry.[9]

If the average net outbound radiation is equal to the incoming energy from the sun, then the radiation energy budget is balanced and the earth is neither warming nor cooling. Experimental evidence from the Earth Radiation Budget Experiment (ERBE)[10] and sea surface temperatures[11] shows that there is no net warming or cooling, i.e., the earth's energy budget is stable and there is no global warming from the GHE. This empirical evidence is ignored by AGW proponents.

In order for global warming from any greenhouse gas to occur, there must be an enhancement of the Greenhouse Effect, i.e., an increased warming in the troposphere. Climate scientists agree that this effect would be most pronounced in the tropical latitudes. Such an effect was predicted by modeling, and illustrated in the 2007 IPCC Fourth Assessment Report shown in Figure 3, left image. But 10 years of radiosonde (balloon) measurements have proven this prediction to be false, as illustrated in the right image in Figure 3. This empirical evidence showing there is no enhanced Greenhouse Effect from CO_2 (or any other greenhouse gas) has been ignored by AGW proponents.

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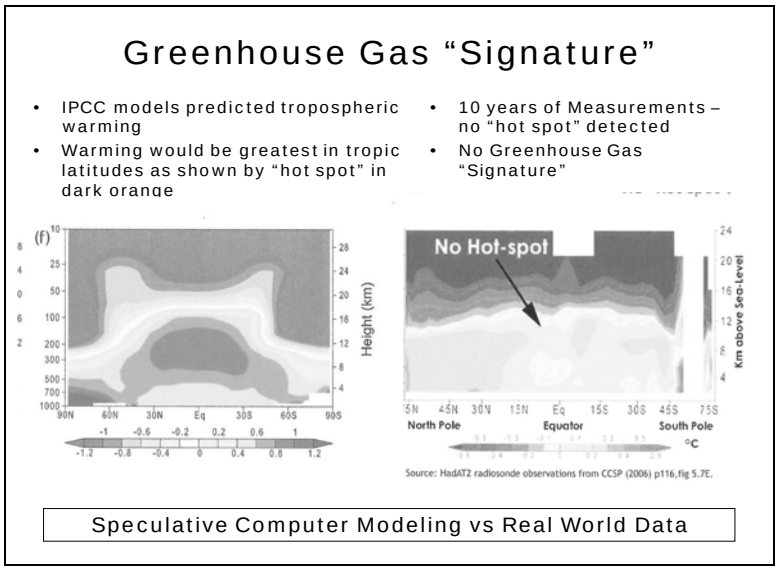
[9] Caryl, Ed, 2012, "Analyzing the Earth's Heat Radiation Using MODTRAN."

[10] Lindzen, R., and Choi, Y., 2009, "On the determination of climate feedbacks from ERBE data."

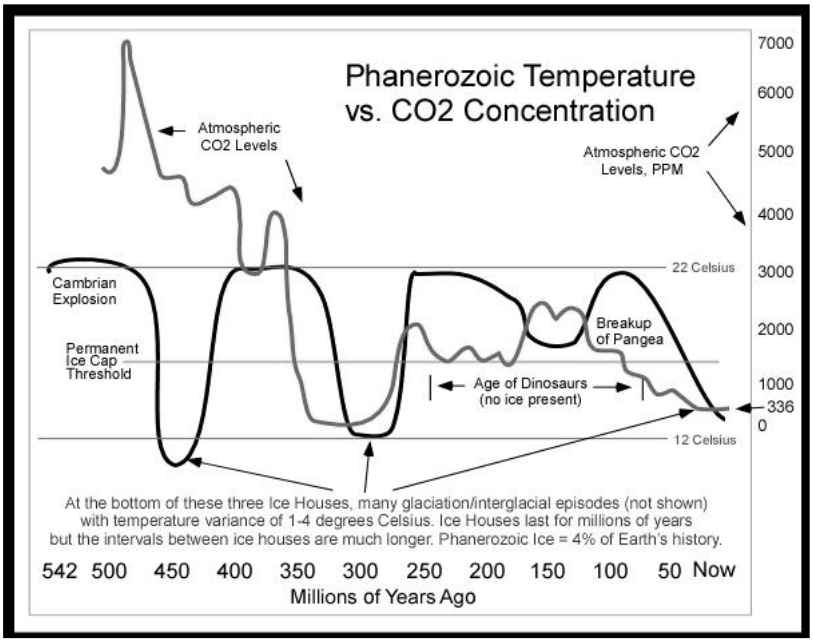
[11] Douglass, D.H., Christy, J.R. , Pearson, B.D. and Singer, S.F. 2007. "A comparison of tropical temperature trends with model predictions." *International Journal of Climatology (Royal Meteorological Society).* DOI:10.1002/joc.1651.

Figure 3: Left hand image illustrates model output predicting a greenhouse effect hotspot "signature" from atmospheric CO2, as displayed in the IPCC 2007 Fourth Assessment Report. Right hand image illustrates data from radiosonde measurements showing no hotspot.



Finally, there is no historical evidence that carbon dioxide has ever been a significant driver of global temperature. This is demonstrated in Figures 4 and 5. Figure 4 shows the long term temperature and carbon dioxide concentration profiles over the 500 million year history of the Phanerozoic Eon. During this period global temperatures were usually much higher than currently and carbon dioxide was as high as 17 times today's levels. It can be seen that there is no correlation demonstrated between CO_2 and global temperature. Note that for over 200 million years, during the Age of the Dinosaurs, the earth was so warm there was no polar ice whatsoever. Despite much higher CO_2 and temperature during most of the Phanerozoic Eon, the earth's plants and animals proliferated and actively evolved from the Cambrian Explosion to today.

Figure 4. CO_2 and Temperature During the Phanerozoic Eon.

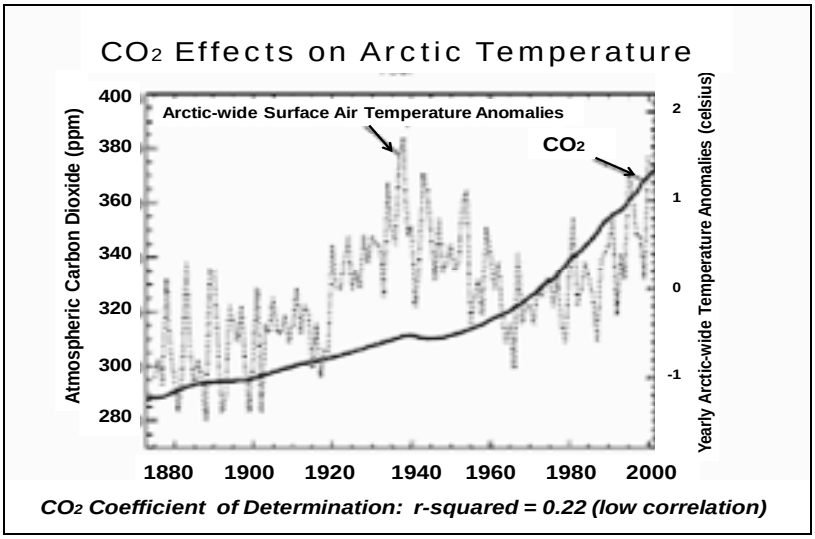


Source: www.geocraft.com carboniferous climate (Monte Hieb). Temperature after Christopher Scotese, CO_2 after R. A. Berner, 2001.

Carbon dioxide and temperature are not highly correlated in more recent history of the earth either. In Figures 5a and 5b, the arctic-wide temperature time series for the years 1880 through 2000 are shown for both carbon dioxide and total solar irradiance. Arctic temperatures are presented because although both arctic and global tracks follow the same trends, arctic temperature changes are more pronounced than global temperatures, permitting a better visual contrast and more definitive correlation coefficient analysis. As shown, for arctic-wide temperatures solar effect is highly correlated while CO_2 is poorly correlated. "It has been claimed that CO2-induced global warming should be expressed most strongly in the Arctic, and its effects therefore should be evident there before anywhere else, making the Arctic the "canary in the coal mine" for those concerned about dangerous global warming."[12]

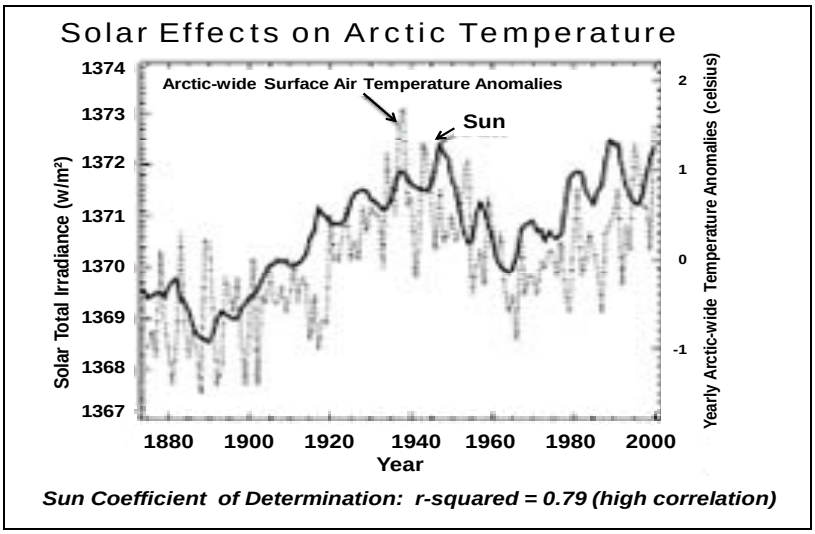
[12] Climate Change Reconsidered II. 2013, p. 661. Available online at: [http://climatechangereconsidered.org/].

Figure 5a: Arctic basin-wide air temperatures (Polyokov) correlated with annual average CO_2



Source: (Soon, 2005).

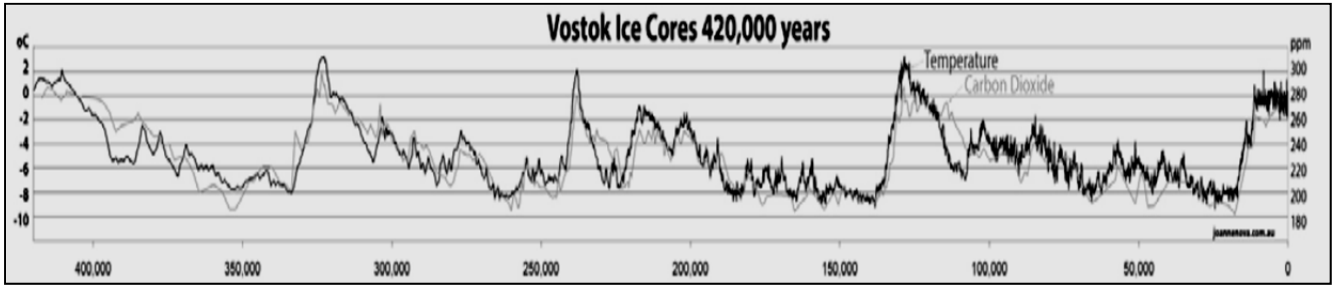
Figure 5b: Arctic basin-wide air temperatures (Polyokov) correlated with Hoyt and Schatten Total Solar Irradiance (TSI).



Also, a comparison of global temperatures versus TSI and CO2 has been done by Soon, W. and Legates, D.R. 2013. "Solar irradiance modulation of Equator-to-Pole (Arctic) temperature gradients: Empirical evidence for climate variation on multi-decadal timescales." *Journal of Atmospheric and Solar-Terrestrial Physics* **93**: 45–56. The 2013 comparison also showed a similar close correlation between TSI and global temperature, and a weak correlation between CO_2 and global temperature.

Over the past 600,000 years, a strong correlation between global temperature and carbon dioxide has been demonstrated based upon analysis of ice cores from Antarctica and Greenland. But despite the correlation, carbon dioxide changes lag temperature by some 800-1000 years, indicating that temperature is the driver and CO_2 concentration is a response to temperature change, not the reverse as AGW proponents have claimed.

Figure 6: Temperature and CO2 levels detail for 420,000 years ago from the Vostock ice core.



Source: (Petit et al., 1999; Fischer et al., 1999; Monnin et al., 2001; Caillon et al., 2003. From Joanne Nova, 2013, http://joannenova.com.au/globalwarming-2/ice-core-graph/.

This is to be expected, because CO_2 solubility in water decreases as temperature rises, so that as global temperatures increase more CO_2 is released from the oceans, and as temperatures fall more CO_2 is absorbed. The 800-year lag response of CO_2 reflects the time required for absorption and release from deep ocean layers following global temperature changes.

Conclusion: despite claims to the contrary, there is no empirical evidence that atmospheric carbon dioxide is a significant driver of global temperature. Conversely, there is an abundance of evidence that natural effects (solar, ocean dynamics, orbital cycles, and continental positioning) are the predominant global temperature forcing mechanisms.

2. Global Climate Models Demonstrate Credible Evidence Of AGW.

Untold hundreds of millions of dollars of grant and research funds have been spent planning, designing, programming, running, and analyzing computer driven climate models. These models seek to incorporate dynamics of physical processes in order to predict future outcomes of climate. The inherent problem in this endeavor is that the physical processes of climate and their interrelationships are too poorly understood and too complex to enable accurate mathematical construction for a global scope and extended time duration. And in the event these processes were understood and mathematically modeled, even the fastest computers would be unable to process these interrelated processes in any satisfactory timeframe.

Global Climate Models (GCMs) have evolved from Atmospheric General Circulation Models (AGCMs) widely used for daily weather prediction. In essence a GCM is a conventional weather AGCM that is scaled up to include other climate factors (oceans, soil moisture, vegetation, surface ice, convection, clouds, etc.) to the degree it is possible to understand and incorporate their effects.

In order to be able to produce computer model output, relevant processes that are not well understood must either be estimated or ignored. Simplifying assumptions must be made to compensate for lack of understanding. Consequently, the models do not accurately characterize the real world, or are so limited in scope to be next to useless. In most cases, models are successively “tuned” to produce a desired result, and the output simply reflects the bias of the designer. As one commenter observed, “data is tortured until it confesses.”

There has been a tendency of AGW proponents to ascribe certainty to model predictions, as though the models were themselves reality. Scientific modelers themselves have been the worst offenders. "Scientists working in fields characterized by complexity and uncertainty are apt to confuse the output of models—which are nothing more than a statement of how the modeler believes a part of the world works—with real-world trends and forecasts."[13]

Nevertheless, the U.N. Intergovernmental Panel on Climate Change (IPCC) places great confidence in the ability of GCMs to simulate future climate and attributes observed climate change to anthropogenic emissions of greenhouse gases. It says, "…climate models are based on well-established physical principles and have been demonstrated to reproduce observed features of recent climate…and past climate changes." "There is considerable confidence that Atmosphere-Ocean General Circulation Models (AOGCMs) provide credible quantitative estimates of future climate change, particularly at continental and larger scales."[14]

The IPCC's stated confidence in the models, however, is not matched by their success. The magnitude of the range of projected temperature responses to a doubling of atmospheric CO2 itself suggests there are large errors and limitations in the models that must be overcome. In other words, if the IPCC is as confident in the models as they say, why are the ranges in model predictions so large and why have global temperature predictions from previous Assessment Reports been so wrong?[15]

Computer models can be "tweaked" to reconstruct climate histories after the fact. But this provides no assurance that the new model will do a better job of forecasting future climates, and it points to how unreliable the models are. Individual climate models often have widely differing assumptions about basic climate mechanisms but are then "tweaked" to produce similar forecasts. This may give an aura of credibility to the

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[13] Bryson, R.A. 1993. Environment, environmentalists, and global change: A skeptic's evaluation. *New Literary History* 24: 783–795.

[14] IPCC, 2007-I, p. 591.

[15] Green, K.C., Armstrong, J.S., and Soon, W. 2009. Validity of climate change forecasting for public policy decision making. *International Journal of Forecasting* 25: 826–832.

uninformed, but many scientists have observed that is nothing like how real scientific forecasting is done.[16]

One of the world's most eminent physicists, Professor Freeman Dyson, professor of physics at the Institute for Advanced Study at Princeton University has said the models used to justify global warming alarmism are "full of fudge factors." Dyson has also commented, "I have studied the climate models and I know what they can do. The models solve the equations of fluid dynamics, and they do a very good job of describing the fluid motions of the atmosphere and the oceans. They do a very poor job of describing the clouds, the dust, the chemistry, and the biology of fields and farms and forests. They do not begin to describe the real world that we live in."[17]

3. AGW Has Caused Glaciers To Melt And Has Decreased Global Ice Volume.

It is often stated by AGW proponents that arctic ice and glaciers are melting as evidence that the earth is warming at an unprecedented rate. The 2007 IPCC Fourth Assessment Report declared that Himalayan Glaciers would be melted by 2035, a claim that turned out to be poorly sourced and entirely false. The IPCC later retracted the claim.

The authors of the 2009 report of the Nongovernmental International Panel on Climate Change (NIPCC) and its 2011 interim report contended many of the IPCC's findings on this subject were incorrect, resulting from the inappropriate use of circumstantial evidence, cherry-picking of data, or misrepresentation of available research. Specifically, Idso and Singer reported:[18]

> Glaciers around the world are continuously advancing and retreating, with a general pattern of retreat since the end of the Little Ice Age. There is no evidence of an increased rate of melting

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[16] Armstrong, J.S., Green, K.C., and Soon, W. 2011. "Research on forecasting for the global warming alarm." *Energy and Environment* 22: 1091–1104.

[17] Dyson, F., 2007. "Heretical thoughts about science and society," *Edge: The Third Culture*.

[18] Craig Idso and Fred Singer 2009. *Non-governmental International Panel on Climate Change*.

overall since CO2 levels rose above their pre-industrial levels, suggesting CO2 is not responsible for glaciers melting.

Sea ice area and extent have continued to increase around Antarctica over the past few decades. Evidence shows that much of the reported thinning of Arctic sea ice that occurred in the 1990s was a natural consequence of changes in ice dynamics caused by an atmospheric regime shift, of which there have been several in decades past and will likely be several in the decades to come, totally irrespective of past or future changes in the air's CO_2 content. The Arctic appears to have recovered from its 2007 decline.

By themselves such facts as melting glaciers and Arctic sea ice, while interesting, tell one nothing about causation. Any significant warming, whether anthropogenic or natural, will melt ice. To claim anthropogenic global warming (AGW) is occurring based on such information is to confuse the consequences of warming with its cause, constituting an error in logic. Similar arguments apply also to fluctuations in glacier mass, sea ice, precipitation, and sea level, all of which can be forced by many factors other than temperature change. It is entirely inappropriate to use this type of circumstantial evidence to claim allegedly dangerous human-caused warming is occurring.

Despite claims that AGW effects are melting arctic sea ice, major sea ice changes are not uncommon and not necessarily a result of global temperature increases. Usually, pulses of warm ocean water or changing wind directions play the main role. Local oceanographic and atmospheric conditions can cause a fast advance or retreat of sea ice, particularly along fringe areas. Longer term, the average extent of arctic sea ice fluctuates along with multidecadal warming and cooling cycles such as the Pacific Decadal Oscillation, the Atlantic Oscillation, and the Arctic Ocean Oscillation. 8,000 years ago, at the height of the Holocene Interglacial Optimum, global temperatures were up to 2.5 degrees Celsius warmer than today and the Arctic Ocean was probably ice free. Despite dramatic variations in Arctic sea ice that have occurred over many millennia from natural causes, fauna and flora, including polar bears, are adapted to deal with these variations.

Antarctica contains 90 percent of the world's ice. The average daily temperature at the South Pole is around -50 degrees Celsius. The main (east) Antarctic ice sheet has been cooling since the mid 1950s, and ice accumulation is increasing rather than decreasing. For at least the next several centuries the Antarctic ice mass will be stable, while during the

Medieval Warm Period shrinkage occurred to positions that have not been reached again.

Antarctica's ice sheet is expected to be stable for the remainder of the Holocene interglacial. First, global temperature has been in a cooling trend for some 8,000 years and all global temperature fluctuations are within the bounds of historic natural variation. Second, even if the warming that stopped 15-20 years ago resumed (not expected) that would enhance moisture, leading to increased snow and ice accumulation. Finally, sediment cores adjacent to Antarctica provide no evidence for breakup of the western Antarctic ice sheet (the area most susceptible to melting) during previous several interglacials that were even warmer than the Holocene.

Greenland contains 8% of the world's ice, so Greenland and Antarctica combined account for 98%. During the last glaciation 20,000 years ago, the Greenland massif was part of a much larger icecap covering virtually all the Arctic Ocean, most of which has now melted. Current temperatures (2000–2010) in Greenland have been exceeded on more than 70 occasions in the past 4,000 years, indicating recent warmth is not unprecedented and not caused by rising CO_2. Recent satellite geophysical measurements suggest Greenland, like Antarctica, is in a state of approximate mass balance.[19]

For the last thousand years glaciers have advanced and retreated multiple times synchronous with the Medieval Warm Period, Little Ice Age, and twentieth century warming. For most glaciers recent observed shrinkage started in the late nineteenth century, many decades before human related CO_2 emissions could have been a factor. Research on mountain glaciers worldwide has failed to provide evidence for unnatural glacial retreat forced by human carbon dioxide emissions. Glacial change is correlated instead with solar cycles and oceanic oscillations.

4. AGW Produces Extremes In Weather Events.

Following Hurricane Sandy, President Obama, New York Governor Cuomo, and Mayor Bloomberg all declared that hurricanes were becoming more frequent and more intense because of global warming. Yet this claim has no basis in fact. Prof. William Gray of Colorado State University's Department of Atmospheric Sciences, a pre-eminent authority on hurricanes stated:

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[19] Ibid.

> I think if you go to ask the last four or five directors of the national hurricane center – we all don't think this is human-induced global warming. And, the people that say that it is are usually those that know very little about hurricanes. I mean, there's almost an equation you can write the degree to which you believe global warming is causing major hurricanes to increase is inversely proportional to your knowledge about these storms.

For more than two decades the United Nations Intergovernmental Panel on Climate Change (IPCC) has supported the model-based narrative that carbon dioxide induced global warming will cause (or is already causing) extreme weather, including more frequent and more severe heat waves, precipitation extremes (droughts and floods), storms, tropical cyclones, and other extreme weather-related events.

However the most recent (2012) report from the IPCC on extreme weather takes a much more moderate tone, (Field *et al*., 2012) assigning only "low confidence" in observed changes in extreme weather events, neither implying nor excluding the possibility of extreme changes. The IPCC has apparently conceded that its previous claims in weather extremes lack supporting evidence.

The current assessment does not support the [*Fourth Assessment Report*] conclusions regarding global increasing trends in droughts but rather concludes that there is not enough evidence at present to suggest high confidence in observed trends in dryness. (Technical Summary, Second Order Draft of AR5, dated October 5, 2012, p. 61).

An increase in weather extremes because of global warming – whatever the cause of that warming – is both wrong in a theoretical sense and not supported by empirical evidence. Extreme weather includes droughts, rainstorms and flooding, hurricanes, and wildfires.

Key findings on the claim of extreme weather from AGW by Madhav Kandekar and Craig Idso are as follows:

- Air temperature variability *decreases* as mean air temperature rises, on all time scales.
- Therefore the claim that global warming will lead to more extremes of climate and weather, including of temperature itself, seems theoretically unsound; the claim is also unsupported by empirical evidence.

- Although specific regions have experienced significant changes in the intensity or number of extreme events over the twentieth century, for the globe as a whole no relationship exists between such events and global warming over the past 100 years.
- Observations from across the planet demonstrate droughts have not become more extreme or erratic in response to global warming. In most cases, the worst droughts in recorded meteorological history were much milder than droughts that occurred periodically during much colder times.
- There is little or no evidence that precipitation will become more variable and intense in a warming world; indeed, some observations show just the opposite.
- There has been no significant increase in either the frequency or intensity of stormy weather in the modern era.
- Despite the supposedly "unprecedented" warming of the twentieth century, there has been no increase in the intensity or frequency of tropical cyclones globally or in any of the specific ocean basins.
- The real-world data overwhelmingly support an opposite conclusion: Weather will more likely be less extreme in a warmer world. Climate Change Reconsidered II, Chapter 7, Extreme Weather, pp. 825-826.)

5. The IPCC Is The World's Authoritative Source On Climate Change, And Their Reports Declare That Most Of The Rise In Global Average Temperature Since The Mid-20th Century Was "Very Likely" Caused By Human-Generated Greenhouse Gas Emissions.

Before considering whether individual claims made by the IPCC are valid, it should be recognized that there are numerous substantial criticisms of the IPCC's stated mission, organization, and scientific credibility.

First, reliance upon the IPCC's statements *as an authoritative source of scientific fact* is not consistent with the Scientific Method. The Scientific Method is based upon empiricism. Empiricism does not include opinion, consensus, speculation, and certainly not overt bias, as indicated in the IPCC's mission statement.

Mission Statement of the IPCC: The role of the IPCC is to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change.

The words "human-induced" highlights the fact that the IPCC is an organization whose purpose is to blame human behavior for the perceived negative dynamics of climate. When only one source of causation is sought, i.e., human behavior, that is usually all one will find.

The IPCC holds itself to be objective in its conduct of scientific inquiry, yet numerous members of its staff have ties to environmental groups and are actively involved in working, writing, and speaking for them. Many of these environmental groups raise funds by hyping the alleged dangers of climate change. As pointed out by author Donna Laframboise, this raises a legitimate concern about their objectivity. Laframboise found that two-thirds of the chapters in the 2007 IPCC report included at least one individual with ties to the World Wildlife Federation.

Rajendra Pachauri has been the IPCC's chairman since 2002 and claims objectivity, yet is an outspoken supporter of emissions reductions, carbon taxes, and a frequent spokesman and writer for environmental groups and publications. Mr. Panchauri has maintained that an independent review of the IPCC found its work "solid and robust," yet that review in 2010 by a committee of the InterAcademy Council (a network of national science academies) identified "significant shortcomings in each major step of the IPCC's assessment process" and criticized the IPCC for claiming to have "high confidence in some statements for which there is little evidence."

The IPCC purports to base its conclusions on peer-reviewed scientific source material. Yet when challenged, the IPCC conceded that many of its sources were press releases, news clippings, discussion papers and unpublished papers, theses, and dissertations. The IPCC false claim that the Himalayan glaciers could disappear by 2035 was sourced from a World Wildlife Federation publication, and was only one of a number of embarrassing declarations that the organization was forced to retract.

In its assessment reports (ARs) over the past twenty years the IPCC has made predictions of global warming – based upon results of climate modeling – that have consistently overestimated what has happened. Actual measured temperatures have been below even the lowest boundary of the IPCC estimates. These IPCC predictions failed completely to anticipate the cessation of warming that began in the late 1990's, an occurrence that was anticipated by scientists who ascribe to the view that the sun's activity and ocean oscillations are the predominant climate forcing mechanisms.

All climate scientists agree that for anthropogenic global warming (AGW) to result – produced by an enhanced greenhouse effect from

additional greenhouse gases – that a "signature" warming must occur in the lower troposphere in the tropical latitudes. Based upon climate models, the IPCC predicted this global warming "signature" hotspot (as shown in Figure 4 from the 2007 IPCC Assessment Report.) This hotspot would be definitive evidence ("a fingerprint") of an enhanced greenhouse effect caused by increasing atmospheric CO_2 from human activities. Over ten years of radiosonde measurements (also illustrated in Figure 4) have demonstrated that the IPCC-predicted hotspot doesn't exist. No signature, no hotspot, no fingerprint.

In its latest assessment report, due out this year, the IPCC again will predict increasing global warming, although it has dialed back the extent of warming from levels forecast in its previous reports. Even though it has decreased its warming forecast, the IPCC has increased its likelihood from "very likely" to "extremely likely." No good definition exists for what these degrees of likelihood mean in a scientific sense.

Because of the problems with the IPCC's organization, mission, bias, and failure to adhere to good scientific procedures and rigor, the organization has suffered through deserved criticism. These problems have caused the IPCC to lose much of the credibility it once held. Skeptical scientists have recognized these deficiencies in the IPCC for many years. Now, because of the recurrence of negative issues and related negative publicity, e.g., "Climategate," the discredited "Hockeystick," the "Fakegate" scandal, etc., the public is becoming more aware of the IPCC's quality and credibility issues. And finally, there has been no satisfactory explanation of why the warming stopped 15-20 years ago.

If AGW Isn't Responsible for Major Climate Change, What Is?

Empirical evidence from hundreds of years to hundreds of millions of years clearly indicates major changes in the earth's climate, and that these changes predate any influence from human activities. Figure 5 shows the earth's temperature has been far warmer than today (around 22 degrees Celsius with no polar ice caps) for much of the Phanerozoic Eon.

The earth's temperature was far warmer than today some 250 million years ago (mya) during the Age of the Dinosaurs and remained so for some 150 million years. Around 100 mya, with the breakup of the supercontinent

Pangea, the earth began a steady cooling trend that proceeded until around 5 mya.[20]

This cooling trend is generally attributed to continental reorientation that caused changes in the oceanic currents resulting in restricted movement of heat by the oceans from the earth's tropical zones to its polar regions. For example 30 mya the Mediterranean was connected to the Indian Ocean and North and South America were unconnected. Later the Panama Isthmus rose up some 5 mya and shut off the flows between Pacific and Atlantic Oceans.

Since 3 mya the earth has been historically very cold and for the past 700,000 years a cyclic glacial pattern has persisted with long ice ages of 80,000-85,000 years followed by interglacial warm periods of 15,000-20,000 years (see Figure 6). We live in a warm interglacial period called the Holocene, and we are much nearer the end of this interglacial than the beginning.

The approximate 100,000 year periodicity of these ice age cycles has been attributed in the past to Milankovitch Cycles. These cycles of 100,000, 41,000, and 23,000 years are caused by regular variations in earth's orbit and tilt to the sun. But in recent years, evidence is increasing that while Milankovitch Cycles may play a part, changes in the earth's surface temperature are largely driven by variations in solar activity.

The earth's "albedo" is the fraction of incident energy that is reflected back out to space (approximately 29%). The principal variable factors that add to earth's albedo are ice and snow cover, and low cloud cover. Snow and ice cover exerts a positive feedback, i.e., more cold adds more ice, and more ice reflects more solar radiation, adding to the cold. Cloud formation exerts a negative feedback, i.e., colder air is drier air (less water vapor), reducing cloud creation, a lower albedo and more warming.[21]

It is well demonstrated that higher cosmic ray flux increases low cloud formation. Cosmic rays have the effect of inducing precipitation of water vapor into clouds. The increase in low clouds increases earth's albedo (more reflection of radiation) thereby producing a global cooling effect.

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[20]Marsh, Gerald E. 2010, "Interglacials, Milankovitch Cycles, and Carbon Dioxide," Argonne National Laboratory.

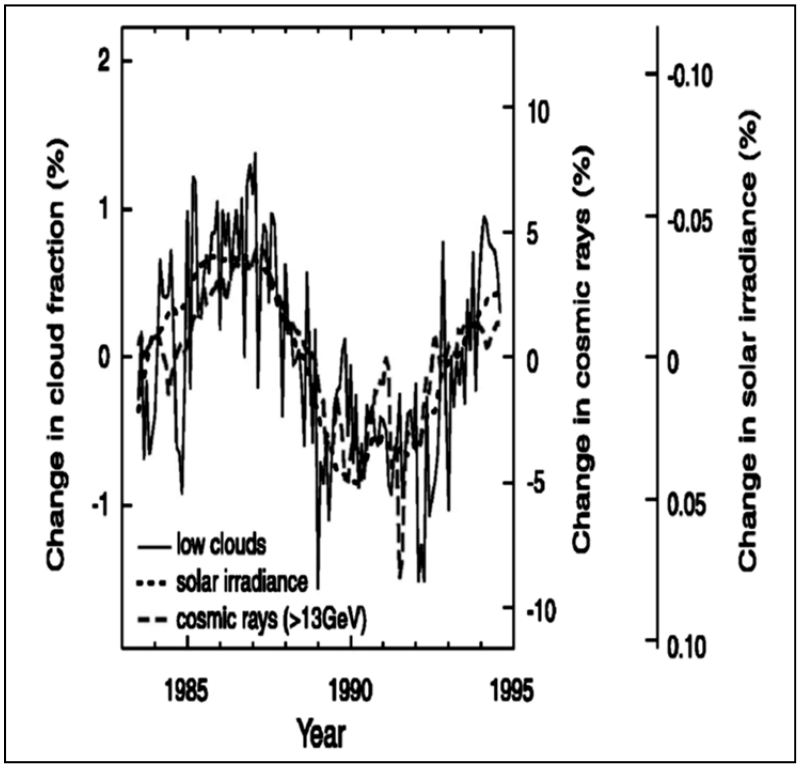
[21] Ibid.

The sun's activity has a powerful effect upon cosmic ray flux incident to the earth. As the sun becomes more active (evidenced by more sunspots and increased solar irradiance) its solar wind (emitted electromagnetic and energetic particles) increases, thereby magnifying the heliosphere's strength, which provides a protective shield to the earth from galactic cosmic rays. In contrast, a quiet sun becomes less energetic, its heliosphere is weaker, and more cosmic rays reach earth. As mentioned, a greater influx of cosmic rays induces more low cloud formation, thereby increasing earth's albedo, leading to global cooling.[22]

While the variation in total solar irradiance (TSI) is small on a percentage basis (around 0.1%) that small but measurable variation is a proxy for electromagnetic activity, the energy that produces the solar wind and the heliosphere. The relationship between solar irradiance, cosmic rays, and low clouds is shown in Fig 8.

[22] Sharma, M. 2002, Variations in solar magnetic activity during the last 200,000 years: is there a Sun-climate connection?" *Earth Planet. Sci. Lett. 199, 459-472.*

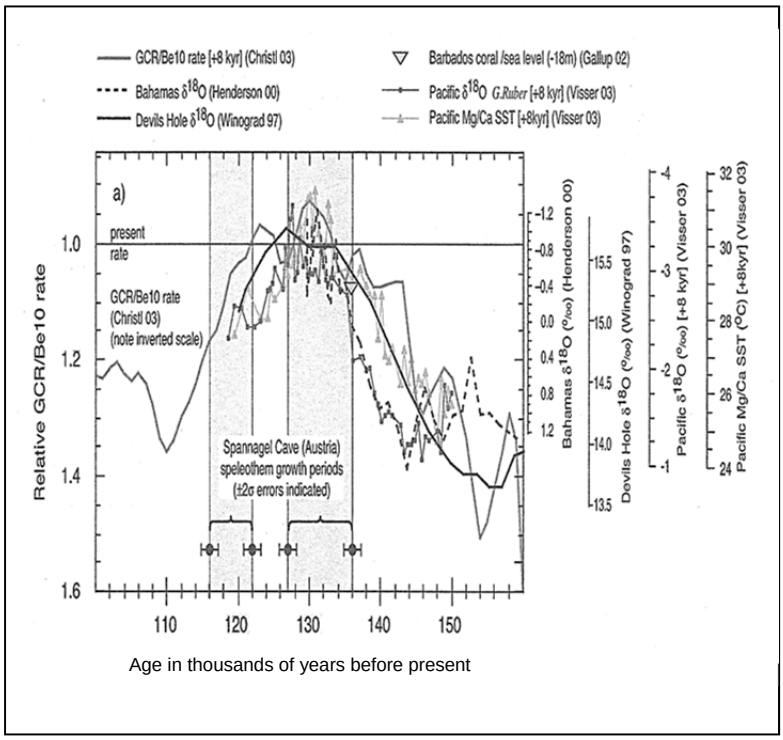
Fig. 8: Variations of low-altitude cloud cover (less than about 3 km), cosmic rays, and total solar irradiance between 1984 and 1994. Note the inverted scale for solar irradiance.



Source: K.S. Carslaw, R.G. Harrison, and J. Kirkby, Science **298**, 1732 (2002).

The cosmogenic radionuclides carbon 14 (^{14}C) and beryllium 10 (^{10}Be) from deep sea sediments can be measured to reconstruct Galactic Cosmic Ray (GCR) flux over many millennia. Using ^{10}Be data and TSI as a proxy for GCR, the inverse correlation between low clouds and GCR flux has been demonstrated over recent time (see Figure 8) Using analysis of the oxygen isotope ^{18}O and Mg/Ca ratios as proxies for ocean temperatures, and ^{10}Be for GCR, a correlation between GCR and global temperature from 120,000 to 150,000 years ago can be seen in Figure 9.

Fig. 9: Galactic Cosmic Ray Rate



The figure shows the corrected galactic cosmic ray (GCR) rate along with: the Bahamian $\delta^{18}O$ record; the date when the Barbados sea level was within 18 meters of its present value (Shown by the single inverted triangle at 136 kyr.); the $\delta^{18}O$ temperature record from the Devils Hole cave in Nevada; and the corrected Visser, et al measurements of the Indo-Pacific Ocean surface temperature and $\delta^{18}O$ records From J. Kirkby, A. Mangini, and R. A. Muller, "The Glacial Cycles and Cosmic Rays," CERN-PH-EP/2004-027 (18 June 2004).

It is important to note that while IPCC models have overestimated the role of human-related CO_2 forcing, the IPCC models do not incorporate important solar factors such as fluctuations in electromagnetic intensity. The IPCC fails completely to consider the importance of the demonstrated empirical relationship between solar activity, the ingress of galactic cosmic rays, the formation of low clouds, and global temperature.

Conclusion

In addition to its already massive fossil fuel endowments, the increases in natural gas, oil, and coal reserves made possible by horizontal drilling and hydrofracking can allow America to emerge as a global energy giant. These accessible energy sources give the U.S. a major advantage in economic competitiveness. To hobble the United States with needless and costly restrictions on energy use based upon a speculative theory that lacks convincing empirical evidence, would constitute a colossal national policy blunder.

America has the potential for stable and secure energy resources for many generations, perhaps even centuries. This advantage must not be squandered by misinformed and ill-advised policymakers.

There is abundant empirical evidence supporting climate change as being predominantly driven by natural forces – primarily from solar activity and ocean oscillations. There is also a great deal of empirical evidence refuting the theory of AGW as caused by an enhancement of the greenhouse effect from atmospheric CO_2. The effect of increased atmospheric carbon dioxide has been so small as to be indistinguishable against the larger forces of natural drivers.

When scientists differ on an issue, empirical evidence as prescribed by the Scientific Method should prevail, not speculation and inadequate climate models.