CC 11-19-19
Study Session #1

Energy & Green Building Standards Codes
(Reach Codes)

Written Communications

Cyrah Caburian

From: City of Cupertino Written Correspondence
Subject: FW: Council Agenda 11/19/19 Item 1 – Study Session Do Not Ban Natural Gas
Attachments: 22514hearingwitnesstestimonymoore.pdf; GE_FuelCells.pdf; CCUP Mayor 29 Natural Gas ban.pdf

From: Myron Crawford <Mcrawford@bergvc.com>
Sent: Thursday, November 14, 2019 9:49 PM
To: Steven Scharf <SScharf@cupertino.org>; Liang Chao <LiangChao@cupertino.org>; Rod Sinks <RSinks@cupertino.org>; Darcy Paul <DPaul@cupertino.org>; Jon Robert Willey <JWilley@cupertino.org>; City Clerk <CityClerk@cupertino.org>
Cc: kevinm@leewardfinancial.com
Subject: Council Agenda 11/19/19 Item 1 – Study Session Do Not Ban Natural Gas

BERG & BERG ENTERPRISES, INC.
10050 Bandley Drive
Cupertino, CA 95014-2188
Ph (408) 725-0700 Fax 408-703-2035
mcrawford@bergvc.com

11/14/19
Mayor & Council Members
City of Cupertino
10300 Torre Avenue
Cupertino, CA 95014
Ph 408-777-3308 3251 Fax 408-777-3333
sscharf@cupertino.org; liangchao@cupertino.org;rsinks@cupertino.org;dpaul@cupertino.org; jwilley@cupertino.org; cityclerk@cupertino.org kevinm@leewardfinancial.com

Dear Council Members & Mayor,

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Item 1 – Study Session

Subject: Do Not Ban Natural Gas

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2) **Using electricity versus natural gas to heat, cook and provide hot water is more expensive. Natural gas is typically half the price of electric heating. It's even more efficient and heats up homes faster on average.**

3) **The scientific community is not unified on what causes the earth to warm or GHG to increase. The global warming GHG alarmist are not well informed. Patrick Moore the original founder of Green Peace did extensive ice core studies and research and has shown that the world was hotter and had higher levels of CO2 previously than today and we had a subsequent ice age following that period. Industrial CO2 production could be insignificant versus the earth's natural cycles. We could in fact be near the beginning of another cooling phase. See "22514hearingwitnesstestimonymoore.pdf" attached. Patrick Moore's presentations can also be found on youtube** https://www.youtube.com/watch?v=TjlmFr4FMvI **among others.**

4) **Natural gas is an alternative and natural form of energy, which can be used to replace traditional fossil fuel (gasoline and diesel). Using natural gas will help reduce the amount of harmful emission released into the atmosphere. There are major advantages to gas cooking. Those include finer temperature control, quicker temperature response times, easy cleaning, and reliability when the power goes out. Ask anyone who watches the Food Network or who works at a restaurant whether they'd like to use a gas range or an electric range.**

5) **Jim Cowell, vice president of facilities for the California Institute of Technology (Caltech), which generates about 90 percent of its annual 120 gigawatt-hour power consumption on site, uses Bloom technology for about 21 percent of that electricity. (That's 3 MWs so far.) During the eight years Caltech has been using the servers, they've never been offline, he said. The university's new neuroscience research building, slated to open by 2020, will use 1 MW of Bloom's technology as its primary generation source. That will bring Caltech's installations up to 4 MW of capacity.**

6) **By banning natural gas you are precluding the fuel cell technology developed by Bloom Energy among others. What is the one thing you hear about during the PGE shut downs, we need to have smaller independent power grids. One place you can expect to see Bloom ramp up its sales outreach during 2019 is in microgrid installations — the company is positioning its technology as both a viable standalone option as well as something that can be integrated cost-effectively with solar and energy storage. And unlike many microgrids powered by renewables, Bloom's technology can help negate the need for a diesel backup generator, according to the company.**

   The GHG proposition: The company claims virtually no nitrogen oxide, sulfur oxide or particulate emissions. That doesn't address the methane leakage issue associated with natural gas production and distribution. But Bloom's argument is that its technology emits 60 percent less carbon dioxide than the typical baseload options available on the U.S. power grid. The company is also hard at work on a biogas clean-up module that will help Bloom servers use biogas produced by landfills, wastewater treatment plants and agricultural operations.

   Bloom's natural-gas-powered fuel cells can serve as a reliable primary power source for microgrids. And microgrids are finally seeing some commercial growth, after a long stay in pilot project purgatory.

7) **General Electric is also working on natural gas fuel cells that produces electrical power and PURE WATER. GE's Fuel Cell-Combined Cycle (FC-CC) is a unique combination of a solid oxide fuel cell (SOFC) and a Jenbacher gas-fueled reciprocating engine. In this configuration, natural gas is reformed to produce hydrogen. The resultant reformate,**

along with oxygen, is used to produce electricity and water through an electrochemical reaction within the SOFC. The fuel output or tail gas is then fed to a Jenbacher gas engine in order to create more electricity and heat. The resultant electrical efficiency of the combined process is projected to be 60 to 65 percent. The combined heat and power (CHP) efficiency is expected to be as high as 90 percent.

By banning natural gas and infrastructure you are regulating out innovation and costing your constituents more money for energy for no good or perhaps misguided reason!!

8) **BUSINESS IS EMBRACING NATURAL GAS WHILE MUNICIPALITIES ARE THROWING ROAD BLOCKS IN THEIR WAY. At a time when companies are increasing their use of natural gas you politicians are working to destroy the natural gas infrastructure. UPS Inc. announced it will spend $450 million to add 6,000 vehicles powered by compressed natural gas as well as supporting infrastructure beginning next year. It is the largest multiyear commitment UPS has made to date for alternative fuel vehicles. The latest CNG fleet expansion also provides additional truck capacity for expanding the use of renewable natural gas.**

"Building CNG truck capacity is vital to increasing our use of RNG and ultimately meeting our 2025 sustainability goals," Juan Perez, chief information and engineering officer at UPS, said in a release. "We intend for 25% of our vehicles purchased in 2020 to run on alternative fuels." RNG is produced from landfills, dairy farms and other bio sources, and yields up to a 90% reduction in life-cycle greenhouse gas emissions compared with conventional diesel.

As of this month, UPS has agreed to purchase 230 million gallon-equivalents of RNG over the next seven years, making the company the largest consumer of RNG in the transportation industry. By the end of 2019, UPS reported it will be operating 61 natural gas fueling stations strategically located across the United States and abroad in Vancouver, Canada, and Tamworth, United Kingdom.

9) **The logic behind the Berkeley ban seems to be this: we can help the planet and reduce carbon emissions by eliminating natural gas and switching to electric heating and cooking. This is completely warped: the electric grid is powered predominantly by fossil fuels. The state prides itself on having very little coal, but it imports electricity from neighboring states like Utah and Arizona where it is generated by coal. Somehow displacing the emissions from California to another state, and charging the taxpayers more, fulfills the criteria for being "green."**

Natural gas is incredibly clean, producing very low emissions. In recent years, thanks to the fracking revolution, American natural gas production has exploded – and it's just the beginning. Experts estimate that Alaska is sitting on 200 trillion cubic feet of untapped natural gas, and the state is working on building a new pipeline to help bring it to market.

Berkeley's natural gas ban adds to the ever-increasing cost of homeownership in California, which has already been stressed by eco-demands. The state is mandating that, beginning next year, every new home must be fitted with solar panels, raising the cost of a new home by $10,000. Higher home prices, higher electric bills, fewer choices – that's the future Californians are being promised by their government. It's no wonder

families are fleeing the state, and that California is led only by New York in out-migration.

10) **Just look to our friends in Europe to see how damaging eco-policies can be. Citizens of Germany and Denmark, for instance, face electric rates around three times that of America. Is this the future we want for our country? The answer is clear, but it seems those running city government in Berkeley and San Jose have a different idea. That American citizens should be deprived of access to natural gas makes very little sense from an economic, environmental, or even logical sense. But that didn't prevent Berkeley and San Jose from pursuing it anyway.**

During the high of California's drought, it was the rich who didn't conserve water and who continued lawn and pool upkeep. It was the poor who were fined. Similarly, under this silly plan, San Jose and Berkeley's wealthy will find a way to bypass the law and get the gas stoves and gas heating they want. It's always the regular, average citizens who suffer when elites and politicians decide to be "green."

11) **Your assertions that the natural gas infrastruction is aging and needs to be replaced, SO WILL THE ELECTRICAL INFRASTRUCTURE, so far the gas infrastructure is and will be more reliable than the electrical infrastructure. What happens when the wind blows and PGE shuts off the electrical power again?**

12) **The governor falsely accuses PGE and global warming for the increased fires. The truth is the State of California has for years neglected and rejected good forestry practices of thinning forests of dead trees and fuel loads. Industry was willing to perform the work in many cases for the value of the lumber they would obtain from thinning. Unfortunately the state rejected good forestry practices and yielded to the so called environmentalist who wanted the forests left as is. The state of California is responsible in good part for increased fire threats and costs.**

The governor wants PGE to pay for fire damage costs and outage related costs. What the governor is really saying is that the PGE rate payers will pay the costs, the utilities like any other business must make a profit to stay in business and provide services. The governor is hypocritically trying to shift all the blame to PGE and drive electrical rates even higher and in turn punishing the rate payers once again.

Various municipalities have advanced proposals to acquire portions of PGE's franchise area will only increase PGE's unit costs and in turn increase the utility rates on the balance of PGE's rate payers, say no to the municipal takeover proposals.

Government actions have help push us into 3rd world status of having our power shut off simply because the wind blows, costing consumers, businesses and the economy billions. Before regulations are past the full economic consequences should be considered.

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Ph 408-777-3308 3251 Fax 408-777-3333
sscharf@cupertino.org;
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Thank you,

Myron Crawford
Cc:

Statement of Patrick Moore, Ph.D.

Before the Senate Environment and Public Works Committee, Subcommittee on Oversight

February 25, 2014

"Natural Resource Adaptation: Protecting ecosystems and economies"

Chairman Whitehouse, Ranking Member Inhofe, and members of the Committee. Thank you for the opportunity to testify at today's hearing.

In 1971, as a PhD student in ecology I joined an activist group in a church basement in Vancouver Canada and sailed on a small boat across the Pacific to protest US Hydrogen bomb testing in Alaska. We became Greenpeace.

After 15 years in the top committee I had to leave as Greenpeace took a sharp turn to the political left, and began to adopt policies that I could not accept from my scientific perspective. Climate change was not an issue when I abandoned Greenpeace, but it certainly is now.

There is no **scientific proof** that human emissions of carbon dioxide (CO2) are the dominant cause of the minor warming of the Earth's atmosphere over the past 100 years. If there were such a proof it would be written down for all to see. No actual proof, as it is understood in science, exists.

The Intergovernmental Panel on Climate Change (IPCC) states: "It is **extremely likely** that human influence has been the **dominant cause** of the observed warming **since the mid-20th century**." (My emphasis)

"Extremely likely" is not a scientific term but rather a judgment, as in a court of law. The IPCC defines "extremely likely" as a "95-100% probability". But upon further examination it is clear that these numbers are not the result of any mathematical calculation or statistical analysis. They have been "invented" as a construct within the IPCC report to express "expert judgment", as determined by the IPCC contributors.

These judgments are based, almost entirely, on the results of sophisticated computer models designed to predict the future of global climate. As noted by many observers, including Dr. Freeman Dyson of the Princeton Institute for Advanced Studies, a computer model is not a crystal ball. We may think it sophisticated, but we cannot predict the future with a computer model any more than we can make predictions with crystal balls, throwing bones, or by appealing to the Gods.

Perhaps the simplest way to expose the fallacy of "extreme certainty" is to look at the historical record. With the historical record, we do have some degree of certainty compared to predictions of the future. When modern life evolved over 500 million years ago, CO2 was more than 10 times higher than today, yet life flourished at this time. Then an Ice Age occurred 450 million years ago when CO2 was 10 times higher

than today. There is some correlation, but little evidence, to support a direct causal relationship between CO2 and global temperature through the millennia. The fact that we had both higher temperatures and an ice age at a time when CO2 emissions were 10 times higher than they are today fundamentally contradicts the certainty that human-caused CO2 emissions are the main cause of global warming.

Today we remain locked in what is essentially still the Pleistocene Ice Age, with an average global temperature of 14.5°C. This compares with a low of about 12°C during the periods of maximum glaciation in this Ice Age to an average of 22°C during the Greenhouse Ages, which occurred over longer time periods prior to the most recent Ice Age. During the Greenhouse Ages, there was no ice on either pole and all the land was tropical and sub-tropical, from pole to pole. As recently as 5 million years ago the Canadian Arctic islands were completely forested. Today, we live in an unusually cold period in the history of life on earth and there is no reason to believe that a warmer climate would be anything but beneficial for humans and the majority of other species. There is ample reason to believe that a sharp cooling of the climate would bring disastrous results for human civilization.

Moving closer to the present day, it is instructive to study the record of average global temperature during the past 130 years. The IPCC states that humans are the dominant cause of warming "since the mid-20th century", which is 1950. From 1910 to 1940 there was an increase in global average temperature of 0.5°C over that 30-year period. Then there was a 30-year "pause" until 1970. This was followed by an increase of 0.57°C during the 30-year period from 1970 to 2000. Since then there has been no increase, perhaps a slight decrease, in average global temperature. This in itself tends to negate the validity of the computer models, as CO2 emissions have continued to accelerate during this time.

The increase in temperature between 1910-1940 was virtually identical to the increase between 1970-2000. Yet the IPCC does not attribute the increase from 1910-1940 to "human influence." They are clear in their belief that human emissions impact only the increase "since the mid-20th century". Why does the IPCC believe that a virtually identical increase in temperature after 1950 is caused mainly by "human influence", when it has no explanation for the nearly identical increase from 1910-1940?

It is important to recognize, in the face of dire predictions about a 2°C rise in global average temperature, that humans are a tropical species. We evolved at the equator in a climate where freezing weather did not exist. The only reasons we can survive these cold climates are fire, clothing, and housing. It could be said that frost and ice are the enemies of life, except for those relatively few species that have evolved to adapt to freezing temperatures during this Pleistocene Ice Age. It is "extremely likely" that a warmer temperature than today's would be far better than a cooler one.

I realize that my comments are contrary to much of the speculation about our climate that is bandied about today. However, I am confident that history will bear me out, both in terms of the futility of relying on computer models to predict the future, and

the fact that warmer temperatures are better than colder temperatures for most species.

If we wish to preserve natural biodiversity, wildlife, and human well being, we should simultaneously plan for both warming and cooling, recognizing that cooling would be the most damaging of the two trends. We do not know whether the present pause in temperature will remain for some time, or whether it will go up or down at some time in the near future. What we do know with "extreme certainty" is that the climate is always changing, between pauses, and that we are not capable, with our limited knowledge, of predicting which way it will go next.

Thank you for the opportunity to present my views on this important subject.

Attached please find the chapter on climate change from my book, "Confessions of a Greenpeace Dropout: The Making of a Sensible Environmentalist". I would request it be made part of the record.

Excerpted from:

Confessions of a Greenpeace Dropout: The Making of a Sensible Environmentalist

Patrick Moore, Ph.D. Published 2013

chapter twenty-one

Climate of Fear

If a man will begin with certainties, he shall end in doubts; but if he will be content to begin with doubts he shall end in certainties. —Sir Francis Bacon

The global media tells us plainly and bluntly that the vast majority of the world's scientists believe we are headed for a climate catastrophe that will devastate human civilization and the environment. We have no choice but to act immediately to save ourselves from this apocalypse. The greatest threat is the CO_2 released from burning fossil fuels and cutting forests. Fossil fuel use must be cut by 80 percent or more, and we must stop cutting trees. How should we react to this warning?

The subject of climate change, also referred to as global warming, is perhaps the most complex scientific issue we have ever attempted to re- solve. Hundreds, possibly thousands of factors influence the earth's cli- mate, many in ways we do not fully understand. So, first, let us recognize that the science of climate is not settled. In fact, we are only beginning to understand how the earth's climate works.

It is not correct to use the terms *global warming* and *climate change* as if they were interchangeable. Global warming is a very specific term meaning exactly what it says, that the average temperature of the earth is increasing over time. Climate change is a much more general term that includes many factors. For one thing the climate is always changing, whereas it is not always getting warmer. The old maxim "the only constant is change" fits perfectly here. And as the belief in human-caused global warming has come into doubt the term climate change has been adopted as a substitute, even though it means something completely different.

It is one thing to claim increases in CO_2 cause global warming and quite another to claim increases in CO_2 cause:

- Higher temperatures
- Lower temperatures
- More snow and blizzards
- Drought, fire, and floods
- Rising sea levels
- Disappearing glaciers
- Loss of sea ice at the poles
- Species extinction
- More and stronger storms
- More storm damage
- More volcanic eruptions
- Dying forests
- Death of coral reefs and shellfish
- Shutting down the Gulf Stream
- Fatal heat waves
- More heat-related illness and disease
- Crop failure and food shortages
- Millions of climate change refugees
- Increased cancer, cardiovascular disease, mental illness, and respiratory disease[290]
- And, a devastating effect on the quality of French wines[291]

The science of climatology is only a few decades old. It is not a single science but rather an interdisciplinary cluster of sciences. These include meteorology (the study of weather), atmospheric chemistry, astrophysics and cosmic rays, geology and other earth sciences, oceanography, carbon cycling through all living species, soil science, geology, climate history through the millennia, ice ages and greenhouse ages, study of the sun, knowledge of earth wobbles, magnetic fields and orbital variations, etc. All of these disciplines are interrelated in complex, dynamic patterns that cannot be reduced to a simple equation. That is why climatologists have built very complicated computer models in the hope of predicting future climatic conditions. A "climate change con- sisting of widely divergent groups with sharply differing opinions. The most prominent and formally structured group is the United Nations Intergovernmental Panel on Climate Change (IPCC) and the scientists,

290. "A Human Health Perspective on Climate Change," National Institute of Environmental Health Sciences, April 2010, http://www.niehs.nih.gov/health/docs/climatereport2010.pdf

291. "Impact of Climate Change on Wine in France," Greenpeace International, September 2009, http://www.greenpeace.org/raw/content/international/press/reports/impacts-of-climate-change-on-w.pdf

scholars, activists, and politicians who associate themselves with this organization. The IPCC was created in 1988 as a partnership between the World Meteorological Organization and the United Nations Environment Program, put simply, meteorologists and environmentalists. Members of this group generally believe humans are causing global warming, that we are changing the climate, and this will generally be negative for civilization and the environment. They claim to represent an "overwhelming consensus among climate scientists."[292]

The IPCC is rather insular, believing its members are the only true climate scientists and that those who disagree with them are either some other kind of scientists, or not really scientists at all. Thus there is a self- defined overwhelming, even unanimous, consensus because they don't recognize the legitimacy of those who disagree with them. In 2007 the IPCC published its *Fourth Assessment Report*, which stated, "Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic (human- caused) greenhouse gas concentrations."[293]

At the other end of this spectrum there is a considerable contingent of scientists and scholars, largely schooled in the earth and astronomical sciences, who believe climate is largely influenced by natural forces and cycles. They were not organized into an official body until 2007 when the Nongovernmental International Panel on Climate Change (NIPCC) was formed in Vienna. Led by atmospheric scientist Dr. Fred Singer, the NIPCC published "Climate Change Reconsidered," a comprehensive scientific critique of the IPCC's findings, in 2009.[294] This report was signed by more than 31,000 American scientists and concluded, "there is no convincing scientific evidence that human release of carbon dioxide, methane, or other greenhouse gases is causing or will, in the foreseeable future, cause catastrophic heating of the Earth's atmosphere and disruption of the Earth's climate."[295] Clearly there is no overwhelming consensus among scientists on the subject of climate.[296] In my opinion the believers and the skeptics of human-caused, catastrophic climate change can be roughly divided between those who see history in very recent terms (years to thousands of years) and those who see history in the long term (thousands to hundreds of millions of years). Both meteorologists and environmentalists tend to think about weather and climate in

292. "Statistical Analysis of Consensus," realclimate.org, December 16, 2004, http://www.realclimate.org/index.php/archives/2004/12/a-statistical-analysis-of-the-consensus/

293. "Summary for Policymakers," *Fourth Assessment Report*, Intergovernmental Panel on Climate Change, 2007, p. 3, http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf

294. Craig Idso and S. Fred Singer, "Climate Change Reconsidered," Nongovernmental International Panel on Climate Change, 2009. http://www.heartland.org/publications/NIPCC%20report/PDFs/NIPCC%20Final.pdf

295. "Climate Change Reconsidered," Center for the Study of Carbon Dioxide and Global Change," 2009, www.nipccreport.org/

296. "More Than 700 International Scientists Dissent Over Man-Made Global Warming Claims: Scientists Continue to Debunk 'Consensus' in 2008 & 2009," U.S. Senate Minority Report, March 16, 2009, http://epw.senate.gov/public/index.cfm?FuseAction=Files.View&FileStore_id=83947f5d-d84a-4a84-ad5d-6e2d71db52d9

terms of recent human history. Geologists, evolutionary biologists, and astrophysicists tend to think of climate in the context of the 3.5 billion-year history of life and the 4.6 billion-year history of the Earth.

The various camps have invented some names for each other and for themselves. Pretty much everyone involved thinks they are “climate scientists.” But people who are convinced we are the main cause of climate change have been dubbed “true believers” and “warmists,” highlighting what are seen to be religious and ideological orientations, respectively. People who are undecided, critical, or questioning are called “skeptics.” The skeptics are happy with this description as it indicates they have an open mind and as scientists they believe they have a duty to challenge un-proven hypotheses. The true believers use the word skeptic as a slur, as in “unbelievers,” as if it is unacceptable to question their beliefs. Then there are the “climate deniers,” or “denialists,” terms invented by the true believers, and characterized by skeptics as associating them with Holocaust deniers. Much of this is just name-calling, but it is useful in the sense that it defines the battleground.

Over the years the media have largely ignored the scientists and organizations that remain skeptical of human-caused global warming and climate change. The public has been inundated with alarmist headlines about catastrophic climate change and many governments have bought into the belief there is a global emergency that must be addressed quickly and decisively. As with fear of chemicals, fear of climate change results in a convergence of interests among activists seeking funding, scientists applying for grants, the media selling advertising, businesses promoting themselves as green, and politicians looking for votes. It may not be a conspiracy, but it is a very powerful alignment that is mutually reinforcing.

In 2007 the IPCC and one of its main champions, Al Gore, were awarded the Nobel Peace Prize for alerting the world to the dire threat of human-caused climate change. One would imagine the public would strongly support this alarmist position, having been exposed to such one- sided media coverage and the news of prestigious awards. Amazingly this is not the case, even in countries such as the United States and England, where the official government positions are sharply accepting of catas-trophic human-caused warming.

A Pew Foundation poll conducted in October 2009 found only 36 per- cent of the general public in the United States believes humans are the cause of global warming, whereas 33 percent does not believe the earth is warming and 16 percent believe the earth is warming but that it is due to natural causes. Public opinion was sharply divided along partisan lines: 50 percent of Democrats believe global warming is caused by humans, while 33 percent of independents, and only 18 percent of Republicans agree with this. The trend since 2007 is decidedly

downwards with about 10 percent fewer people believing in human-caused global warming in all categories.

Another Pew Foundation poll taken in May 2010 asked Americans to rank priorities for Congress. It found only 32 percent think it is very important for Congress to address climate change in the coming months, including 47 percent of Democrats, 29 percent of independents, and 17 percent of Republicans.[297]

The partisan spread mirrors the poll on belief in human-caused cli- mate change almost perfectly. This is a strong indication that the reason a majority is not concerned about climate change legislation is because it doesn't believe in human-caused climate change in the first place.

A poll taken by Ipsos Mori in June 2008 found 60 percent of Britons believed, "many scientific experts still question if humans are contributing to climate change."[298] Clearly a majority of the British public does not believe there is a scientific certainty on the subject.

A more recent British poll in February 2010, again taken by Ipsos Mori, showed that only 17 percent of Britons put climate change in their top three most important issues facing them and their families.[299]

In one of the most surprising surveys taken, 121 U.S. television weather presenters, all members of the American Meteorological Society, were asked their opinions on climate change in April 2010. Ninety-four percent of those surveyed were accredited meteorologists. When asked about the UN's Intergovernmental Panel on Climate Change's statement, "Most of the warming since 1950 is very likely human-induced," a full 50 percent either disagreed or strongly disagreed. Twenty-five percent were neutral and only 24 percent said they agreed or strongly agreed.[300]

In April 2013 a US Department of Agriculture-funded survey of US Midwest corn farmer's beliefs in climate change was published. 18,800 farmers with an income of US$100,000 or more were polled, of whom 26 percent responded (4,778). Only 8 percent of these farmers, who spend their lives in the weather and the climate, agreed with the statement, "Climate change is occurring and it is caused mostly by human activities." In other words, 92 percent of corn farmers do not believe humans are the main cause of climate change. I say give them all honorary doctorates of science.

297. "Public's Priorities, Financial Regs: Congress's Job Rating—13%," Pew Research Center for People and the Press, May 18, 2010, http://people-press.org/report/615/

298. "Scientists Exaggerate Climate-Change Fears, Majority of Britons Believe," Mail Online, June 22, 2008, http://www.dailymail.co.uk/news/article-1028425/Scientists-exaggerate-climate-change-fears-majority-Britons-believe.html

299. "Climate Change Omnibus: Great Britain," Ipsos Mori, February 24, 2010, http://www.ipsos-mori.com/researchpublications/researcharchive/poll.aspx?oItemId=2552

300. Edward Maibach et al., "A National Survey of Television Meteorologists About Climate Change: Preliminary Findings," George Mason University Center for Climate Change Communication, March 29, 2010, http://www.climatechangecommunication.org/images/files/TV_Meteorologists_Survey_Findings_(March_2010).pdf

Why is there such a high degree of skepticism among professionals and the public when the mainstream media is so biased toward the IPCC view? It would appear they are reading about skeptical opinions on the Internet, blogs in particular, and talking to one another about the subject in an open-minded manner. Obviously most weather presenters are acutely interested in and aware of the fine points of the debate. The fact they disagree with the IPCC "consensus" by two-to-one speaks volumes about where these weather professionals find credibility on the subject of global warming.

Climate science is a classic case of the necessity to distinguish between historical and present facts on the one hand, and predictions of the future on the other. There are a number of things we can say with relative certainty:

• During the past 500 million years, since modern life forms emerged, the earth's climate has been warmer than it is today most of the time. During these "Greenhouse Ages" the earth's temperature averaged around 22 to 25 degrees Celsius (72 to 77 Fahrenheit).[301] All the land was either tropical or subtropical and the world was generally wetter. The sea level was much higher than today and life flourished on land and in the oceans. These warm periods were punctuated by three Ice Ages during which large ice sheets formed at the poles and in mountainous areas, effectively eliminating most plants and animals in those regions.

• The two Ice Ages that preceded the current one occurred between 460 and 430 million years ago and between 360 and 260 million year ago. From 260 million years ago until quite recently, a Greenhouse Age existed for about 250 million years. Ice started to accumulate in Antarctica beginning 20 million years ago and eventually the cur- rent Ice Age, known as the Pleistocene, began in earnest about 2.5 million years ago.[302] *The Pleistocene, which we are still in today and during which our species evolved to its current state, accounts for only 0.07 percent of the history of life on earth.*

• During the coldest periods of the Pleistocene Ice Age the average temperature of the earth was around 12 degrees Celsius (54 degrees Fahrenheit) and there were large ice sheets on both poles. Before the recent retreat of the glaciers, beginning 18,000 years ago, the ice extended below the U.S./Canada border, over all of Scandinavia, much of northern Europe, and well into northern Russia. The sea was about 122 meters (400 feet) lower than it is today, having risen steadily since then and continuing to do so today.[303] In recent times the sea has risen about 20 centimeters (8 inches) per century. The

301. Christopher R. Scotese, "Climate History," Paleomar Project, April 20, 2002, http://www.scotese.com/climate.htm 302. "Ice Age" Wikipedia, http://en.wikipedia.org/wiki/Ice_age 303. "Sea Level," Wikipedia, http://en.wikip

cause of sea level rise is a combination of melting glaciers (ice on land) and rising ocean temperature, as water expands when it gets warmer.

- The earth's climate underwent a general warming trend beginning with the end of the last major glaciation, about 18,000 years ago. This has not been an even warming, as there have been many fluctuations along the way. For example, during the Holocene Thermal Maximum between 9000 and 4000 years ago it was warmer than it is today by as much as 3 degrees Celsius (5.4 degrees Fahrenheit).[304] During this time the present-day Sahara Desert was covered with lakes and vegetation, clearly indicating there was much more rain- fall there than today.[305] We know for a fact this was not caused by humans. Many scientists believe it was caused by variations in the earth's orbit around the sun.

- This historical record highlights the importance of analyzing the starting point and end point of temperature measurements when explaining trends, both up and down. It is warmer today than it was 18,000 years ago. But it is cooler today than it was 5,000 years ago during the Holocene Thermal Optimum. So it could be said we have been in a cooling trend for the past 5000 years even though it is warmer now than it was when the glaciation ended. I will try not to "trick" the reader by cherry-picking timelines that support a particular bias.

- Today the average temperature of the earth is about 14.5 degrees Celsius (58 degrees Fahrenheit), decidedly closer to the Ice Age level than the Greenhouse Age level and only 2.5 degrees above the temperature at the height of the last major glaciation. The fact is we are still in the Pleistocene Ice Age and it is possible another major glaciation may occur sometime in the next 10,000 years, but that is a prediction, not a fact.

- Carbon Dioxide (CO_2) is a greenhouse gas in that it tends to heat the atmosphere and thus raise the temperature of the earth. But water vapor is by far the most important greenhouse gas, contributing at least two thirds of the "greenhouse effect." CO_2 and other minor gases, such as methane and nitrous oxide, make up the other third of the greenhouse effect.[306] It is not possible to prove the exact ratios among the various greenhouse gases as they interact in complex ways.

304. Chris Caseldine et al., "Holocene Thermal Maximum up to 3oC Warmer Than Today, *Quaternary Science Reviews* 25, no. 17–18 (September 2006): 2025–2446.

305. "Earth's Climatic History: The Last 10,000 Years," *CO_2 Science*, http://www.co2science.org/subject/other/clim_hist_tenthousand.php

306. J. T. Kiehl and Kevin E. Trenberth, "Earth's Annual Global Mean Energy Budget," *Bulletin of the American Meteorological Society* 78, no. 2 (February 1997): 197-208, www.atmo.arizona.edu/students/courselinks/spring04/atmo451b/pdf/RadiationBudget.pdf

In particular, the balance between water vapor and clouds (made up of condensed water vapor) is impossible to predict accurately.[307]

- We know global levels of CO_2 in the atmosphere have risen steadily from 315 parts per million (ppm) to nearly 390 ppm since scientists began taking regular measurements at Mauna Loa on the big island of Hawaii in 1958.[308] This is a very short time compared to the 3.5 billion years of life on earth. Many scientists assume that human emissions of CO_2 from burning fossil fuels are the main cause of this increase. Some scientists question this assumption. It is a fact that CO_2 levels were much higher than they are today during previ ous eras. This will be discussed in detail later.

- The average temperature of the earth has fluctuated during the past 100 years, sometimes cooling, sometimes warming, and in balance has increased somewhat, especially during the periods from 1910 to 1940 and from 1980 to 1998. Since 1998 there has been no further warming and apparently a slight cooling. There is a lot of controversy around the accuracy of these trends. In particular there is a concern that many of the weather stations used to determine the global aver- age were originally in the countryside but over the years have been swallowed up by expanding urban development. The "urban heat island effect" refers to the fact that concrete and heat from buildings results in an increase in temperature in urban areas compared to the surrounding countryside,[309] thus the possibility exists that the results have been skewed. In N ovem ber 2
  or hacked, from the Climatic Research Unit of the University of East Anglia in the U.K. shocked the climate change community. It was quite clear from a number of email exchanges that the scientists with this most important source of information had been manipulating data, withholding data, and conspiring to discredit other scientists who did not share their certainty that humans were the main cause of climate change. These revelations were quickly dubbed "Climategate" and have since been hotly debated in climate change circles.[310] [311] [312] It is very difficult to find

307. "Forecast: Water and Global Warming," ESPERE, http://www.espere.net/Unitedkingdom/water/uk_forecast.html
308. R. F. Keeling et al., "Atmospheric CO_2 Values (ppmv) Derived from In Situ Air Samples Collected at Mauna Loa, Hawaii, USA," Scripps Institute of Oceanography, September 2009, http://cdiac.ornl.gov/ftp/trends/co2/maunaloa.co2
309. "Surfacestations Project Reaches 82% of the Network Surveyed," surfacestations.org, July 16, 2009, http://www.surfacestations.org/
310. "The Tip of the Climate Change Iceberg," *Wall Street Journal*, December 8, 2009, http://online.wsj.com/article/SB10001424052748704342404574576683216723794.html
311. James Delingpole, "Climategate: The Final Nail in the Coffin of 'Anthropogenic Global Warming'?" *Telegraph*, November 20, 2009, http://blogs.telegraph.co.uk/news/jamesdelingpole/100017393/climategate-the-final-nail-in-the-coffin-of-anthropogenic- global-warming/
312. Andrew C. Revkin, "Hacked E-Mail Is New Fodder for Climate Dispute," *New York Times*, November 20, 2009, http://www.nytimes.com/2009/11/21/science/earth/21climate.html

a balanced account of this scandal. Commentary is divided sharply, with believers claiming that while the scientists involved behaved badly, this does not change the fact that the science is clear that humans are causing warming, while skeptics claim the revelations demonstrate the books have been cooked, placing the entire hypothesis of global warming in doubt.

In December 2009, after months of promotion and hype, the Copenhagen conference on climate change ended in disaster for the true believers. The delegates at the largest international meeting in history failed to reach a single binding decision to control CO_2 emissions. There does not seem to be any conceivable strategy to achieve international agreement on this subject. The United States will not sign a deal that does not include China, India, Brazil, and the other developing countries. The developing countries will not agree to reduce or restrict their CO_2 emissions so long as the U.S. and other industrialized countries have far higher emissions on a per capita basis. Whereas the U.S. emits nearly 20 tonnes (22 tons) of CO_2 per person, China emits 4.6 tonnes (5.1 tons) and India emits 1.2 tonnes (1.3 tons). There is no possibility this impasse will be resolved in the near future. The U.S. will not agree to reduce its emissions to a lower level while the developing countries increase theirs. The developing countries will not agree to a system in which the U.S. and other industrialized countries are allowed even higher per capita emissions. Despite this obvious impasse, the delegates continue to meet regularly, thousands of people jetting to desirable locations like Bali, Montreal, and Rio de Janeiro at public expense, with no possibility of ever reaching agreement.

We can be fairly certain of the facts listed above, with the qualifications given. While this is very interesting, it is not the known facts but rather the unanswered questions that are most intriguing. Climate change cannot be defined by a single question. It is much like peeling back the layers of an onion, beginning with the science, leading to possible environmental impacts, followed by potential economic and social impacts, and concluding with policy options. Among these questions are:

- Is CO_2, the main cause of global warming, either natural or human-caused?
- Are human-caused CO_2 emissions the principal cause of recent global warming?
- Is the recent warming trend fundamentally different from previous warming and cooling trends?
- If warming continues at the rate experienced in the 20th century into the 21st century will this be positive or negative for human civilization and the environment?
- Is the melting of glaciers and polar ice really a threat to the future of human civilization?

- Will increased CO_2 result in "acidification" of the oceans and kill all the coral reefs and shellfish?
- Is it possible for humans to halt global warming and to control the earth's climate?
- Which would cost more to the economy, an 80 percent reduction in fossil fuel use or adaptation to a warmer world?
- Could the United States and China ever agree to a common policy on reducing CO_2 emissions?
- Is the effort to conclude a binding agreement to control CO_2 emissions among all nations futile?

These are just some of the many questions we must answer if we are to make intelligent choices about the direction public policy should take on the subject of climate change.

Before going int

the fact that both CO_2 and temperature are increasing at the same time does not prove one is causing the other. It may be that increased CO_2 is causing some or most of the increased temperature. It may also be that increased temperature causes an increase in atmospheric CO_2. Or it may be they are both caused by some other common factor, or it may be just coincidental they are both rising together and they have nothing to do with one an- other. Correlation does not prove causation. In order to demonstrate one thing causes another, we need among other things, to be able to replicate the same cause-effect sequence over and over again. This is not possible with the earth's climate as we are not in control of all (or any of) the factors that might influence climate. Now, if we had a record of CO_2 and temperature going back many millions of years and it showed that increased temperature always followed increased CO_2, we would be a long way toward proving the point. As we shall see later, the historical record is not so clear on the relationship between CO_2 and temperature.

Second, it is often as

interests of the environment are one and the same. This may be the case for some factors, such as rainfall, but for others it simply does not apply. Take sea level rise, for example. If the sea level rises relatively rapidly, it will damage a great deal of human infrastructure and a great deal of work and expense will be required either to protect or to replace farms, buildings, wharfs, roadways, etc. But fish and other marine creatures will be perfectly happy with the rising sea level and most land animals will not find it difficult to move a few feet higher. A 1.5 meter (5-foot rise) in sea level may inundate Bangladesh, turning much of it into a salt marsh and displacing millions of people. This would be devastating for humans, but from an environmental perspective there is nothing wrong with a salt marsh. From an ecological point of view, a natural salt marsh represents an improvement over intensive agriculture with monocultures of nonnative food crops.

Fortunately, no credible scientist believes the sea level will rise anywhere near 1.5 meters in the next century.

A Longer View

Our lifetimes are so short compared to the billions of years of life's history on earth that we tend to dwell on the very recent past when considering historical information. Nearly all the discussion of climate change is in the context of the past 100 years, or occasionally the past 1000 years, even though the earth's climate has changed constantly for billions of years. Let's take a look at the history of climate change in this larger context, in particular the past 500 million years since modern life forms evolved.

Temperature

The earth's average temperature has fluctuated widely over the past one bil- lion years (see Figure 1). It is interesting to note that during the Cambrian Period, when most of the modern life forms emerged, the climate was much warmer than it is today, averaging 25 degrees Celsius (77 degrees Fahrenheit). Only at three other times during the past billion years has the temperature been as cold as or colder than it is today. The age of the dinosaurs, the Jurassic and Cretaceous Periods, experienced a warm climate with a moderate cooling spell in the late Jurassic. Following the dinosaur extinction the climate remained warm for 10 million years, spiking to 27 degrees Celsius (80 degrees Fahrenheit), followed by a gradual decline that eventually led to the Pleistocene Ice Age. As the graph below indicates, it is colder today than it has been throughout most of the past billion years.

Humans generally prefer warmer climates to colder ones. When I mention that the global climate was much warmer before this present Ice Age, people often say something like, "But humans were not even around five million years ago, certainly not 50 or 500 million years ago. We have not evolved in a warmer world and will not be able to cope with global warming." The fact is we did evolve in a "warmer world." The human species originated in the tropical regions of Africa, where it was warm even during past glaciations nearer the poles. Humans are a tropical species that has adapted to colder climates as a result of harnessing fire, making clothing, and building shelters. Before these advances occurred, humans could not live outside the tropics. It may come as a surprise to most that a naked human in the outdoors with no fire will die of hypothermia if the temperature goes below 21 degrees Celsius (70 degrees Fahrenheit). Yet as long as we have food, water, and shade we can survive in the hottest climates on earth without fire, clothing, or shelter.[313] The Australian Aborigines survived in

313. Claude A. Piantadosi, *The Biology of Human Survival: Life and Death in Extreme Environments* (Oxford: Oxford University Press, 2003)

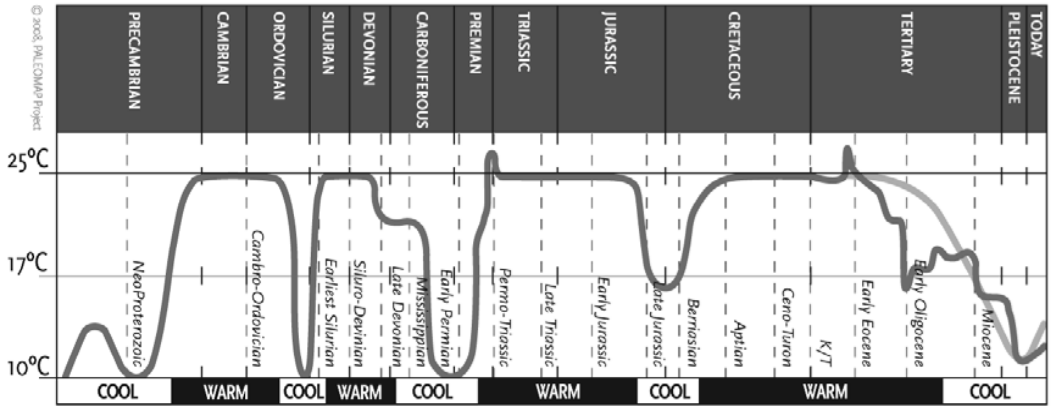


Figure 1. Graph showing global average temperature during the past billion years.[314]

temperatures of over 45 degrees Celsius (113 degrees Fahrenheit) without air conditioning for 50,000 years.

The fact that humans are essentially a tropical species explains why even today there are no permanent residents of Antarctica and only four million people living in the Arctic (0.06 percent of the global population). Most of the Arctic population is engaged in resource extraction and would not choose to live there otherwise. Historically, the very small populations of indigenous people in the Arctic managed to eke out a living by inhabiting ice-shelters, getting food from marine mammals and oil from marine mammals for heating and light. They used sled dogs for transport and protection from polar bears. There is a good reason why there are more than 18 million people in Sao Paulo, Brazil, only 4,429 residents in Barrow, Alaska,[315] and 3,451 inhabitants of Inuvik, Northwest Territory.[316]

Why are there 300 million people in the United States and only 30 million in Canada, which is larger geographically? One word answers this question: cold. About 80 percent of Canadians live within 100 miles of the U.S. border, as it is warmer there (although not by much in many regions) than it is in 90 percent of Canada, which is frozen solid for six or more months of the year.

So clearly, on the basis of temperature alone, it would be fine for humans if the entire earth were tropical and subtropical as it was for millions of years during the Greenhouse Ages. It would also be fine for the vast majority of species in the world today, most of which live in tropical and subtropical regions. But this would not be the case for some other species that have evolved specifically to be able to survive in cold climates.

The polar bear did not exist until the Pleistocene Ice Age froze the Arctic and created the conditions for adaptation to a world of ice. Polar bears are not really

314. Global Temperature Curve by C.R. Scotese, PALEOMAP Project, http://www.scotese.com/climate.htm

315. "City of Barrow – Farthest North American City," http://www.cityofbarrow.org/ 316. "Inuvik," http://www.inuvik.ca/tourism/faq.html

a distinct species; they are a variety of the European brown bear, known as the grizzly bear in North America. They are so closely related genetically that brown bears and polar bears can mate success- fully and produce fertile offspring.[317] The white variety of the brown bear evolved as the ice advanced, the white color providing a good camouflage in the snow. Once bears could walk out to sea on the ice floes, it became feasible to hunt seals. It is possible that if the world warmed substantially over the next hundreds of years that the white variety of the brown bear would become reduced in numbers or even die out. This would simply be the reverse of what happened when the world became colder. Some varieties of life that exist today are only here because the world turned colder a few million years ago, following a warmer period that lasted for over 200 million years. If the climate were to return to a Greenhouse Age those varieties might not survive. Many more species would benefit from a warmer world, the human species among them.

The polar bear did not evolve as a separate variety of brown bear until about 150,000 years ago, during the glaciation previous to the most recent one.[318] [319] This is a very recent adaptation to an extreme climatic condition that caused much of the Arctic Ocean to freeze over for most of the past 2.5 million years. The polar bear did manage to survive through the inter- glacial period that preceded the one we are in now even though the earth's average temperature was higher during that interglacial than it is today.[320] So as long as the temperature does not rise more than about 5 degrees Celsius (9 degrees Fahrenheit) above the present level, polar bears will likely survive. But that is a prediction, not a fact.

To listen to climate activists and the media, you would think the polar bear population is already in a steep decline. A little investigation reveals there are actually more polar bears today than there were just 30 years ago. Most subpopulations are either stable or growing. And the main cause of polar bear deaths today is legally sanctioned trophy hunting, not climate change. Of an estimated population of 20,000 to 25,000 bears, more than 700 are shot every year by trophy hunters and native Inuit. One hundred and nine are killed in the Baffin Bay region of Canada alone. And yet activist groups like the World Wildlife Fund use the polar bear as a poster child for global warming, incorrectly alleging that they are being wiped out by climate change.

The population of polar bears was estimated at 6000 in 1960. In 1973 an International Agreement between Canada, the United States, Norway,

317. Katherine Hamon, "Climate Change Likely Caused Polar Bear to Evolve Quickly," *Scientific American*, March 1, 2010, http://www.scientificamerican.com/article.cfm?id=polar-bear-genome-climate

318. "Polar Bear" Wikipedia, http://en.wikipedia.org/wiki/Polar_bear

319. Katherine Hamon, "Climate Change Likely Caused Polar Bear to Evolve Quickly," *Scientific American*, March 1, 2010, http://www.scientificamerican.com/article.cfm?id=polar-bear-genome-climate

320. "Interglacial,"Wikipedia,http://en.wikipedia.org/wiki/Interglacial

Russia, and Greenland ended unrestricted hunting and introduced quotas. Since then only native people have been allowed to hunt polar bears, although in Canada the native Inuit often act as guides for non- native hunters. As a result of this restriction on hunting, the population has rebounded to its present level of 20,000 to 25,000. The International Union for the Conservation of Natural Resources Polar Bear Specialist Group reports that of 18 subpopulations of bears, two are increasing, five are stable, five are declining, while for six subpopulations, mainly those in Russia, there is insufficient data.[321] There is no reliable evidence that any bear populations are declining due to climate change and all such claims rely on speculation; they are predictions based on conjecture rather than actual scientific studies.

At the other end of the world in Antarctica, numerous species of pen- guins have evolved over the past 20 million years so that they can live in ice-bound environments. There are also many species of penguins that live in places where there is no ice, such as in Australia, South Africa, Tierra del Fuego, and the Galapagos Islands. It took 20 million years for the Antarctic ice sheet to grow to the extent it has been for the past 2.5 million years, during the Pleistocene Age. Antarctica differs significantly from the Arctic in that most of the ice is on land and at higher elevation. It is very unlikely Antarctica will become ice-free in the near future. It took millions of years for the present ice sheet to develop. In all likelihood the penguins will be able to breathe easily for thousands, possibly millions of years.

Coming closer to the present day, there is good historical evidence that it was warmer than it is today during the days of the Roman Empire 2000 years ago and during the Medieval Warming Period 1,000 years ago.[322] [323] We know that during the Medieval Warming Period, the Norse (Vikings) colonized Iceland, Greenland, and Newfoundland. The settlements in Newfoundland and Greenland were then abandoned during the Little Ice Age that lasted from about 1500 to the early 1800s.[324] The Thames River in England froze over regularly during the cold winters of the Little Ice Age. The Thames last froze over in 1814.[325] Since then the climate has been in a gradual warming trend. Given that there were very low levels of CO_2 emissions from human activity in those times, it is not possible that humans caused the Medieval Warming Period or the Little Ice Age. Natural factors had to be instrumental in those changes in climate.

321. “Summary of Polar Pear Population status per 2010,” IUCN Polar Bear Specialist Group, http://pbsg.npolar.no/en/status/status-table.html

322. “Roman Warm Period (Europe – Mediterranean) – Summary,” *CO_2 Science*, http://www.co2science.org/subject/r/summaries/rwpeuropemed.php

323. “Medieval Warm Period Project,” *CO_2 Science*, http://www.co2science.org/data/mwp/mwpp.php

324. “20th Century Climate Not So Hot,” Harvard Smithsonian Center for Astrophysics, March 31, 2003, http://www.cfa.harvard.edu/news/archive/pr0310.html

325. “The Frozen Thames in London: An Introduction,” History and Traditions of England, January 10, 2010, http://www.webhistoryofengland.com/?p=613

Speaking of natural factors, it is clear the climate changes over the past billions of years were not caused by our activities. So how credible is it to claim we have just recently become the main cause of climate change? It's not as if the natural factors that have been causing the climate to change over the millennia have suddenly disappeared and now we are the only significant agent of change. Clearly the natural factors are still at work, even if our population explosion and increasing CO_2 emissions now play a role in climate change. So the real question is, are human impacts over- whelming the natural factors or are they only a minor player in the big picture? We do not know the definitive answer to that question.

Let's go back to the IPCC's *Fourth Assessment Report* in 2007, which stated: "*Most* of the observed increase in global average temperatures *since the mid-20th century* is *very likely* due to the observed increase in anthropogenic (human-caused) greenhouse gas concentrations"[my emphasis]. The first word, *most*, in common usage means more than 50 percent and less than 100 percent, i.e., more than half but not all. That's a pretty big spread, so clearly IPCC members don't have a very precise estimate of how much of the warming they think we are causing. If they are that uncertain, how do they know it's not 25 percent, or 5 percent? They restrict the hu- man influence to "since the mid-20th century," implying humans were not responsible for climate change until about 60 years ago. So the logical question is, What was responsible for the significant climate changes be- fore 60 years ago, the warming between 1910 and 1940, for example? The most problematic term in their statement is "very likely," which certainly provides no indication of scientific proof. The IPCC claims that "very likely" means "greater than 90 percent probability."[326] But the figure 90 is not the result of any calculation or statistical analysis. The footnote entry for the term "very likely" explains, "in this Summary for Policymakers, the following terms have been used to indicate the assessed likelihood, *using expert judgement*, [my emphasis] of an outcome or a result: *Virtually certain* > 99% probability of occurrence, *Extremely likely* > 95%, *Very likely* > 90%, *Likely* > 66%, *More likely than not* > 50%, *Unlikely* < 33%, *Very unlikely* < 10%, *Extremely unlikely* < 5%."[327] One expects "judgments" from judges and opinionated journalists. Scientists are expected to provide calculations and observable evidence. I'm not convinced by this loose use of words and numbers.

According to the official records of surface temperatures, 1998 was the warmest year in the past 150 years. Since then the average global temperature remained relatively flat down, completely contrary to the predictions of the IPCC,

326. "Summary for Policymakers," Intergovernmental Panel on Climate Change, 2007, p. 3 http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf

327. Ibid.

and in spite of steadily growing CO_2 emissions from countries around the world. This drop in temperature is now attributed to natural factors, something that was downplayed in previous predictions. Mojib Latif, a prominent German meteorologist and oceanographer, explains it this way, "So I really believe in Global Warming. Okay. However, you know, we have to accept that there are these natural fluctuations, and therefore, the temperature may not show additional warming temporarily."[328] The question is, How long is temporarily? At this writing the global temperature has not increased during the past 16 years. The assertion that it will resume warming at some time in the future is a prediction, not a fact. And even if warming does resume, it is possible that this may be due to natural factors. *It is not logical to believe that natural factors are only responsible for cooling and not for warming.*

The situation is complicated further by the revelations of "Climategate" in November 2009, which clearly showed that many of the most influential climate scientists associated with the IPCC have been manipulating data, withholding data, and conspiring to discredit other scientists who do not share their certainty that we are the main cause of global warming.[329] It has also been well documented that the NASA Goddard Institute for Space Science, which is responsible for one of the primary temperature records, has dropped a large number of weather stations, mainly in colder regions, thus likely making it seem warming is occurring even though this may not be the case.[330] The situation is in such a state of flux that it may be several years before an objective process is in place to sort out what is believable and what is not.

Leading up to the 15th Conference of the Parties in the Framework Convention on Climate Change in Copenhagen in December 2009, the IPCC, the European Union, and many other participants warned we must keep global temperatures from rising more than 2 degrees Celsius (3.6 degrees Fahrenheit) or we will face climate catastrophe.[331] Yet the global temperature has been 6 to 8 degrees Celsius (11 to 14 degrees Fahrenheit) warmer than it is today through most of the past 500 million years. It seems clear that the real "climate catastrophes" are the major glaciations that occurred during the Ice Ages, not the warm Greenhouse Ages when life flourished from pole to pole.

328. "Scientist Explains Earth's Warming Plateau," National Public Radio, November 22, 2009 http://www.npr.org/templates/story/story.php?storyId=120668812&ft=1&f=1007

329. James Delingpole, "Climategate: The Final Nail in the Coffin of 'Anthropogenic Global Warming'?" *Telegraph*, November 20, 2009, http://blogs.telegraph.co.uk/news/jamesdelingpole/100017393/climategate-the-final-nail-in-the-coffin-of- ... - ... anthropogenic global-warming/

330. Joseph D'Aleo and Anthony Watts, "Surface Temperature Records: Policy-Driven Deception?" Science & Public Policy Institute, June 2, 2010, http://scienceandpublicpolicy.org/images/stories/papers/originals/surface_temp.pdf

331. James Murray, "IPCC Chief Warns Even Two Degree Rise Spells 'Bad News'," businessgreen.com, March 10, 2009, http://www.businessgreen.com/business-green/news/2238184/ipcc-chief-warns-two-degree

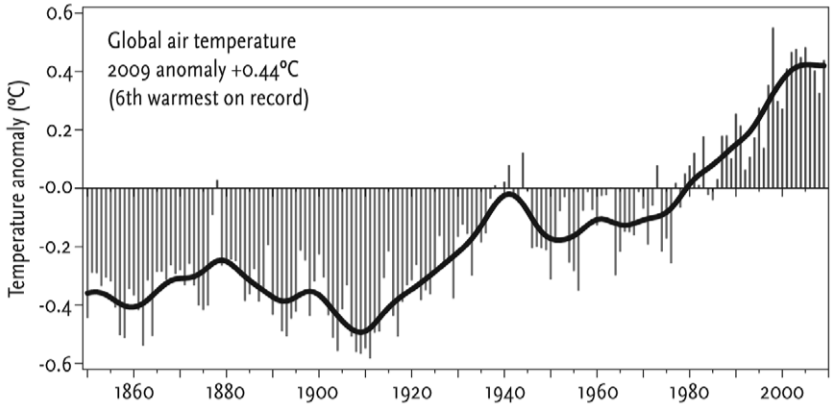


Figure 2. Global temperature trends 1860–2008 according to Phil Jones of the Climatic Research Unit in the U.K.

The graph on this page, Figure 2, is a record of global temperatures from 1850 to 2008, as prepared by the Climatic Research Unit at the University of East Anglia in the U.K.[332] It was authored by Phil Jones, who was at the centre of the "Climategate" scandal. As previously mentioned, the emails he and his colleagues exchanged indicated they withheld data, manipulated data, and attempted to discredit other scientists who held contrary views. Jones was suspended from his post in November 2009, pending an inquiry into the scandal. Therefore the data this graph is based on are not necessarily credible; they need to be rigorously re-examined.[333] But the graph does provide a useful tool for examining a couple of points about recent temperature trends.

The graph indicates global temperature has risen by about 0.8 degrees Celsius (1.4 degrees Fahrenheit) over the past 150 years. But about half of this warming occurred from 1910 to 1940, before the huge increase in CO_2 emissions from fossil fuel that began after the Second World War. What caused this increase? We simply don't know. Then there was a period of cooling from 1940 to 1980, just as CO_2 emissions started to increase dramatically. In the mid-1970s, mainstream magazines and newspapers, including *Time*, *Newsweek*, and the *New York Times*, published articles on the possibility of a coming cold period, perhaps another Ice Age.[334] [335] These articles were based on interviews with scientists at the National Academy of Sciences and NASA, among others. Prominent supporters of the global cooling

332. Phil Jones, "Global Temperature Record," Climatic Research Unit, March 2010, http://www.cru.uea.ac.uk/cru/info/warming/

333. Joseph D'Aleo and Anthony Watts, "Surface Temperature Records: Policy-Driven Deception?" Science & Public Policy Institute, June 2, 2010, http://scienceandpublicpolicy.org/images/stories/papers/originals/surface_temp.pdf

334. Mauritzio Marabito, "Same Fears: Different Name?" *Spiked*, December 10, 2009, http://www.spiked-online.com/index.php/site/article/7817/

335. Robert Bradley Jr, "The Global Cooling Scare Revisited ('Ice Age' Holdren Had Plenty of Company)," Master Resource, September 26, 2009, http://www.masterresource.org/2009/09/the-global-cooling-scare-revisited/

theory included present-day global warming supporters such as John Holdren, the Obama administration's science czar[337] and the late Stephen Schneider, a former leading member of the IPCC.[338]

In 1980, global temperatures began a 20-year rise, according to the now questionable records used by the IPCC for its predictions of climate disaster. This is the only period in the 3.5 billion years of life on earth in which the IPCC attributes climate change to human activity. Since 1998 there has been no further increase in global temperature, even according to the IPCC sources. How does one 20-year period of rising temperatures out of the past 150 years prove we are the main cause of global warming?

The alarmists declare that the present warming trend is "unprecedented" because it is happening on a scale of centuries whereas past warming trends have been much slower, giving species time to adapt. This is shown to be false even during the past century. The IPCC does not contend that humans caused the warming from 1910 to 1940; therefore it must have been a natural warming trend. But the warming from 1910 to 1940 was just as large (0.4 degrees Celsius or 0.7 degrees Fahrenheit) and just as rapid over time as the supposed human-caused warming from 1975 to 2000. How can scientists who claim to be on the cutting edge of human knowledge miss this point?

It is a testament to the fickleness of trends in science, public policy, and media communications that such certainty about human-caused climate change came about. That era finally seems to have ended now that more attention is being paid to the proposition that we really don't have all the answers. One hopes this will usher in a more sensible conversation about climate change and a more balanced approach to climate change policy.

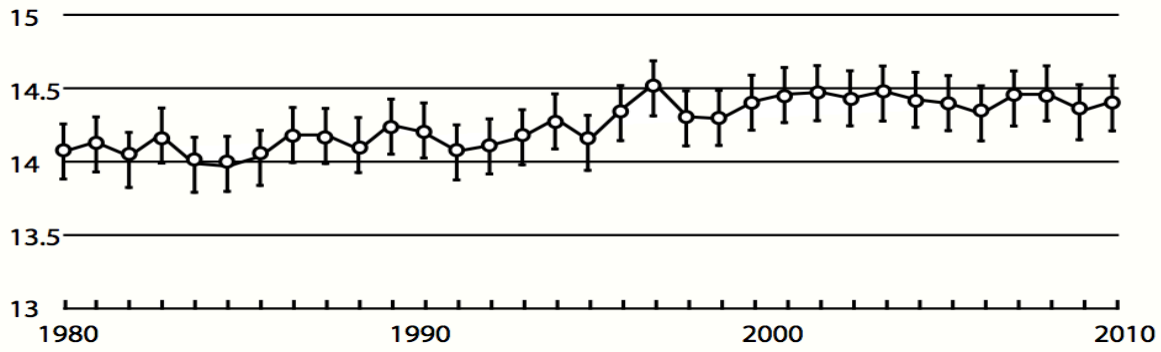


Figure 3. The HadCRUT 3 record of global temperature since 1980. There is no statistically significant increase in temperature since 1997.[336]

336. http://www.thegwpf.org/temperature-standstill-continues-2012-scrapes-top-ten/hadcrut3-2/
337. "John Holdren in 1771: 'New Ice Age Likely'," Zomblog, September 16, 2009, http://www.zombietime.com/zomblog/?p=873
338. John L. Daly, "Stephen Schneider: Greenhouse Superstar," August 2008, http://www.john-daly.com/schneidr.htm

In early 2013 there were three independent announcements by leading believers in human-caused catastrophic climate change that confirmed the standstill in global temperature. James Hansen, Director of the NASA Goddard Institute for Space Studies and senior science advisor to Al Gore, stated "The 5-year running mean of global temperature has been flat for the past decade." In January 2013 The UK Met Office and the Climatic Research Unit of the University of East Anglia released the data for December in their Hadcrut3 and Hadcrut4 global temperature datasets. The data clearly shows that there has been no increase in global temperature for 16 years, since 1997. In an interview with The Australian in February 2013, Rajenda Pachauri, the chair of the Intergovernmental Panel on Climate Change, acknowledged the reality of the post-1997 standstill in global average temperatures.

Carbon Dioxide

The trains carrying coal to power plants are death trains. Coal-fired power plants are factories of death. —James Hansen, director, NASA Goddard Institute for Space Studies, science advisor to former vice president Al Gore

The entire global warming hypothesis rests on one belief—human emissions of CO_2 are causing rapid global warming that will result in a "catastrophe" if we don't cut emissions drastically, beginning now. Let's look at the history, chemistry, and biology of this much-maligned molecule.

Carbon dioxide (CO_2) and carbon are probably the most talked about substances in the world today. We hear the term "carbon footprint" every day and fossil fuels are now routinely described as "carbon-based energy." True believers speak of CO_2 as if it is the greatest threat we have ever faced. Perhaps our CO_2 emissions will have some negative effects. But in my view CO_2 is one of the most positive chemicals in our world. How can I justify this statement given that the US Environmental Protection Agency has declared CO_2 and other greenhouse gases are "pollutants" that are dangerous to human health and the environment?[339]

What about the undisputed fact that CO_2 is the most important food for all life on earth? Every green plant needs CO_2 in order to produce sugars that are the primary energy source for every plant and animal. To be fair, water is also essential to living things, as are nitrogen, potassium, phosphorus, and many other minor elements. But CO_2 is the most important food, as all life on earth is carbon-based, and the carbon comes from CO_2 in the atmosphere. Without CO_2 life on this planet would not exist. How important is that?

339. "Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the Clean Air Act," U.S. Environmental Protection Agency, December 7, 2009, http://www.epa.gov/climatechange/endangerment.html

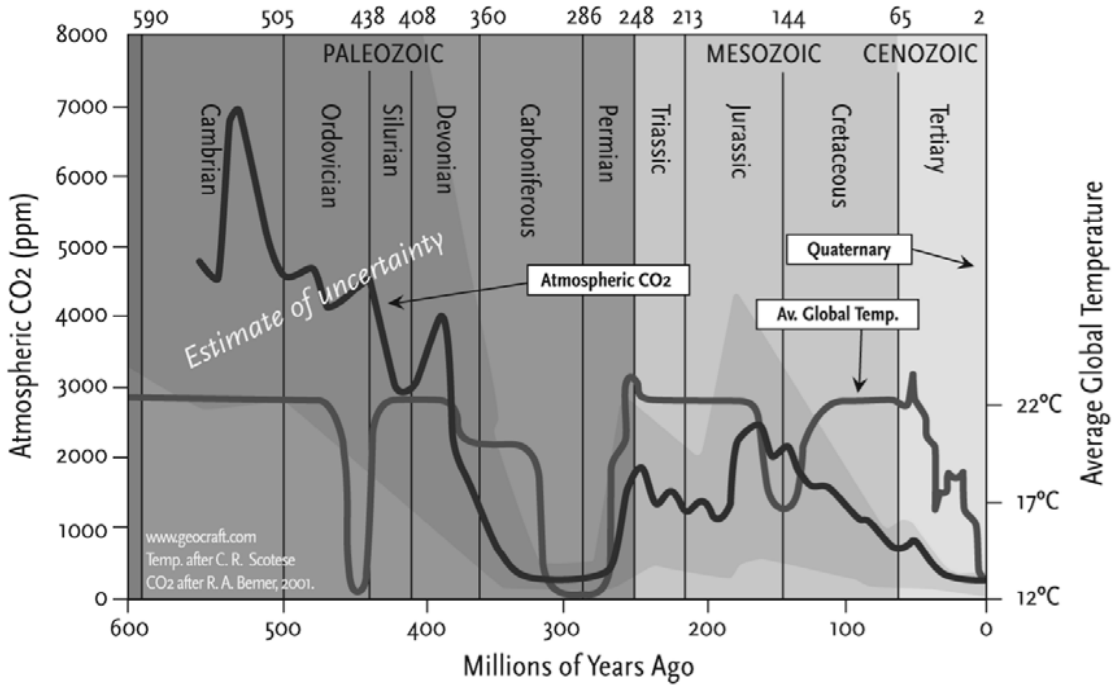


Figure 4. This graph shows global levels of CO2 and the global temperature for the past 600 million years. The correlation between the two parameters is mixed at best, with an Ice Age during a period of high CO2 levels and Greenhouse Ages during a period of relatively low CO2 levels.340

When President Obama appointed Lisa Jackson as head of the EPA, she promised to "ensure EPA's efforts to address the environmental crises of today are rooted in three fundamental values: science-based policies and programs, adherence to the rule of law, and overwhelming transparency." During the EPA's deliberations on the "endangerment" ruling for CO_2, one of its top economic policy experts, Alan Carlin, a 35-year veteran of the agency, presented a 98-page analysis concluding that the science behind man-made global warming is inconclusive at best and that the agency should re-examine its findings. His analysis noted that global temperatures were on a downward trend. It pointed out problems with climate models. It highlighted new research about climate change that contradicts apocalyptic scenarios. "We believe our concerns and reservations are sufficiently important to warrant a serious review of the science by EPA," the report read.

In response to the report Carlin's boss, Al McGartland, emailed him, forbidding him from engaging in "any direct communication" with any- one outside his office about his analysis. In a follow-up email, McGartland wrote, "With the endangerment finding nearly final, you need to move on to other issues and subjects. I don't want you to spend any additional EPA time on climate change.

340. Monte Hieb, "Climate and the Carboniferous Period," Plant Fossils of West Virginia, March 21, 2009, http://www.geocraft.com/WVFossils/Carboniferous_climate.html

No papers, no research, etc., at least until we see what EPA is going to do with Climate."[341] These emails were leaked. So much for transparency, and so much for science.

There is an interesting parallel here with the issue of chlorine, a chemical described by Greenpeace as the "devil's element." There are some chlorine-based chemicals that are very toxic and should be tightly con- trolled and even banned in certain contexts. But as discussed earlier, chlorine is the most important element for public health and medicine, just as carbon is the most important element for life. And yet Greenpeace and its allies give the impression these two building blocks of nature are essentially evil. It is time to bring some balance into this discussion.

Al Gore is fond of reminding us that there is more CO_2 in the atmosphere today than there has been for the past 400,000 years.[342] He may be correct, although some scientists dispute this.[343] But 400,000 years is a blink of an eye in geological history. It is also true to state that CO_2 levels in the atmosphere have rarely been as low as they are today over the entire 3.5 billion years of life on earth, and particularly during the past 500 million years since modern life forms evolved. Figure 4 (previous page) shows the historic levels of CO_2 as well as the global temperature, going back 600 million years

Note the graph shows CO_2 was at least 3000 ppm, and likely around 7000 ppm, at the time of the Cambrian Period, a Greenhouse Age when modern life forms first evolved. This is nearly 20 times the CO_2 concentration today. The Ice Age that peaked 450 million years ago occurred when CO_2 was about 4000 ppm, more than 10 times its present level. If both warm and cold climates can develop when there is far more CO_2 in the atmosphere than today, how can we be certain that CO_2 is determining the climate now?

The graph does show a limited correlation between temperature and CO_2 during the late Carboniferous, and a very weak correlation from then until today. It is true that the most recent Ice Age corresponds with a relatively low CO_2 level in the atmosphere. None of this is intended to make the argument that CO_2 does not influence climate. I am no denier. We know that CO_2 is a greenhouse gas and that it plays a role in warming the earth. The real questions are: How much of a role? and If warming is caused by our CO_2 emissions, does this really harm people and the planet?

Coming closer to the present, one of the best sets of data comes from ice cores at the Russian Vostok station in Antarctica. These cores give

341. Kimberley A. Strassel, "The EPA Silences a Climate Skeptic," *Wall Street Journal*, July 3, 2009, http://online.wsj.com/article/SB124657655235589119.html

342. Dave McArthur, "The Inconvenient Truth About *An Inconvenient Truth*," *Scoop*, July 26, 2006, http://www.scoop.co.nz/stories/HL0607/S00400.htm

343. Ernst-Georg Beck, "180 Years of Atmospheric CO_2 Gas Analysis by Chemical Methods," *Energy and Environment*,18, no. 2 (2007), http://icecap.us/images/uploads/EE_18-2_Beck.pdf

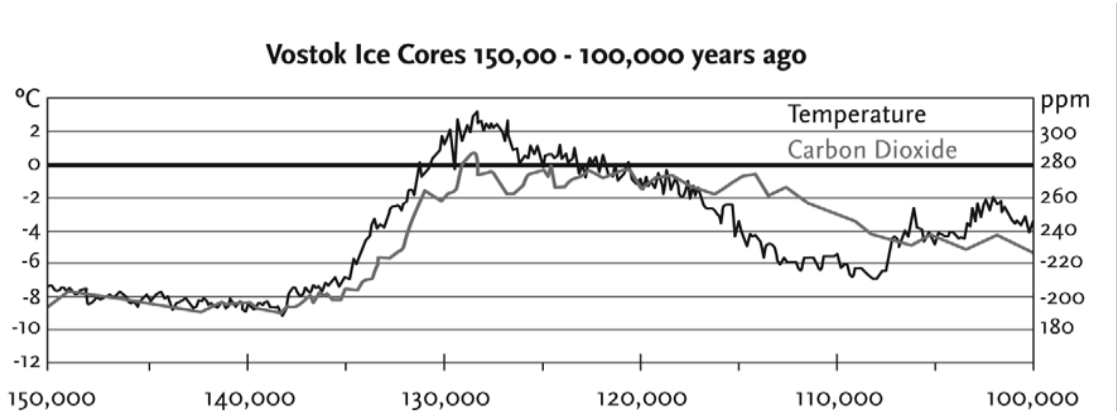


Figure 5. Graph showing temperature and CO_2 levels from 150,000 to 100,000 years ago. Note that temperature rises ahead of a rise in CO_2.

us a picture of both temperature and atmospheric CO_2 levels going back 420,000 years. Al Gore uses this information in his film *An Inconvenient Truth* to assert that it provides evidence that increased CO_2 causes an in- crease in temperature. Closer examination of the data shows that it is the other way around.[344] Through most of this period it is temperature that leads CO_2 as shown for the period 150,000 to 100,000 years ago in Figure 5. When temperature goes up, CO_2 follows and when temperature goes down, CO_2 follows it down.

This does not prove that increases in temperature cause increases in CO_2, it may be that some other common factor is behind both trends. But it most certainly does not indicate rising CO_2 levels cause increases in temperature. It may be that CO_2 causes a tendency for higher temperatures but that this is masked by other, more influential factors such as water vapor, the earth's orbit and wobbles, etc.

The April 2008 edition of *Discover* magazine contains a full-page article about plants, written by Jocelyn Rice, titled, "Leaves at Work." The article begins with this passage, "In the era of global warming, leaves may display an unexpected dark side. As CO_2 concentrations rise, plants can become full. As a result, their stomata—the tiny holes that collect the CO_2...will squeeze shut. When the stomata close, plants not only take less CO_2 from the air but also draw less water from the ground, resulting in a run of water into rivers. The *stomata effect* [my emphasis] has been responsible for the 3 percent increase in river runoff seen over the past century."[345] At this point my BS meter came on. There is no possibility anyone has a data set that could determine a 3 percent increase in global

344. Joanne Nova, "Carbon Follows Temperature in the Vostok Ice Cores," JoNova, 2008–2010, http://joannenova.com.au/global-warming/ice-core-graph/

345. Jocelyn Rice, "Leaves at Work," *Discover* magazine, April 2008, p. 17 http://www.beattystreetpublishing.com/confessions/references/stomata-effect

river runoff in the past 100 years. The U.K.'s Hadley Centre for Climate Prediction and Research was given as the source of this information. A thorough review of the Hadley Centre website turned up nothing on the subject.[346]

The story goes on to predict that, given present trends in CO_2 emissions, "runoff within the next 100 years could increase by as much as 24 percent above pre-industrial levels... in regions already hit hard by flooding, the stomata effect could make matters much worse." The Great Flood will return and inundate the earth due to trillions of tiny stomata shutting their doors in the face of too much CO_2!

I also knew immediately that the entire article was bogus because I am familiar with the fact that greenhouse growers purposely divert the CO_2 -rich exhaust gases from their wood or gas heaters into their greenhouses in order to greatly increase the CO_2 level for the plants they are growing. I searched the Internet using the phrase "optimum CO_2 level for plant growth." All I needed were the first few results to see plants grow best at a CO_2 concentration of around 1500 ppm, which boosts plant yield by 25 to 65 percent.[347] The present CO level in the global atmosphere is about 390 ppm. In other words, the trees and other plants that grow around the world would benefit from a level of CO_2 about four times higher than it is today. There is solid evidence that trees are already showing increased growth rates due to rising CO levels.[348]

Greenhouse growers are able to obtain growth rates that are 40 to 50 percent higher than the rates plants grow under in today's atmospheric conditions. This makes sense when you consider that CO_2 levels were generally much higher during the time when plant life was evolving than they are today. The fact is, at today's historically low CO_2 concentrations, all the plants on earth are CO_2-deprived. Those plants are starving out there!

Yet believers in catastrophic climate change will not abide by this clear evidence. In May 2010 Science magazine published an article titled, "Carbon Dioxide Enrichment Inhibits Nitrate Assimilation in Wheat and Arabidopsis."[349] The article implied that increased CO levels in the atmos phere might inhibit the uptake of nitrogen. The popular press interpreted this as evidence that increased CO_2 might not result in increased growth rates, as has been conclusively demonstrated in hundreds of lab and field experiments.[350] This is why greenhouse growers purposely inject CO into their greenhouses. Typically, the *Vancouver Sun* ran with the headline,

346. "Met Office Hadley Centre," Met Office, http://www.metoffice.gov.uk/climatechange/science/hadleycentre/

347. "Indoor Growing: Using CO_2," Planet Natural, http://www.planetnatural.com/site/xdpy/kb/implementing-co2.html

348. "Forest are Growing Faster, Climate Change Appears to be Driving Accelerated Growth," Smithsonian Environmental Research Center, February 1, 2010, http://sercblog.si.edu/?p=466

349. Arnold J. Bloom, "Carbon Dioxide Enrichment Inhibits Nitrate Assimilation in Wheat and Arabidopsis," *Science* 328, no. 5980 (May 14, 2010): 899–903, http://www.sciencemag.org/cgi/content/abstract/328/5980/899

350. "Plant Growth Database," *CO_2 Science*, http://www.co2science.org/data/plant_growth/plantgrowth.php

"Rising Carbon Dioxide Levels May Hinder Crop Growth: Greenhouse Gas Is Not Beneficial to Plants, As Once Thought."[351] The Science article was clever enough not to suggest that CO_2 would "hinder" plant growth, or even to question the proven fact that CO_2 increases plant growth. But by raising a side issue of nitrogen uptake it encouraged the media to make sensationalist claims, apparently debunking the fact that doubling, tripling, or even quadrupling CO_2 results in increased growth, regardless of some point about nitrogen.

It may turn out to be a very good thing that humans discovered fossil fuels and started burning them for energy. By the beginning of the Industrial Revolution CO_2 levels had gradually diminished to about 280 ppm. If this trend, which had been in effect for many millions of years, had continued at the same rate it would have eventually threatened plant life at a global level. At a level of 150 ppm, plants stop growing altogether. If humans had not appeared on the scene, it is possible that the declining trend in CO_2 levels that began 150 million years ago would have continued. If it had continued at the same rate, about 115 ppm per million years, it would have been a little over one million years until plants stopped growing and died. And that would be the end of that!

This is perhaps my most heretical thought: that our CO_2 emissions may be largely beneficial, possibly making the coldest places on earth more habitable and definitely increasing yields of food crops, energy crops, and forests around the entire world. Earlier I referred to my meeting with James Lovelock, the father of the Gaia Hypothesis and one of the world's leading atmospheric scientists. I found it strange he was so pessimistic about the future, and cast our species as a kind of rogue element in the scheme of life.

Whereas the Gaia Hypothesis proposes that all life on earth acts in concert to control the chemistry of the atmosphere in order to make it more suitable for life, Lovelock believes human-caused CO_2 emissions are the enemy of Gaia. But surely humans are as much a part of Gaia as any other species, past or present? How could we know we are the enemy of Gaia rather than an agent of Gaia, as one would expect if "all life is acting in concert"? In other words, is it not plausible that Gaia is using us to pump some of the trillions of tons of carbon, which have been locked in the earth's crust over the past billions of years, back into the atmosphere? Perhaps Gaia would like to avoid another major glaciation, and more importantly avoid the end of nearly all life on earth due to a lack of CO_2. One thing I know for sure is we should be a lot more worried the climate will cool by 2 or 3 degrees Celsius than we should be about it warming by 2

351. Amina Khan, "Rising Greenhouse Gas Levels May Hinder Crop Growth," *Vancouver Sun*, May 15, 2010, http://www.vancouversun.com/health/Rising+carbon+dioxide+levels+hinder+crop+growth/3031640/story.html#ixzz0oFzR7jth

or 3 degrees Celsius. Cooling would definitely threaten our food supply; warming would almost certainly enhance it.

I'm not saying I buy into the entire Gaia Hypothesis hook, line, and sinker. I find some aspects of it very compelling, but it might be a bit of a stretch to believe all life is acting in harmony, like on the planet Pandora in the movie *Avatar*. But that's not my point. What bothers me is the tendency to see all human behavior as negative. Lovelock and his followers seem to need a narrative that supports the idea of original sin, that we have been thrown out of the Garden of Eden, or is it the Garden of Gaia?

The Hockey Stick

No discussion of climate change would be complete without mention of the infamous hockey stick graph of global temperature. The graph, said to depict Northern Hemisphere temperatures over the past 1,000 years, was created by Michael Mann of Pennsylvania State University and his colleagues. It shows a very even temperature until the modern age when there is a steep rise.[352] The surprise for many scientists was that the graph implied the Medieval Warm Period and the Little Ice Age did not exist and that the only significant change in temperature during the past 1000 years was a precipitous rise during the past century. The graph was very controversial in climate science circles. Despite the sharp debate, it was showcased in the 2001 and 2004 reports of the IPCC. [353]

Two Canadians, Steve McIntyre, a retired mining engineer, and Ross McKitrick, an economist, became concerned that the data used to create the hockey stick graph were not objective and the statistical analysis used was not legitimate. They asked Mann and others to provide them with the original data and the statistical methods used to arrive at the hockey stick graph. Mann and his colleagues at the Climatic Research Unit (CRU) at the University of East Anglia refused repeated requests to supply the data. The effort to obtain the data went on for 10 years as the researchers even refused requests under Freedom of Information Act rules. It was not until the release of thousands of emails from the CRU that it became clear information was being withheld illegally and there was a conspiracy of sorts to manipulate the data and discredit opposing opinions.

In 2003 McIntyre and McKitrick published a critique of the hockey stick graph in *Energy & Environment* in which they contended that Mann's paper contained, "collation errors, unjustifiable truncation or

352. Michael E. Mann et al., "Global-Scale Temperature Patterns and Climate Forcing Over the Past Six Centuries," *Nature* 392 (April 23, 1998). http://www.junkscience.com/MSU_Temps/PDF/mann1998.pdf

353. Suzanne Goldenberg, "'Hockey Stick' Graph Creator Michael Mann Cleared of Academic Misconduct," *Guardian*, February 3, 2010, http://www.guardian.co.uk/environment/2010/feb/03/climate-scientist-michael-mann

extrapolation of source data, obsolete data, geographical location errors, incorrect calculation of principal components and other quality control defects."[354] As a result of this and other critiques the IPCC did not use the hockey stick graph again in its 2007 report. The continuing debate over this graph highlights the absence of a consensus on the temperature record, never mind whether or not humans are responsible for climate change.

What's So Good About Glaciers, Anyway?

Much has been made of the fact that many glaciers around the world have been retreating in recent years. By many accounts we should be viewing this with alarm. The potential loss of glaciers is portrayed as an ecological catastrophe, as if it were equivalent to a species becoming extinct. In its June 2007 issue the *National Geographic* magazine reported that a certain Peruvian glacier was in a "death spiral," as if it were a living thing.[355] What should we make of this hysterical reaction to melting ice?

It is important to recognize that glaciers have been retreating for about 18,000 years, since the height of the last glaciation. It has not been a steady retreat as there have been times, such as during the Little Ice Age, when the glaciers advanced. But there is no doubt that in balance there has been a major retreat and it appears to be continuing today.

The retreat of the glaciers is largely a result of the climate becoming warmer. It brings us back to the question of whether humans are responsible for the warming or if it is just a continuation of the trend that began 18,000 years ago. Either way, we then must ask whether, in balance, this is a good thing or a bad thing. We know the climate was warmer than it is today during most of the past 500 million years, and that life flourished during these times. We also know there is very little life on, in, or under a glacier. Glaciers are essentially dead zones, proof that ice is the enemy of life.

When a glacier retreats up the valley it carved, the bedrock and gravels are exposed to light and air. Seeds find their way there, on the wind and in bird droppings, and can germinate and grow. Before long the lifeless barrens become a newly developing ecosystem full of lichens, mosses, ferns, flowering plants, and eventually, trees. Isn't it fairly obvious that this is a better environmental condition than a huge blob of frozen water that kills everything beneath it? Glaciers certainly are photogenic, but as we dis-

354. Stephen McIntyre and Ross McKitrick, "Corrections to the Mann et al. (1998) Proxy Data Base and Northern Hemispheric Average Temperature Series," *Energy & Environment* 14, no. 6 (2003): 751–771, http://www.uoguelph.ca/~rmckitri/research/MM03.pdf 355. Tim Appenzeller, "The Big Thaw," *National Geographic*, June 2007, http://ngm.nationalgeographic.com/2007/06/big-thaw/big-thaw-text

cussed in the chapter on forests, you can't judge the health of an ecosystem by the fact that it looks pretty. Sand dunes make for nice scenery too, but they aren't very welcome when they bury a town and kill all the crops.

Much attention has been focused on the Greenland ice cap, virtually one big glacier with many arms to the sea. During the warming that occurred in the 1980s and 1990s it was reported that the Greenland ice cap was melting rapidly. Al Gore predicted the sea might rise by 20 feet in the next century, apparently assuming the entire ice cap might melt in 100 years.[356] This is a physical impossibility. The high elevation and extreme low temperatures dictate that it would take at least thousands of years for the glaciers of Greenland to disappear.

More recently the focus has been on the Himalayan glaciers, the largest ice cap outside the Polar Regions. The story of what has become "Glaciergate" helps to illustrate the present very confused state of climate science and of how important glaciers are, or are not. The 2007 report of the IPCC, its fourth report, stated Himalayan glaciers may be completely gone by 2035, less than 25 years from now.[357] [358] The report warned, "if the present rate continues, the likelihood of them disappearing by the year 2035 and perhaps sooner is very high if the Earth keeps warming at the current rate." It was not until the lead-up to the 2009 Kyoto Protocol meeting in Copenhagen that scientists began to question this assertion. The Ministry of the Environment in India published a paper rejecting the 2035 prediction, stating that it would be hundreds of years before the glaciers melted, even if the present warming trend continued.[359] This caused the chairman of the IPCC, Dr. Rajendra Pachauri, who happens to be Indian, to denounce the Environment Ministry's report as "voodoo science."[360]

It was not until after the Copenhagen conference that the IPCC published an admission of error. They stated, "In drafting the paragraph in question, the clear and well-established standards of evidence, required by the IPCC procedures, were not applied properly."[361] Yet Dr. Pachauri refused to apologize for calling the Environment Ministry's report "voodoo science."[362] It was revealed that the 2035 date was based

356. Jeffrey Masters, "Al Gore's *An Inconvenient Truth*," Weather Underground, http://www.wunderground.com/education/gore.asp
357. "The Himalayan Glaciers," Intergovernmental Panel on Climate Change, 2007, http://www.ipcc.ch/publications_and_data/ar4/wg2/en/ch10s10-6-2.html
358. "IPCC Slips on the Ice with Statement About Himalayan Glaciers," climatesciencewatch.org, January 19, 2010, http://www.climatesciencewatch.org/index.php/csw/details/ipcc_slips_on_the_ice/
359. V. K. Raina, "Himalayan Glaciers," Science & Public Policy Institute, November 12, 2009, http://scienceandpublicpolicy.org/reprint/himalayan_review_of_glacial_studies.html
360. "Pachauri Calls Indian Govt. Report on Melting Himalayan Glaciers as 'Voodoo Science,'" *Thaindian News*, January 9, 2010, http://www.thaindian.com/newsportal/health/pachauri-calls-indian-govt-report-on-melting-himalayan-glaciers-as-voodoo-science_100301232.html
361. "Worldwide Glacier Melt a Real Concern; Himalaya Controversy Leaves Questions About IPCC Leadership, climatescience-watch.org, January 21, 2010, http://www.climatesciencewatch.org/index.php/csw/details/glacier-melt-ipcc-controversy/
362. "Pachauri Won't Apologies [sic.], Admits IPCC's Credibility Damaged," *India Post*, February 3, 2010, http://www.indiapost.com/international-news/6964-Pachauri-wont-apologies-admits-IPCCs-credibility-damaged.html

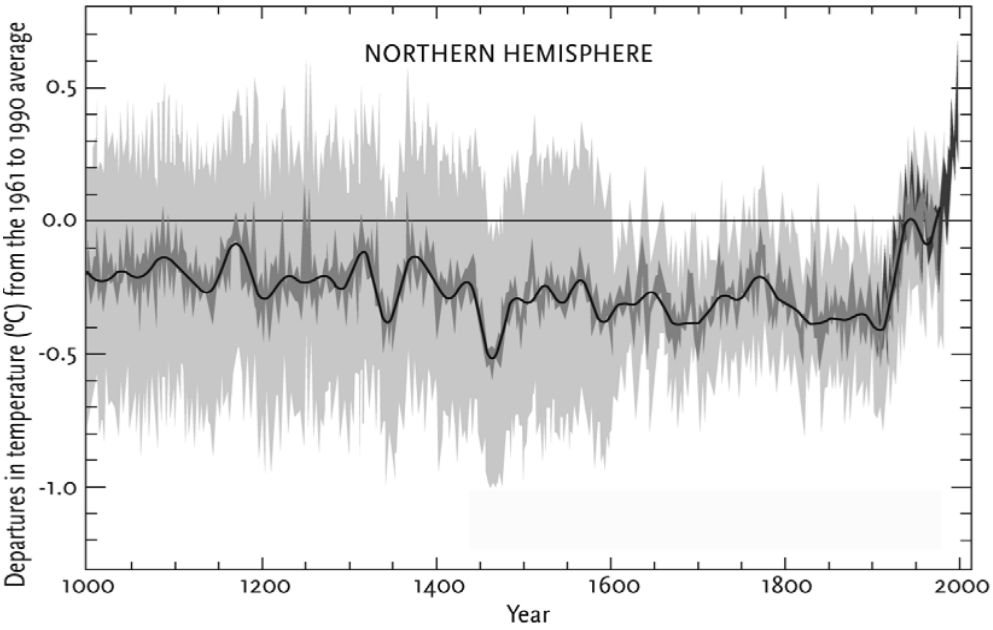


Figure 6. The Michael Mann Hockey Stick Graph as it appeared in the 2001 Assessment Report of the Intergovernmental Panel on Climate Change. 363

on an interview by *New Scientist* magazine of a single Indian scientist, who subsequently admitted his statement was "speculative."[364] The *New Scientist* article was then referred to in a 2005 WWF report on glaciers, which was cited as the only reference in support of the 2035 date.[365]

This has caused something of a crisis of credibility for the IPCC, which had insisted all its predictions were based on peer-reviewed science. As it turns out, the most credible scientists who specialize in the subject of Himalayan glaciers believe it would take at least 300 years for them to melt completely, even if it continues to get warmer. Other indefensible statements in the IPCC report then emerged regarding the disappearance of the Amazon rain forest[366] and the collapse of agricultural production in Africa.[367]

363. "Working Group I: The Scientific Basis," Intergovernmental Panel on Climate Change, 2001, http://www.ipcc.ch/ipccreports/tar/wg1/005.htm

364. Fred Pearce, Debate Heats Up Over IPCC Melting Glaciers Claim, *New Scientist*, January 11, 2010, http://www.newscientist.com/article/dn18363-debate-heats-up-over-ipcc-melting-glaciers-claim.html

365. Jonathan Leake and Chris Hastings, "World Misled Over Himalayan Glacier Meltdown," *Sunday Times*, January 17, 2010, http://www.timesonline.co.uk/tol/news/environment/article6991177.ece

366. Christopher Booker, "Amazongate: New Evidence of the IPCC's Failures," *Telegraph*, January 30, 2010, http://www.telegraph.co.uk/comment/columnists/christopherbooker/7113582/Amazongate-new-evidence-of-the-IPCCs-failures. html

367. Lawrence Solomon, "Climategate Is One of Many Known IPCC Failings," *Financial Post*, February 26, 2010, http://network.nationalpost.com/np/blogs/fpcomment/archive/2010/02/06/392245.aspx

Perhaps the most bizarre case of logical disconnect in the climate change hysteria involves the predictions of disaster if the Himalayan glaciers continue to melt. Lester Brown, president of the Earth Policy Institute, predicts that if this happens there will be mass starvation in Asia.[368] The theory goes like this: the meltwater from the glaciers is essential for irrigation of food crops throughout much of Asia. The Ganges, Indus, Mekong, Yellow, Yangtze, and many other rivers flow from the Himalayas, providing water for over one-third of the human population. If these glaciers were to melt completely, there would be no more meltwater for irrigation, and so food production would plummet, resulting in mass starvation. This seems plausible to many people and has been repeated countless times in the media as another "catastrophic" aspect of climate change.

After hearing Lester Brown speak at length about this doomsday scenario, it dawned on me that his thesis was illogical. On the one hand he is saying the meltwater (from the melting glaciers) is essential for food production, and on the other hand he insists that we must try to stop the glaciers from melting so they will not disappear. Obviously if the glaciers stop melting, there will be no more meltwater from them. So my questions for Lester Brown, and the IPCC, are, Are you saying you want the glaciers to stop melting? Then where would the irrigation water come from? I might add, How about if the glaciers started growing again, reducing water flows even further, perhaps advancing on the towns where the food is grown?

It has since been revealed that only 3 to 4 percent of the water flowing into the Ganges River is glacial meltwater. Ninety-six percent of the river flow is from snow that fell in the previous winter and melted in the summer, and from rainfall during monsoons.[369] Therefore the people will not likely starve if the glaciers melt completely. A warmer world with higher CO_2concentrations, and likely more precipitation, will allow expansion of agricultural land and will result in faster-growing, more productive crops. Forests and crops will grow where now there is only a sheet of ice. I say let the glaciers melt.

Arctic and Antarctic Sea Ice

The Arctic and Antarctic regions are polar opposites in more ways than one. Whereas the Arctic is mainly an ocean surrounded by continents, the Antarctic is a large continent, almost centered on the South Pole, surrounded by seas. The Antarctic is colder than the Arctic largely due

368. Lester R. Brown, "Melting Mountain Glaciers Will Shrink Grain Harvests in China and India," Earth Policy Institute, March 20, 2008, http://www.earthpolicy.org/index.php?/plan_b_updates/2008/update71

369. Palava Bagla, "No Sign of Himalayan Meltdown, Indian Report Finds," *Observatory*, November 15, 2009, http://www.thegwpf.org/the-observatory/91-no-sign-of-himalayan-meltdown-indian-report-finds.html

to its high elevation.[370] The Antarctic ice sheet began to form 20 million years ago and has been a permanent fixture since then, advancing and retreating with the pulses of glaciation over the past 2.5 million years during the Pleistocene Ice Age. The Arctic was largely ice-free until the onset of the Pleistocene and since then has had varying degrees of ice cover as glacial periods have waxed and waned.

Much has been made recently of the fact that the extent of summer sea ice in the Arctic has shrunk substantially. In September of 2007, typically the low month after summer melting, there was about three million square kilometers of ice cover, about two million less than the average since records were first made. Many pundits immediately predicted that the Arctic would be ice-free in the summer within 20 to 30 years, and that this would be our fault entirely. The fact that the area of ice recovered by about one million square kilometers in 2008 and again in 2009 didn't dampen the shrillness of their predictions. In September of 2012 the extent if ice cover again reached a record low, but winter ice cover continued to remain relatively steady, close to the average since measurements began.

Our knowledge of the extent of sea ice in the Arctic and Antarctic began in 1979, the first year satellites were used to photograph the Polar Regions on a continual basis. Before 1979 it is not possible to reconstruct the comings and goings of sea ice, as unlike glaciers, sea ice leaves no trace when it melts. There is an implicit assumption among the true believers that the reduction in sea ice observed in 2007 and 2012 is unique in the historical record and that we are now on a one-way trip to an ice-free Arctic Sea (see Figure 7 on next page). Putting aside the fact that mariners consider an ice-free sea a good thing, it is not possible to conclude a long-term trend in the extent of Arctic sea ice from 30 years of satellite observation.

Between 1903 and 1905 the Norwegian Raold Amundsen became the first person to navigate the Northwest Passage in a 47-ton sailing ship equipped with a small gasoline motor.[371] We do not know the extent of ice over the entire Arctic at that time but the fact that a small boat could sail through the passage indicates the present era was not the only time the area of ice was reduced.

Between 1940 and 1944, years before we had any idea of the extent of sea ice during the summers and winters, a small Canadian trawler name the *St. Roch* navigated the Northwest Passage twice, from west to east and from east to west.[372] [373] It was not an icebreaker and it had only a 150-horsepower diesel engine and sails. From 1910 to 1940 there was a well-documented rise in the average global temperature of nearly half

370. "Antarctic Climate," Wikipedia, http://en.wikipedia.org/wiki/Antarctica#Climate
371. "Roald Amundsen," Wikipedia, http://en.wikipedia.org/wiki/Roald_Amundsen
372. Noel Sheppard, "Reports of Record Arctic Ice Melt Disgracefully Ignore History," NewsBusters, September 9, 2007, http://newsbusters.org/blogs/noel-sheppard/2007/09/09/reports-record-arctic-ice-melt-disgracefully-ignore-history
373. "Second Through the Passage, First West to East," Athropolis, http://www.athropolis.com/arctic-facts/fact-st-roch.htm

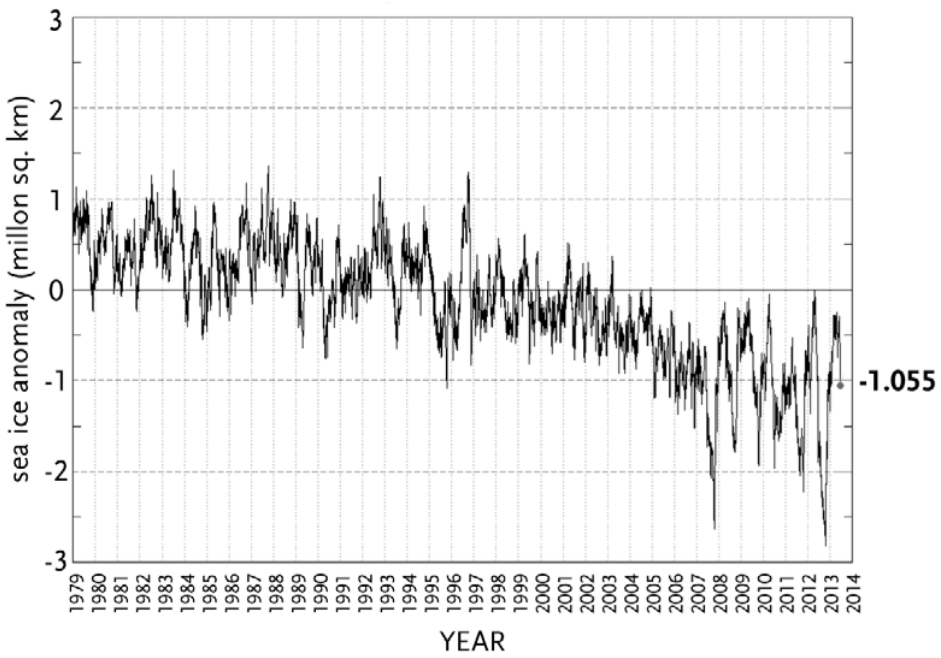
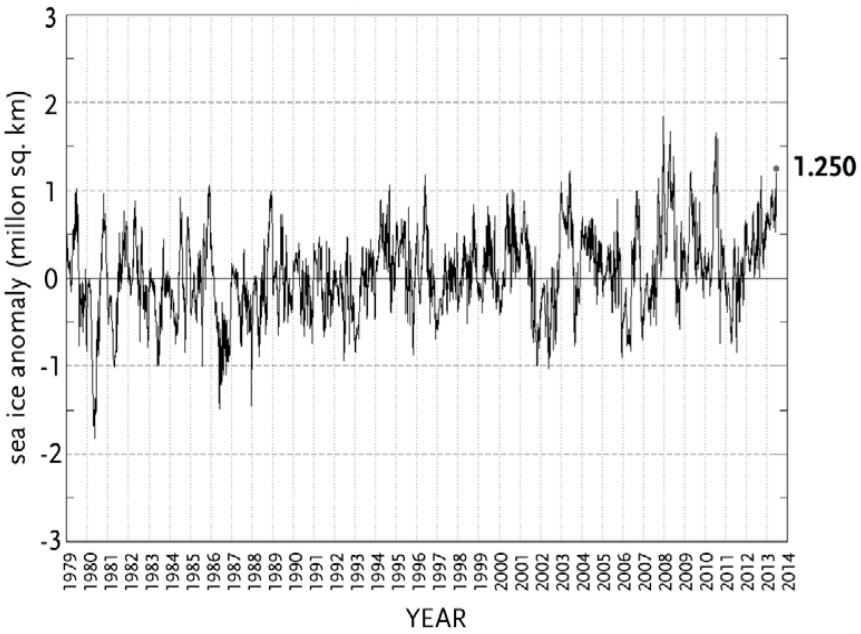


Figure 7. *Northern Hemisphere Sea Ice Anomaly (1979–2008 mean).*The extent of sea ice in the Arctic showed a clear downward trend from 1995 to 2007. Since 2007 it has recovered by about one-third over the lowest area. Only time will tell what the trend will be in the coming decades.

Figure 8. *Southern Hemisphere Sea Ice Anomaly (1979–2008 mean).* Graph showing the deviance from the 1979 to 2008 average extent of sea ice in the Antarctic. The winter of 2007 saw the greatest extent of Antarctic sea ice since measurements were first taken, coincident with the least extent in the Arctic. Whereas the extent of Arctic sea ice has shown a recent downward trend, the extent of Antarctic sea ice has shown an upward trend.



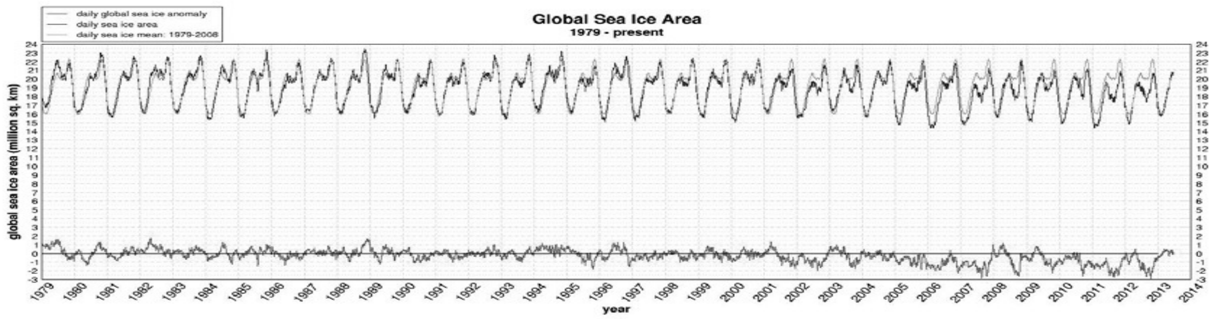


Figure 9. Global sea ice area, 1979 to present. The top line shows the total sea ice cover for the Arctic and the Antarctic. The bottom line shows the divergence from the mean of Arctic and Antarctic sea ice cover. As you can see, there is no significant trend when Arctic and Antarctic sea ice areas are added together.

a degree Celsius. There is every possibility that Arctic ice was as reduced when the *St. Roch* sailed through the passage as it has been in recent years. We will never know.

While all the media's and activist's attention has been on Arctic sea ice, the Antarctic has been playing out its own history in a very different way. The winter sea ice around Antarctica has grown above the average from 1979 to 2008 (See Figure 8). This has proven problematic for believers as it indicates Antarctica is cooling, contrary to what they have been led to believe by predictions based on computer models. In December 2008 *Nature* published an article claiming the Antarctic was warming.[374] Many climate activists, including Al Gore, seized on this article to bolster their belief in human-caused warming.[375] It turned out that the *Nature* article had been largely based on a computer model rather than real measurements of temperature. This represented another turning point in the questioning of the science used to claim humans were definitely causing the earth to warm up.[376]

In 2009 the U.S. Geological Survey (USGS) published a paper in which it reported sea ice had retreated in one part of the Antarctic Peninsula.[377] The paper made it clear that ice was growing in other parts of Antarctica and it was not clear whether the total amount of ice on and around the continent was shrinking or growing. In Greenpeace-like fashion the USGS then issued a media release claiming the sea ice was "disappearing" in Antarctica and that sea level rise was imminent.[378] News services

374. Eric J. Steig et al., "Warming of the Antarctic Ice-Sheet Surface Since the 1957 International Geophysical Year," *Nature* 457 (22 January 2009): 459–462, http://www.nature.com/nature/journal/v457/n7228/abs/nature07669.html 375. Al Gore, "The Antarctic Warming," February 5, 2009, http://blog.algore.com/2009/02/the_antarctic_is_warming.html 376. Christopher Booker, "Despite the Hot Air the Antarctic Is Not Warming Up," *Telegraph*, January 24, 2009, ...
... http://www.telegraph.co.uk/comment/columnists/christopherbooker/4332784/Despite-the-hot-air-the-Antarctic-is-not- warming-up.html 377. Ferrigno, J.G., Coastal-Change and Glaciological Map of the Palmer Land Area, Antarctica: 1947–2009," U.S. Geological Survey, 2009, http://pubs.usgs.gov/imap/i-2600-c/
378. "Ice Shelves Disappearing on Antarctic Peninsula: Glacier Retreat and Sea Level Rise Are Possible Consequences," U.S. Geological Survey Newsroom, February 22, 2010, http://www.usgs.gov/newsroom/article.asp?ID=2409&from=rss_home

picked up this story, which gave the impression Antarctica was melting away. Perhaps the USGS scientists feel the need to sensationalize their otherwise good research in order to get more funding. I don't know, but it certainly misleads the public about what is really happening down there.

The University of Illinois' website, *The Cryosphere Today*, contains the entire record of sea ice since 1979.[379] (The Cryosphere is the area of the earth covered with ice.) Figure 9 (on previous page) shows the global sea ice cover, adding together the Arctic and the Antarctic, from 1979 until the present.[380] This is our total knowledge of the history of sea ice cover on planet Earth. There is no obvious trend up or down because increased ice cover in the Antarctic offsets most of the reduced ice cover in the Arctic. So even the very short record we do have for global sea ice cover provides no evidence of rapid global warming.

Coral Reefs, Shellfish, and "Ocean Acidification"

It has been widely reported in the media, based on a few scientific papers, that the increasing levels of CO_2in the atmosphere will result in "ocean acidification," threatening coral reefs and all marine shellfish with extinction within 20 years.[381] The story goes like this: The oceans absorb about 25 percent of the CO_2we emit into the atmosphere each year. The higher the CO_2content of the atmosphere, the more CO_2will be absorbed by the oceans. When $CO_2$is dissolved in water, some of it is converted into carbonic acid that has a weak acidic effect. If the sea becomes more acidic, it will dissolve the calcium carbonate that is the main constituent of coral and the shells of clams, shrimp, crabs, etc. It is one more doomsday scenario, predicting the seas will "degrade into a useless tidal desert,"[382]

In his latest book, *Eaarth: Making a Life on a Tough New Planet*, Bill McKibben claims, "Already the ocean is more acid than anytime in the last 800,000 years, and at current rates by 2050 it will be more corrosive than anytime in the past 20 million years." In typical hyperbolic fashion, McKibben, the author of the well-know essay, "The End of Nature," uses the words *acid* and *corrosive* as if the ocean will burn off your skin and flesh to the bone if you dare swim in it in 2050. This is just plain fear-mongering.

Results of research published in the journal *Science* by M.R. Palmer et al., indicate that over the past 15 million years, "All five samples record surface seawater pH values that are within the range observed in the oceans today, and they all show a decrease in the calculated pH with depth that is similar to that observed

379. "The Cryosphere Today," Polar Research Group, University of Illinois, http://arctic.atmos.uiuc.edu/cryosphere/
380. "Global Sea Ice Area: 1979 to Present," Polar Research Group, University of Illinois, http://arctic.atmos.uiuc.edu/cryosphere/IMAGES/global.daily.ice.area.withtrend.jpg
381. Frank Pope, "Great Barrier Reef Will Be Gone in 20 Years, Says Charlie Veron," *Sunday Times*, July 7, 2009, http://www.timesonline.co.uk/tol/news/environment/article6652866.ece
382. Richard Girling, "The Toxic Sea," *Sunday Times*, March 8, 2009, http://www.timesonline.co.uk/tol/news/environment/article5853261.ece#cid=OTC-RSS&attr=3392178

in the present-day equatorial Pacific." The five samples recorded pH values for 85,000 years ago and for 2.5, 6.4, 12.1, and 15.7 million years ago.[383]

First, one should point out that the ocean is not acidic, it has a pH of 8.1, which is alkaline, the opposite of acidic. A pH of 7 is neutral, below 7 is acidic, above 7 is alkaline. Researchers have reported in scientific journals that the pH of the seas has gone down by 0.075 over the past 250 years, "Between 1751 and 1994 surface ocean pH is estimated to have decreased from approximately 8.179 to 8.104 (a change of −0.075)."[384] One has to wonder how the pH of the ocean was measured to an accuracy of three decimal places in 1751 when the concept of pH was not introduced until 1909.[385]

It turns out that just as with climate science in general, these predictions are based on computer models. But oceans are not simple systems whose components can just be plugged into a computer. First, there is the complex mix of elements and salts dissolved in the sea. Every element on Earth is present in seawater and these elements interact in complex ways. Then there is the biological factor, tens of thousands of species that are consuming and excreting every day. The salt content of seawater gives the oceans a very large buffering capacity against change in pH. Small additions of acidic and alkaline substances can easily alter the pH of freshwater, whereas seawater can neutralize large additions of acidic and alkaline substances.

One of the most important biological phenomena in the sea is the combining of calcium, carbon, and oxygen to form calcium carbonate, $CaCO_3$, the primary constituent of corals and shells, including the skeletons of microscopic plankton. The formation of calcium carbonate is called calcification. All of the vast chalk, limestone, and marble deposits in the earth's crust are composed of calcium carbonate, which was created and deposited by marine organisms over millions of years. The carbon in calcium carbonate is derived from CO_2 dissolved in seawater. One might therefore imagine that an increase in CO_2 in seawater would enhance calcification rather than destroy it. It turns out this is precisely the case.

As is the case with terrestrial plants, it has been thoroughly demonstrated that increased CO_2 concentration in the sea results in higher rates of photosynthesis and faster growth. Photosynthesis has the effect of in- creasing the pH of the water, making it more alkaline, counteracting any minor acidic effect of the CO itself.[386] The owners of saltwater aquariums

383. M. R. Palmer et al., "Reconstructing Past Ocean pH-Depth Profiles," *Science* 282, no. 5393 (November 20, 1998): 1468– 1471, http://www.scienceonline.org/cgi/content/short/282/5393/1468 (Register with *Science* to see full article free-of-charge)

384. James C. Orr et al., "Anthropogenic Ocean Acidification Over the Twenty-First Century and Its Impact on Calcifying Organisms," *Nature* 437 (September 29, 2005): 681–686, http://www.ipsl.jussieu.fr/~jomce/acidification/paper/Orr_OnlineNature04095.pdf

385. "pH,"Wikipedia,http://en.wikipedia.org/wiki/PH

386. Ocean Acidification: The Other CO2 Problem Propaganda Film by The National Resources Defense Council

often add CO_2 to the water in order to increase photosynthesis and calcification, a practice that is similar to greenhouse growers adding CO_2 to the air in their greenhouses to promote the faster growth of plants. The vast bulk of scientific literature indicates increased CO_2 in the ocean will actually result in increased growth and calcification, as opposed to the catastrophe scenario pushed by the NRDC, Greenpeace, and many other activist organizations.[387] [388]

A long list of scientific publications that support the view that increased CO_2 in seawater results in increased calcification can be found on the CO_2 Science website.[389] A paper by Atkinson et al., published in the journal *Coral Reefs*, states that their finding "seems to contradict conclusions ... that high CO may inhibit calcification."[390]

"Ocean acidification" is a perfect example of a contrived catastrophe scenario. The average person does not have a grasp of the complexities of marine chemistry and biology. The activists simply coin a new, scary term like "acidification" and then effectively extort money from people who are concerned for the future. And all this emphasis on the dangers of CO_2tends to divert people from thinking about the real dangers to coral reefs like destructive fishing methods and pollution from sewage.

Our little house by the Sea of Cortez in Cabo Pulmo in southern Baja, Mexico, looks out over a National Marine Park that contains the only large coral reef on the west coast of the Americas. Pulmo Reef is a popular dive site, known for its rich abundance of reef fish, many of which school in the thousands. It was after a dive on the reef during our first visit to Cabo Pulmo in 1999 that Eileen and I decided to make a base there. Since then we have dived and snorkeled on the reef many times each year.

In September of 2002 a tropical storm brought torrential rains that dumped over 20 inches of rainfall in a 24-hour period. It must have been a once in a 100-year event as the flooding was the worst the locals could remember. A lens of freshwater about 20 feet deep spread out over the reef as a result of the runoff from the mountains. This killed all the coral, as coral cannot live in freshwater. Only the corals below the 20-foot depth of the freshwater layer survived.

Fails the Acid Test," Science & Public Policy Institute, January 5, 2010, http://scienceandpublicpolicy.org/images/stories/papers/originals/acid_test.pdf

387. Ocean Acidification: The Other CO_2 Problem, Natural Resources Defense Council, September 17, 2009, http://www.nrdc.org/oceans/acidification/default.asp

388. Putting a Stop to the Arctic Meltdown," Greenpeace International, January 26, 2010, http://www.greenpeace.org/international/news/hands-off-the-arctic-260110

389. Global Warming and *Coral Reefs*: Prospects for the Future," CO_2 *Science*, http://www.co2science.org/education/reports/corals/part2ref.php

390. Atkinson, M. J., Carlson, B. Growth in High-Nutrient, Low-pH Seawater: A Case Study of Corals Cultured at the Waikiki Aquarium, Honolulu, Hawaii," *Coral Reefs* 14, no. 4, pp. 215–223, http://www.springerlink.com/content/g2554037454q13wp/

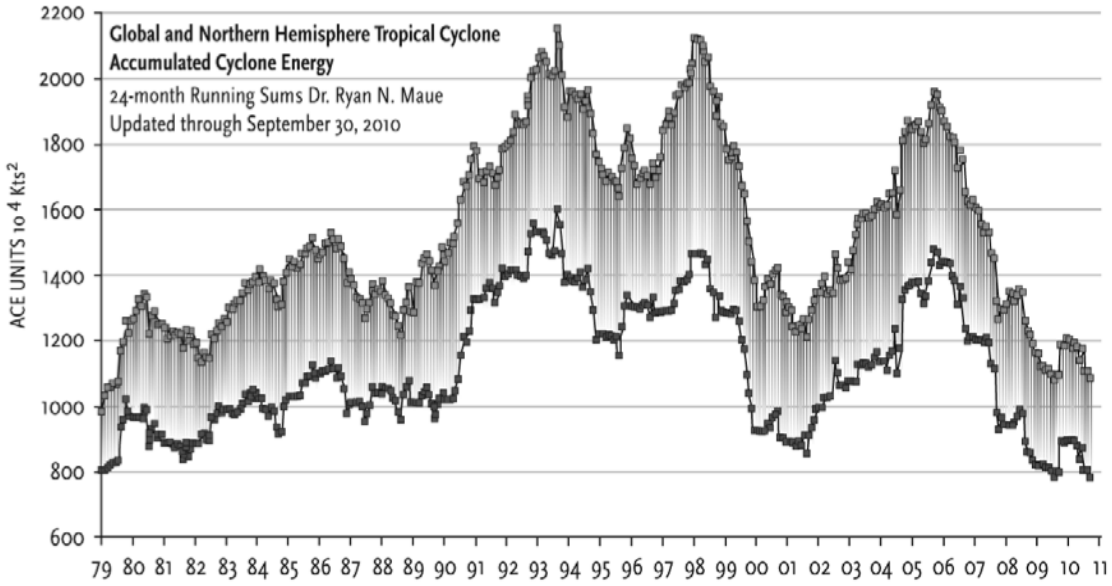


Figure 10. Global and Northern Hemisphere tropical cyclone energy 1979 to 2010. Since the peak during the 1990s, the frequency and intensity of tropical cyclones has diminished considerably.[391]

For a few years after the event virtually no living coral could be seen in the shallower waters. The reef turned white and became covered in green algae, which in turn resulted in an explosion of sea urchins where there had been very few before. By 2006 the reef began to recover noticeably with nodules of new coral becoming established. Coral polyps from the deeper regions of the reef were recolonizing the shallow waters. The sea urchins died out and fish returned in greater abundance. Today the reef is in full recovery as the coral is now growing substantially each year. It may take another 20 years or more to recover completely, and will only do so if there is not another torrential rainstorm.

I imagine some people who believe we are causing catastrophic cli- mate change would suggest we were responsible for the torrential rains that killed part of the reef. I don't believe we can be so certain, especially as such events have been occurring since long before humans began emitting billions of tons of CO_2each year. And regardless of the storm's cause, it is comforting to know that the reef can recover de- spite the dire predictions of the early death of coral reefs worldwide.

Storms, Hurricanes, and Severe Weather Events

Everyone likes to talk about the weather and climate activists are no exception. In the aftermath of Hurricane Katrina in 2005, which caused so much devastation to New Orleans and the surrounding regions, Al Gore gave a rousing speech

391. Ryan Maue, "Ryan N. Maue's 2010 Global Tropical Cyclone Activity Update," Florida State University, http://www.coaps.fsu.edu/~maue/tropical/

in which he predicted hurricanes would continue to become more frequent and more

severe as global warming intensified.[392] Since that speech the intensity of global hurricanes has diminished by about half from the peak years of 1993 and 1998. Still, on the cover of his 2009 book, *Our Choice: A Plan to Solve the Climate Crisis*, Al Gore had four fake hurricanes airbrushed onto a photo of the earth from space.[393] [394] He continues to push the fear of hurricanes when it has become clear there is no longer any basis for such concern. In fact, scientists at the U.S. National Hurricane Center predict that global warming will result in not more but fewer hurricanes.[395] Al Gore must be aware of this.

Sea Level Rise

There is conclusive proof that increased CO_2levels will be good for plants both on the land and in the sea. If increased CO_2does make the world warmer, it will almost certainly make it wetter, which will also be good for plants and most animals, including us. Then what is so bad about global warming anyway, whether it is natural or caused by humans? The prospect that sea levels will rise in a warmer world is the main draw- back as this would threaten the infrastructure we have built in low-lying coastal areas.

The seal level has fluctuated a great deal during the Pleistocene, as ice sheets have advanced and retreated and as temperatures have risen and fallen. At the height of the last glaciation, which ended 18,000 years ago, the sea was about 120 meters (nearly 400 feet) lower than it is today (See Figure 11). There was relatively rapid glacial melting and subsequent sea level rise between 15,000 and 6000 years ago as large, lower elevation ice sheets melted and disappeared. During the past 6000 years, the rise has been slower but steady. In recent times the sea level has risen by about 20 centimeters (8 inches) per century.[396]

Clearly human activity was not responsible for the end of the last glaciation, subsequent warming, and the retreat of the world's glaciers during the past 18,000 years. To date we have no indication that the rate of sea level rise is increasing, whether by natural causes or by our impact on climate. Many predictions of future sea level rise have been based on computer models. In its 2007 report the IPCC predicted sea level would rise between 18 and 59 centimeters (7 to 23 inches) during the

392. Al Gore, "On Katrina, Global Warming," Common Dreams, December 12, 2005, http://www.commondreams.org/views05/0912-32.htm

393. Al Gore, *Our Choice: A Plan to Solve the Climate Crisis*, (Rodale Press, November 2009). http://ourchoicethebook.com/

394. Noel Sheppard, "Al Gore Photoshops Hurricanes Into New Book's Cover," Newsbusters, November 19, 2009, http://newsbusters.org/blogs/noel-sheppard/2009/11/19/al-gore-photoshops-hurricanes-new-books-cover?page=1

395. Jonathan Leake, "UN's Climate Link to Hurricanes in Doubt," *Sunday Times*, February 28, 2010, http://www.timesonline.co.uk/tol/news/environment/article7044158.ece

396. "Current Sea Level Rise," Wikipedia, http://en.wikipedia.org/wiki/Current_sea_level_rise

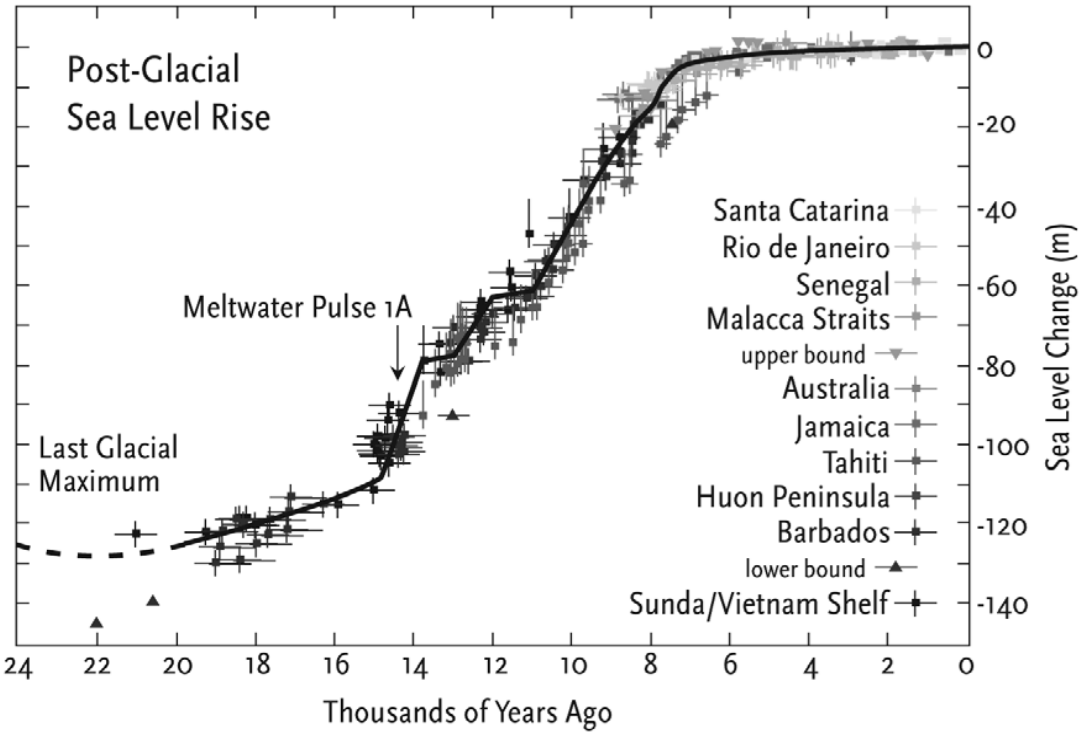


Figure 11. Graph showing that sea level was 120 meters (nearly 400 feet) lower at the height of the last glaciation.[397]

next century. The low end is entirely reasonable as this is about equal to the present rate. The high end is three times the present rate and would require a considerable amount of warming during this century. As yet there has been no warming in this century and sea level rise has not been increasing.

If the sea were to rise nearly two feet as the IPCC suggests in its extreme case, there would be disruptions to infrastructure and related activities. While natural ecosystems would adapt with little difficulty, coastal infrastructure would definitely be impacted negatively, especially our wharfs, buildings, farms, and industries. It wouldn't matter whether or not the sea level rise was due to natural or human causes.

The 120-meter (400-foot) sea level rise during the past 18,000 years did not damage the environment and was not a significant factor in human survival. We have managed to cope with the 20-centimeter (8-inch) rise over the past century. But we have built vastly more coastal infrastructure over the past century than we have in all of human history, and we will continue to do so during the next century.

What should we do about this? Is it wise to assume we are the cause of sea level rise and then to end the activities we think are responsible? Or would it make more sense

397. "Post-Glacial Sea Level," Wikipedia, http://en.wikipedia.org/wiki/File:Post-Glacial_Sea_Level.png"

to plan for a sea level rise of, say, 30 centimeters (12 inches) over the next century. If we are not the cause of sea level rise, which I believe is likely, then there is not much we can do to stop it any- way. If we plan for continued sea level rise at 50 percent above the present rate, we could avoid all or most damage by thinking ahead. We could build the dykes a little higher, not develop suburbs in areas that are susceptible to sea level rise, and generally plan our infrastructure to withstand sea level rise. How could that cause more negative impacts than an 80 percent or larger reduction in fossil fuel use worldwide in the next decade?

I repeat my assertion that we should make an effort to reduce our reliance on fossil fuels and switch to alternatives where this is technologically feasible and reasonably cost-effective. But anything approaching an 80 percent reduction in fossil fuel use over the next decade or two would do more to destroy our civilization than any plausible impact of climate change, even if we were responsible for it. Yet that is what many climate activists, including Greenpeace and Al Gore, are calling for. I believe there are more practical and logical steps that can be taken to find a balance between our environmental, social, and economic priorities. I believe it would be possible to reduce fossil fuel use by 80 percent over the next 50 to 75 years, but we must consider the economic and social cost of doing so.

Pacific Islands and Sea Level Rise

Climate change activists have made great fanfare about the possibility that many island states, such as the Marshall Islands, Kiribati, Tuvalu, and the Maldives, will be inundated and disappear due to rising sea levels caused by human-induced climate change.[398] The government of the Maldives has made the case that rich, carbon-emitting industrial nations should provide financial compensation for the loss of their countries. None of the projections of sinking island states has taken into account the fact that most of them are built on coral reefs and atolls and that coral reefs are alive. A recent survey of 27 Pacific Islands, comparing aerial photographs from up to 61 years ago with current photographs, demonstrated that 23 islands maintained the same land area or increased in size, while only four islands suffered a net loss in size. [399] [400] During this period there was a rise in sea level of 2 mm per

398. “Sea Level Rise Will Claim Island States.” Seaweb, Vol. 15, no. 7 (April 6, 2010), http://www.seaweb.org/news/ou15_7.php#sealevel

399. “Tuvalu and Many Other South Pacific Islands are Not Sinking, claims they are Due to Global Warming Driven Sea Level Rise are Opportunistic,” Watts Up With That, Anthony Watts, June 2, 2010, http://wattsupwiththat.com/2010/06/02/tuvalu-and-many-other-south-pacific-islands-are-not-sinking-claims-they-are-due-to- global-warming-driven-sea-level-rise-are-opportunistic/

400. “Pacific Islands ‘Growing not Shrinking’ Due to Climate Change,” Paul Chapman, the *Telegraph*, June 3, 2010, http://www.telegraph.co.uk/news/worldnews/australiaandthepacific/tuvalu/7799503/Pacific-islands-growing-not-shrinking-due- to-climate-change.html

year. This indicates that the coral is able to grow as fast or faster than the rising sea, and that coral islands grow as a result of coral breaking off and forming reefs that in turn catch more coral and grow in size. Many of the coral islands in the tropics have existed for thousands of years, while during that time the sea has risen by hundreds of feet. It is therefore likely that yet another doomsday scenario regarding the impact of climate change is wildly overblown and may actually have no impact even if the sea does continue to rise.

The "Trick" to "Hide the Decline"

The most quoted email among the thousands released from the Climatic Research Unit, which led to the "Climategate" crisis, was one from the CRU's head, Phil Jones, referring to "Mike's *Nature* trick...to hide the decline."[401] [402] Mike is Michael Mann, the creator of the infamous and, to many, discredited hockey stick graph. *Nature* is the science journal that shows a marked bias in support of human-caused climate change. The "trick" was to discard tree-ring data that did not fit the true believer's bias, data that showed a drop in temperature in recent decades. These climate scientists clearly colluded to hide the data that showed the decline and to substitute data that indicated unprecedented warming over the past 50 years.

In response to the "Climategate" emails the U.K. House of Commons Science and Technology Committee held hearings to determine if Phil Jones and his staff at the Climatic Research Unit had done anything un- toward. They concluded that "trick" and "hide the decline" were "colloquial terms used in private emails and the balance of evidence is that they were not part of a systematic attempt to mislead."[403] [404] This is an obvious white- wash, because whether or not they are colloquial terms, "trick" means "trick" and "hide the decline" means "hide the decline." The committee did not provide an explanation of what it thought the terms meant in a "colloquial" context. It is amazing what deceptions can be perpetrated in broad daylight by people in responsible positions.

Another "independent inquiry" conducted by the University of East Anglia, where the Climatic Research Unit is housed, and supported by the Royal Society, concluded with the statement, "We saw no evidence of

401. Steve McIntyre, "IPCC and the 'Trick'," climateaudit.org, December 10, 2009, http://climateaudit.org/2009/12/10/ipcc-and-the-trick/

402. Terry Hurlbut, "Context for 'Hide the Decline' Discovered," examiner.com, December 10, 2009, http://www.examiner.com/x-28973-Essex-County-Conservative-Examiner~y2009m12d10-Context-for-hide-the-decline-discovered

403. "The Disclosure of Climate Data From the Climatic Research Unit at the University of East Anglia," Science and Technology Committee, U.K. Government, March 31, 2010, http://www.parliament.uk/parliamentary_committees/science_technology/s_t_cru_inquiry.cfm

404. "British Parliamentary Inquiry Clears 'Climategate' Scientists," Environmental News Service, March 31, 2010, http://www.ens-newswire.com/ens/mar2010/2010-03-31-02.html

any deliberate scientific malpractice in any of the work of the Climatic Research Unit."[405] The inquiry was headed by Lord Oxburgh, who has deep personal and financial interests in climate policy. He is the chair of a multinational wind energy company and the chair of the Carbon Capture and Storage Association.[406] Missing from the inquiry's report is the fact that the inquiry did not examine the "Climategate" emails or consider evidence from anyone other than the CRU staff. In this report the "trick" "to hide the decline" was not even mentioned; never mind the many other indications of impropriety that were contained in the emails.[407] Phil Jones himself clearly requested that his colleagues delete previous emails containing damaging information.[408]

The Enigmatic Dr. Lovelock

James Lovelock is one of the most insightful and at the same time most enigmatic of scientists. He is certainly one of the leading experts on atmospheric chemistry. Earlier passages in this book have shown Lovelock to be profoundly pessimistic about the future of civilization and the earth's environment. In an interview in 2006, he stated, "We have given Gaia a fever and soon her condition will worsen to a state like a coma...Before this century is over, billions of us will die, and the few breeding pairs of people that survive will be in the Arctic where the climate remains tolerable... a broken rabble led by brutal war lords".[409] [410] Nice visuals! Cue James Cameron! I feel a Hollywood blockbuster coming on. Yet recently, in the wake of the "Climategate" scandal and the failure of the Copenhagen climate summit, Lovelock has had some change of heart.

Speaking at the London Science Museum in March 2010 Lovelock said, "It is worth thinking that what we are doing in creating all these car- bon emissions, far from being something frightful, is stopping the onset of a new ice age.... If we hadn't appeared on the earth, it would be due to go through another ice age and we can look at our part as holding that up. I hate all this business about feeling guilty about what we're doing." This sounds surprisingly like the line of thinking I challenged him with

405. "Report of the International Panel Set Up by the University of East Anglia to Examine the Research of the Climatic Research Unit," University of East Anglia, April 12, 2010, http://www.uea.ac.uk/mac/comm/media/press/CRUstatements/SAP

406. Lawrence Solomon, "Climate-Change Partisans Find Mere Sins of Omission," *National Post*, April 16, 2010, http://network.nationalpost.com/NP/blogs/fullcomment/archive/2010/04/15/lawrence-solomon-climategate-scientists-we-re-not-guilty.aspx

407. James Delingpole, "Climategate: the Final Nail in the Coffin of 'Anthropogenic Global Warming'?" *Telegraph*, November 20, 2009, http://blogs.telegraph.co.uk/news/jamesdelingpole/100017393/climategate-the-final-nail-in-the-coffin-of-anthropogenic- global-warming/

408. Bishop Hill, "Climate Cuttings 33," November 20, 2009, http://bishophill.squarespace.com/blog/2009/11/20/climate-cuttings-33.html

409. Michael McCarthy, "Environment in Crisis: 'We Are Past the Point of No Return'," *Independent*, January 16, 2006, http://www.independent.co.uk/environment/environment-in-crisis-we-are-past-the-point-of-no-return-523192.html

410. James Lovelock, "The Earth Is About to Catch a Morbid Fever That May Last as Long as 100,000 Years," *Independent*, January 16, 2006, http://www.independent.co.uk/opinion/commentators/james-lovelock-the-earth-is-about-to-catch-a-morbid-fever-that- may-last-as-long-as-100000-years-523161.html

during my visit to his home in 2002. His other colleagues have undoubtedly raised similar points, that there is a possibility we are a positive force rather than an entirely negative one.

It is clear Lovelock was rattled by the revelations in the thousands of leaked emails from the Climatic Research Unit. During his first interview after the "Climategate" scandal he stated, "Fudging the data in any way whatsoever is quite literally a sin against the holy ghost of science. I'm not religious, but I put it that way because I feel so strongly. It's the one thing you do not ever do." And he was surprisingly warm toward skeptics, allowing, "What I like about skeptics is that in good science you need critics that make you think: 'Crumbs, have I made a mistake here?' If you don't have that continuously, you really are up the creek...If you make a [computer] model, after a while you get suckered into it. You begin to for- get that it's a model and think of it as the real world."[411]

Some of his recent statements are chilling. Lovelock contends that, "We need a more authoritative world...even the best democracies agree that when a major war approaches, democracy must be put on hold for the time being. I have a feeling that climate change may be an issue as severe as a war. It may be necessary to put democracy on hold for a while."[412] If we are indeed preventing a new ice age, then why is it like a war, and why must we suspend democracy? Perhaps Lovelock just can't make up his mind which it is, catastrophe or salvation. In any case he provides good reason why brilliant scientists who have been cloistered in labs and research institutes most of their lives should not be running the government.

Conclusion

Beginning in the 1980s a widespread alarmist view has developed regard- ing future climate change. The United Nations, most national academies of science, the majority of political parties, the mainstream media, many scientists, and virtually all environmental activist groups have come to believe that if human emissions of CO_2 continue at present levels the global temperature will soar, resulting in untold destruction to civilization and the environment. This has caused many countries to consider, and even to adopt, policies to reduce fossil use to levels that could cripple their economies.[413]

As of 2013 it has become clear that the global temperature stopped rising 16 years ago, after a 20-year period of increasing temperature. This is despite the fact that CO_2 emissions have continued to rise at an increasing

411. Leo Hickman, "James Lovelock: 'Fudging Data Is a Sin Against Science'," *Guardian*, March 29, 2010, http://www.guardian.co.uk/environment/2010/mar/29/james-lovelock

412. Ibid.

413. New Energy for America

rate. No scientist professes to know why global warming has stopped, but many continue to believe humans are driving a "climate catastrophe." Experts and opinion leaders who have publicly bought into the climate crisis hypothesis are obviously reluctant to change their views. They can't do so without losing face, having invested their reputations in such a high- profile issue. There is a sense that the true believers have become the real deniers.[414]

Considering that the increase in temperature has stopped for the time being, and noting the three issues of the "Climategate" scandal, the col- lapse of the Copenhagen conference, and the errors in the 2007 IPCC report, it seems clear that the foundation of climate change alarmism has been shaken. Many top scientists have made public statements to distance themselves from the supposed prevailing view.[415] [416] [417] One of the most influential skeptical voices is that of physicist Freeman Dyson, considered one the world's most brilliant thinkers by many of his peers.[418] A feature article that made his views on climate clear appeared in the *New York Times Magazine* in March 2009 and turned a lot of heads.[419] He said, "The cli- mate-studies people who work with models always tend to overestimate their models," and "They come to believe models are real and forget they are only models." He explained, "Most of the evolution of life occurred on a planet substantially warmer than it is now, and substantially richer in car- bon dioxide." Dyson referred to Al Gore as climate change's "chief propagandist," and as someone who preaches "lousy science, distracting public attention from more serious and more immediate dangers to the planet."

While the author of this article politely derided Dyson's point of view, there was no doubt about where one of the great thinkers of our time stands on the subject. I think one Freeman Dyson is worth 10,000 true believers who mimic one another, falsely claiming that there is an "over- whelming consensus" and extolling, "the vast body of evidence showing the world is warming because of man-made greenhouse gas emissions" without providing any details of the "vast body of evidence."

In recent months a number of mainstream media outlets, including many British and American newspapers, have abandoned their strong biases and are now publishing articles that are balanced and even skeptical of human-caused warming. The collapse of the "overwhelming

414. "In Denial: The Meltdown of the Climate Campaign," Steven F. Hayward, *The Weekly Standard*, March 15, 2010, http://www.weeklystandard.com/articles/denial

415. "The Deniers," Wikipedia, http://en.wikipedia.org/wiki/The_Deniers:_The_world-renowned_scientists_who_stood_up_against_global_warming_hysteria,_political_persecution,_and_fraud

416. Marc Morano, "Scientists Write Open Letter to Congress," ClimateDepot, July 1, 2009, http://climatedepot.com/a/1745/Scientists-Write-Open-Letter-to-Congress-You-Are-Being-Deceived-About-Global-Warming–Earth-has-been-cooling-for-ten-years

417. Neil Reynolds, "Please Remain Calm: The Earth Will Heal Itself," *Globe and Mail*, July 19, 2010, http://www.theglobeandmail.com/news/opinions/please-remain-calm-the-earth-will-heal-itself/article1642767/

418. "Freeman Dyson," Wikipedia, http://en.wikipedia.org/wiki/Freeman_Dyson

419. Nicholas Dawidoff, "The Civ
York Times, March 25, 2009, http://www.nytimes.com/2009/03/29/magazine/29Dyson-t.html

consensus" is good news for everyone who believes this topic should be discussed openly and objectively. There is a breath of fresh air in the climate change debate.

There is much work to do in trying to validate or reject the assertions of the major players in climate science. They include the Climatic Research Unit of the University of East Anglia, the U.S. National Oceanic and Atmospheric Administration, the Goddard Institute of Space Science of the U.S. National Aeronautics and Space Agency (NASA), and the Intergovernmental Panel on Climate Change. All these top agencies are implicated in the "Climategate" scandal and are being investigated by various authorities. The U.K. Institute of Physics' submission to the Parliamentary Committee investigating the leaked emails from the Climatic Research Unit made these observations:[420]

1. The Institute is concerned that, unless the disclosed e-mails are proved to be forgeries or adaptations, worrying implications arise for the integrity of scientific research in this field and for the credibility of the scientific method as practised in this context.

2. The CRU e-mails as published on the Internet provide prima facie [at first sight] evidence of determined and coordinated refusals to comply with honourable scientific traditions and freedom of information law. The principle that scientists should be willing to expose their ideas and results to independent testing and replication by others, which requires the open exchange of data, procedures and materials, is vital. The lack of compliance has been confirmed by the findings of the Information Commissioner. This extends well beyond the CRU itself – most of the e-mails were exchanged with researchers in a number of other international institutions who are also involved in the formulation of the IPCC's conclusions on climate change.

3. It is important to recognize that there are two completely different categories of data set that are involved in the CRU e-mail exchanges:

- those compiled from direct instrumental measurements of land and ocean surface temperatures such as the CRU, GISS and NOAA data sets, and
- historic temperature reconstructions from measurements of 'proxies', for example, tree-rings.

4. The second category relating to proxy reconstructions are the basis for the conclusion that 20th century warming is unprecedented.

420. Steve McIntyre, "Institute of Physics Submission," *Climate Audit*, February 26, 2010, http://climateaudit.org/2010/02/26/institute-of-physics-submission/

Published reconstructions may represent only a part of the raw data available and may be sensitive to the choices made and the statistical techniques used. Different choices, omissions or statistical processes may lead to different conclusions. This possibility was evidently the reason behind some of the [rejected] requests for further information.

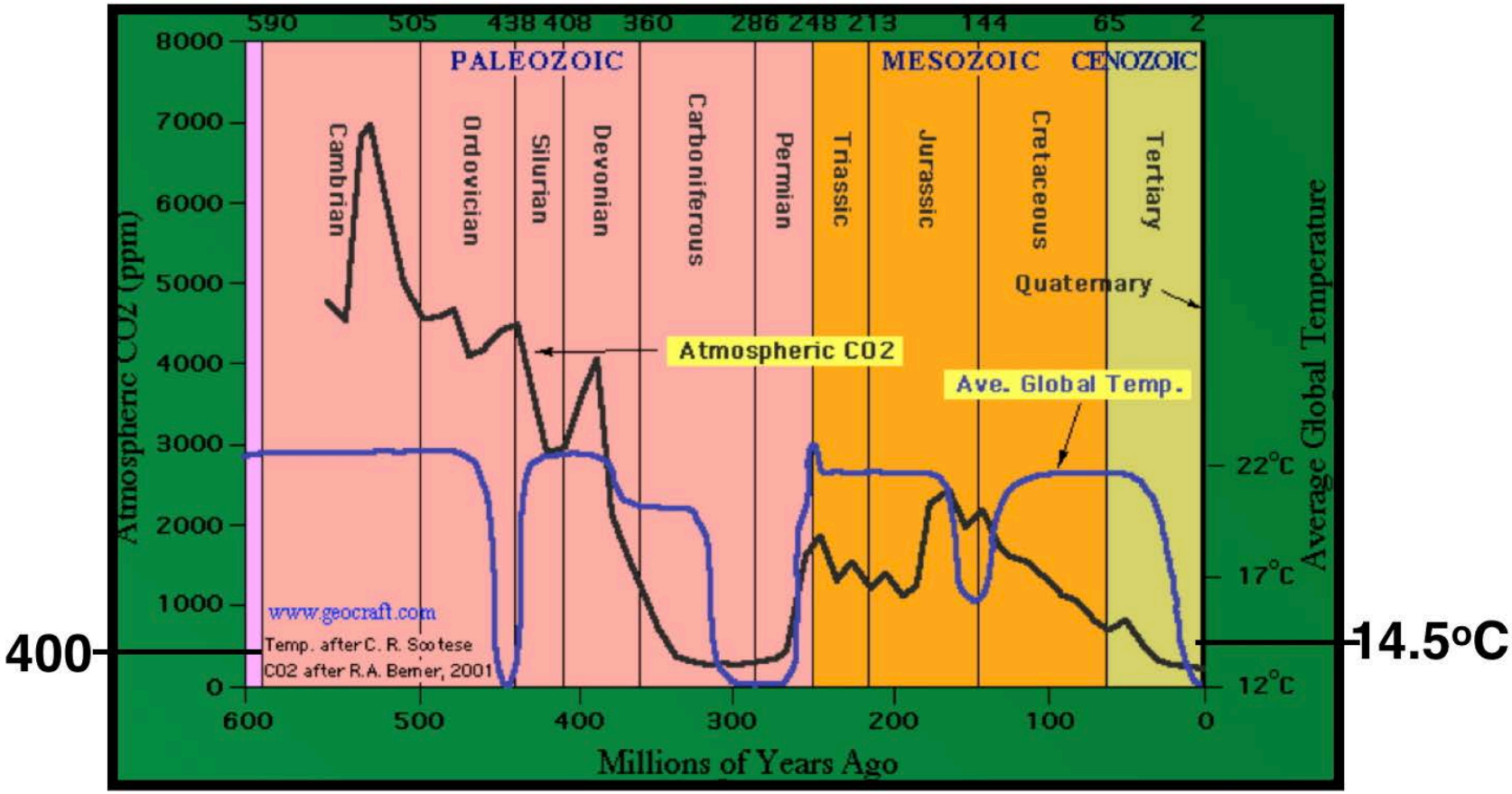
5. The e-mails reveal doubts as to the reliability of some of the re- constructions and raise questions as to the way in which they have been represented; for example, the apparent suppression, in graphics widely used by the IPCC, of proxy results for recent decades that do not agree with contemporary instrumental temperature measurements.

The Institute of Physics has no reason to exaggerate or to hold any bias. The Institute makes it clear that the information provided by the Climatic Research Unit may not be credible or trustworthy. Clearly it will be some time before the “science is settled.”

On May 29, 2010, Britain’s top science body, the Royal Society, an- nounced it would review its literature on climate change in order to reflect the skeptical view. The Royal Society stated, “Any public perception that science is somehow fully settled is wholly incorrect—there is always room for new observations, theories, measurements.” Along with the change of tone by the London Science Museum this marks a sharp turning point, from certainty and “overwhelming consensus,” to a balanced dialogue on the subject. One can only hope that other major science bodies will adopt the same policy.

At this writing the developments in the climate change debate are changing faster than the climate itself. The public is becoming more skeptical by the day, while the believers work doubly hard to shore up their position, assuring us warming will eventually return in earnest. This may be, but it is not happening now, and even If warming does recur in future, that by itself won’t prove that we are the main cause. I remain open to new information and continue to follow the discussion on a daily basis.

Some readers will argue that I have only presented the skeptical side of the debate. This is only because the historical evidence, what has actually occurred, does not support the idea that we are the primary cause of global warming, never mind that its impacts will be “catastrophic.” All the pre- dictions based on computer models in this world can’t change history or manufacture the future. For that we must patiently wait. Meanwhile we should embark on the path toward a future that focuses on sustainable energy as outlined in Chapter 15. We could gradually reduce our over- whelming reliance on fossil fuels and replace some of them with cleaner, sustainable energy sources. This will satisfy many agendas, including the agenda of the believers in human-caused climate change.



400

14.5°C

Global CO2 and Temperature Over the Past 600 Million Years

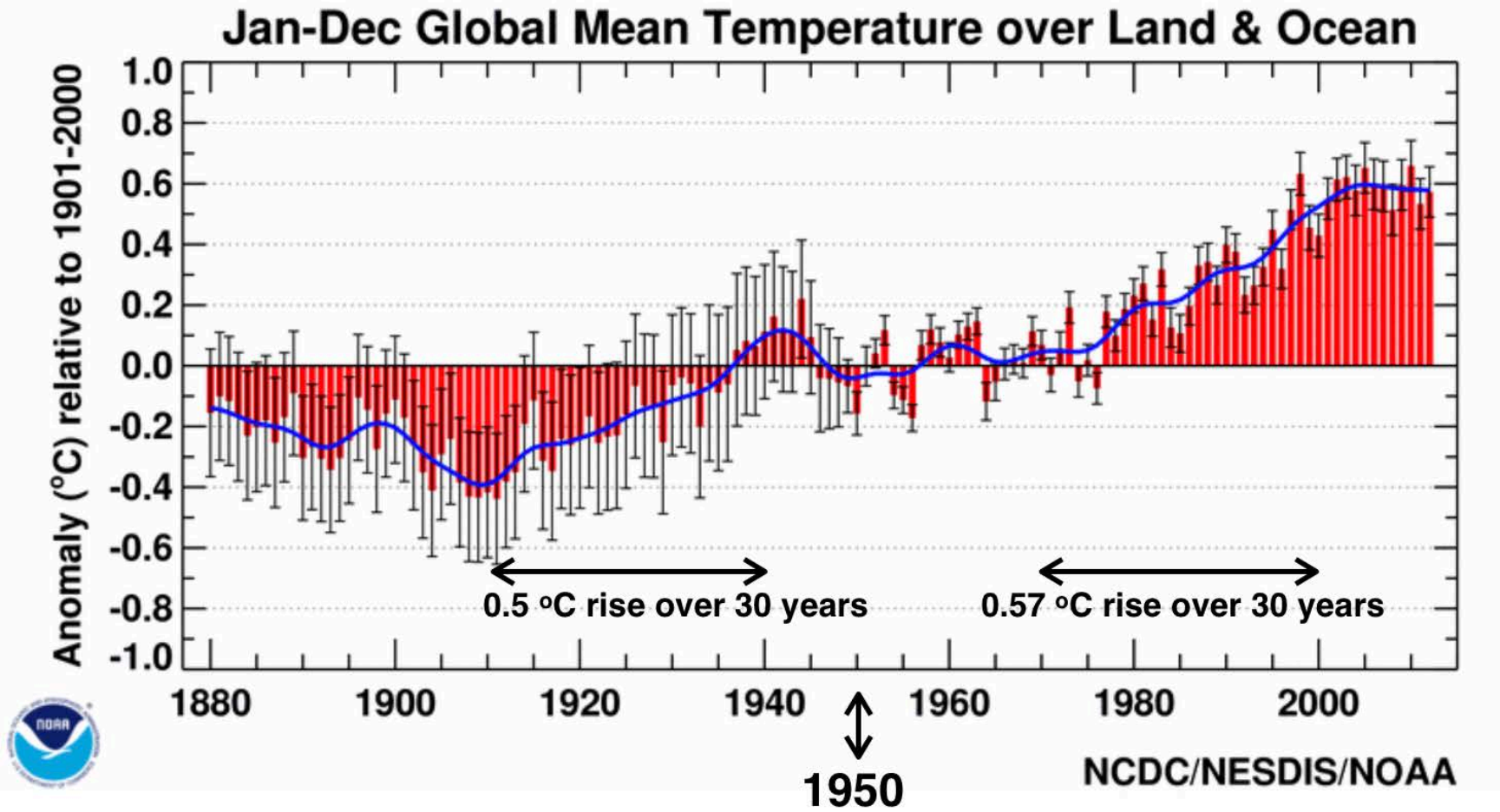
http://www.scotese.com/climate.htm
http://www.aps.org/units/fps/newsletters/200807/monckton.cfm

"Some Degree of Expert Judgement is Inevitable"

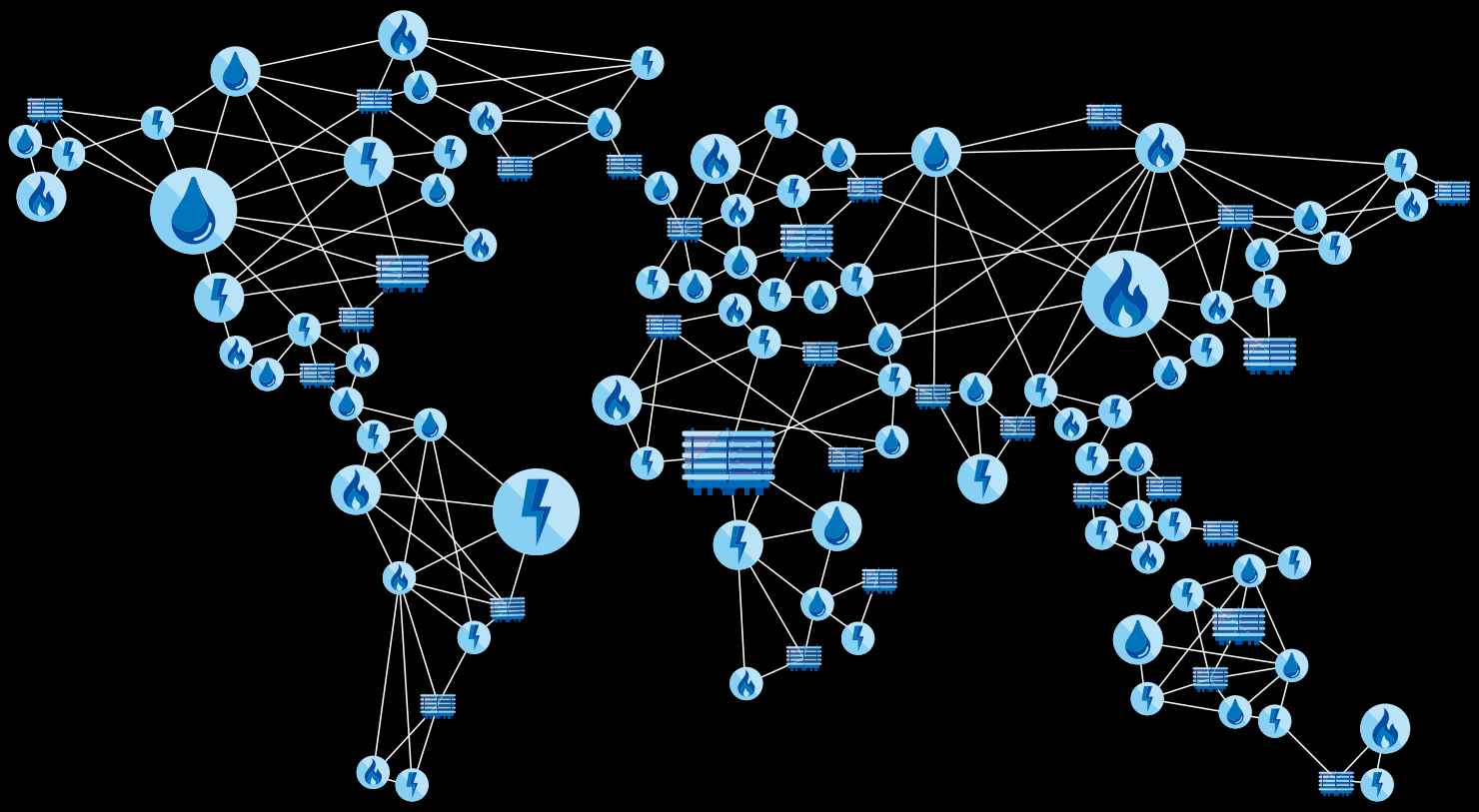
Table 1.2 | Likelihood terms associated with outcomes used in the AR5.

Term	Likelihood of the Outcome
Virtually certain	99–100% probability
Very likely	90–100% probability
Likely	66–100% probability
About as likely as not	33–66% probability
Unlikely	0–33% probability
Very unlikely	0–10% probability
Exceptionally unlikely	0–1% probability

Notes:
Additional terms that were used in limited circumstances in the AR4 (*extremely likely* = 95–100% probability, *more likely than not* = >50–100% probability, and *extremely unlikely* = 0–5% probability) may also be used in the AR5 when appropriate.



"It is **extremely likely** that human influence has been the **dominant cause** of the observed warming **since the mid-20th century". IPCC 2013**



GE-FUEL CELLS
THE POWER OF TOMORROW

By BRANDON OWENS
and JOHN McGUINNESS

Ecomagination

CONTENTS

AUTHOR BIOGRAPHIES

Brandon Owens,
Strategy & Analytics Director, GE Ecomagination

Brandon Owens is an economist, energy specialist, technology researcher, and writer. His research has been published in industry-leading journals such as *INFORMS*, *Public Utilities Fortnightly*, *Energy Policy*, and *Research Evaluation*. An author, keynote speaker, and expert witness, Mr. Owens has been cited in periodicals such as the *New York Times* and *USA Today*.

The author of GE's 2014 whitepapers *The Rise of Distributed Power* and *Digital Resource Productivity*, Mr. Owens is currently the director of Ecomagination Strategy & Analytics at GE, where he helps guide the strategic direction of GE's flagship environmental sustainability initiative. Prior to this role, he was the Manager of Strategy & Analytics within GE Energy's Global Strategy & Planning group.

Prior to joining GE, Mr. Owens was Global Power Director at IHS Cambridge Energy Research Associates (IHS CERA). Before this, he founded and led the renewable power consulting practice at Platts Research & Consulting. Earlier in his career, Brandon served as Senior Analyst for the National Renewable Energy Laboratory (NREL). Mr. Owens holds an MS in Mineral Economics from the Colorado School of Mines and a BA in Mathematics and Economics from the University of Colorado, Boulder.

John McGuinness,
Strategic Marketing Leader, GE-Fuel Cells

John McGuinness is currently the Strategic Marketing Leader for GE-Fuel Cells. Throughout his 25-year career in the power generation industry, John has served in many cross-functional positions including power plant operations and maintenance, manufacturing, engineering, product management, and technical marketing. In his most current role, Mr. McGuinness is responsible for the commercial and business development of this newly formed start-up company.

Prior to this role, John led the Renewable Energy Services Platform team, responsible for bringing wind turbine and solar service-related technology developments into commercial and operational practice. Mr. McGuinness also served as the 9F Gas Turbine Product Manager, leading the creation of a multigeneration product plan for the 9F family of gas turbines. Earlier in his career, he was an officer in the Naval Nuclear Power Program. John holds an MBA from State University at Albany and a BS in Engineering Physics from Rensselaer Polytechnic Institute.

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EXECUTIVE SUMMARY

The future of power has arrived. After more than a century of technology development, market and technology forces are now converging to accelerate fuel cell adoption across the globe. These forces will work in harmony to expedite the integration of fuel cells into the global energy landscape in the decade ahead. In many ways, the adoption of fuel cells will mirror the renewable energy transition that has taken place over the last decade, which moved renewable power technologies from niche applications to mainstream power technologies. The three primary drivers that are moving fuel cells to the tipping point are: technology innovation, the emerging age of gas, and the rise of distributed power.[i]

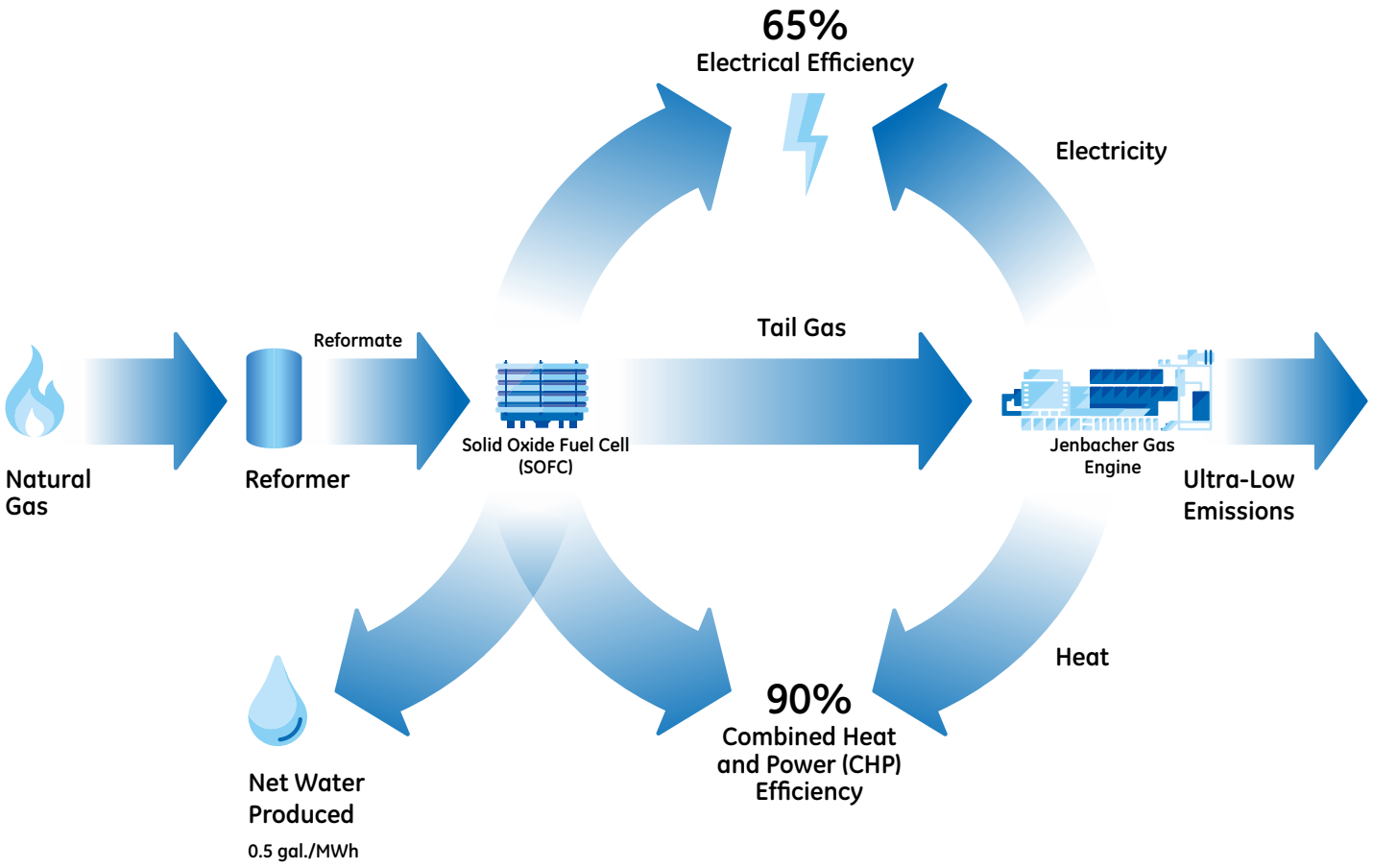
INNOVATION

GE is a global technology company in relentless pursuit of innovation. We are deeply committed to clean energy innovation. GE's ongoing investment in fuel cells is part of our $25 billion commitment to clean energy development over the past decade, which is part of our Ecomagination initiative. Our new Fuel Cell-Combined Cycle (FC-CC) technology is the latest example of GE's clean energy innovation. The FC-CC is a small heat and power generation system that is comprised of a natural gas-fueled solid oxide fuel cell (SOFC) and a GE Jenbacher reciprocating gas engine.

The FC-CC is unique in several ways. First, the SOFC will be produced using proprietary additive manufacturing techniques that dramatically reduce costs beyond what has been previously achieved. Second, by combining the SOFC and the Jenbacher, the FC-CC is projected to achieve an electrical efficiency between 60 and 65 percent—that's an unprecedented level that has previously been the domain of only the most advanced large natural gas combined-cycle machines. Together, we believe that these breakthroughs will

Figure 1. The power of tomorrow

GE's Fuel Cell-Combined Cycle (FC-CC) is a unique combination of a solid oxide fuel cell (SOFC) and a Jenbacher gas-fueled reciprocating engine. In this configuration, natural gas is reformed to produce hydrogen. The resultant reformate, along with oxygen, is used to produce electricity and water through an electrochemical reaction within the SOFC. The fuel output or tail gas is then fed to a Jenbacher gas engine in order to create more electricity and heat. The resultant electrical efficiency of the combined process is projected to be 60 to 65 percent. The combined heat and power (CHP) efficiency is expected to be as high as 90 percent.



Source: GE

drive FC-CC costs down to a level that will enable it to successfully compete with other distributed generation technologies in the absence of direct policy supports.

We are so excited about the technology that we created GE-Fuel Cells—a nimble start-up company within GE that will commercialize the FC-CC. "We have a real breakthrough in fuel cell technology that will enable a distributed power system with a high electrical efficiency. GE-Fuel Cells is moving fast to bring this technology to the world," says Johanna Wellington, CEO of GE-Fuel Cells. The FC-CC will provide customers with modular, flexible power that provides near-zero environmental emissions and is a net water producer. We believe

The Fuel Cell-Combined Cycle epitomizes what Ecomagination is all about—solving the world's toughest challenges by creating technologies that are both economically and environmentally beneficial.

that this package of benefits is ideally suited for stationary power applications from 1 to 10 megawatts (MW). Furthermore, one of the most exciting aspects of the FC-CC is its ability to provide power as a new source as well as a retrofit option. Existing gas engine installations around the world can be retrofitted with an SOFC module and transformed into an FC-CC system. This option provides customers with the ability to triple their power output without any additional environmental emissions on a per megawatt hour (MWh) basis and produce water in the process.

In this manner, the SOFC provides a pathway for increasing power generation in key markets across the globe without increasing the environmental footprint of power production. The FC-CC's water production potential is particularly attractive in arid regions of the world such as parts of the United States and China, the Middle East, and North Africa. When all of these pieces are considered together, it is easy to be enthusiastic about the world-changing potential of this extraordinary GE innovation.

Because of the unique environmental benefits offered by the FC-CC, we have included the technology in GE's Ecomagination portfolio of clean technology products and services. In order to be included in the Ecomagination portfolio, technologies must qualify by meeting strict environmental standards. According to Debora Frodl, GE's Ecomagination Global Executive Director, "The Fuel Cell-Combined Cycle technology epitomizes what Ecomagination is all about—solving the world's toughest challenges by creating technologies that are both economically and environmentally beneficial."

THE AGE OF GAS

After decades on the margin of the global power system, natural gas is shifting from a regional and marginal fuel to becoming a focal point of the global energy landscape. It has caught up with and now competes head-to-head with oil and coal, and complements wind and other renewable energy resources. At the global level, natural gas production and consumption is growing, in part because the land-based and seaborne networks that underpin the connection between supply and demand are becoming more diverse as they expand around the world. Gas network growth, coupled with technology innovation, is contributing to creating greater availability, delivery flexibility, and improved economics. Natural gas fuel cells like the FC-CC are poised to benefit from this emerging age of gas, which promises greater gas availability around the globe and more economically favorable gas prices.

THE RISE OF DISTRIBUTED POWER

Beyond the increased availability of natural gas, the rise of distributed power technologies across the globe is also a driving force for the FC-CC. The rise of distributed power is being driven by the same forces that are propelling the broader decentralization movement: distributed power technologies are more widely available; they are smaller, more efficient, and less costly today than they were just a decade ago.

However, the rise of distributed power is also being driven by the ability of these systems to overcome the constraints that typically inhibit the development of large capital projects, and transmission and distribution lines. Distributed power systems have lower capital requirements and can be built, and become operational, faster and with less risk than large power plants or new transmission lines. GE expects annual distributed power capacity additions to grow from roughly 150 gigawatts (GW) per year today to 200 GW per year by 2020.

Stationary distributed power fuel cells like GE's FC-CC will be a primary beneficiary as global power networks incorporate an increasing number of distributed generation technologies and migrate toward what we call integrated power networks. Integrated power networks are those that contain a combination of both central and distributed power systems connected through increasingly sophisticated physical and digital networks. Indeed, a cluster of fuel cells that is already being used in this manner has been coined a transmission-integrated grid energy resource (TIGER) by researchers at the National Fuel Cell Research Center (NFCRC). The world's largest fuel cell installation is the 59 MW TIGER station at the Gyeonggi Green Energy facility in Hwaseong City, South Korea.

LET THE TRANSFORMATION BEGIN

According to the US Department of Energy's *2013 Fuel Cell Technologies Market Report*, worldwide fuel cell industry revenues reached $1.3 billion in 2013. About 35,000 fuel cell systems were shipped in 2013, an increase of 26 percent over 2012, and 400 percent more than 2008. One hundred and fifty megawatts of stationary fuel cells shipped worldwide in 2013, an increase of 24 percent over 2012 and 244 percent over 2008.[ii]

Although fuel cells reflect a small fraction of today's overall distributed generation market space—accounting for 570 MW of installed capacity across the globe—fuel cell market growth projections show a strong positive trajectory. For example, fuel cell industry experts project a 400 percent increase in annual MW-scale stationary fuel cell installations by 2020.[iii]

Stationary power applications hold the most promise for fuel cells over the next decade. Industrial, commercial, and residential power-only and combined heat and power (CHP) applications are a particularly attractive fit for the technology. Indeed, stationary fuel cells are already commercially installed across a wide variety of applications including universities, hospitals, data centers, water resource recovery facilities, and at leading companies like Verizon, AT&T, Walmart, Coca-Cola, eBay, FedEx, and Google. In California, in excess of 100 MW are deployed. In South Korea, the installed fleet is approaching 300 MW.[iv] This is why we are in the process of developing a 1.3 MW FC-CC demonstration, with an eye toward scaling the technology up to the 10 MW range.

The benefits of the 1.3 MW FC-CC are considerable. First, it will generate enough electricity to meet the needs of approximately 1,000 US homes. Second, the FC-CC actually produces one half gallon of water per MWh. This water production stands in contrast to the US power plant average consumption rate of 2,000 gallons per MWh.[v] By generating electricity without consuming water for cooling, the FC-CC will save enough water to fill eight Olympic swimming pools every year. Of course, this level of water savings is extremely valuable, particularly in arid regions or areas grappling with drought. Third, because the 1.3 MW FC-CC generates electricity at a projected efficiency of 60 to 65 percent, it will consume less fuel compared to the average US power plant. When compared to the US average natural gas-fired power plant, we estimate that the fuel savings as a result

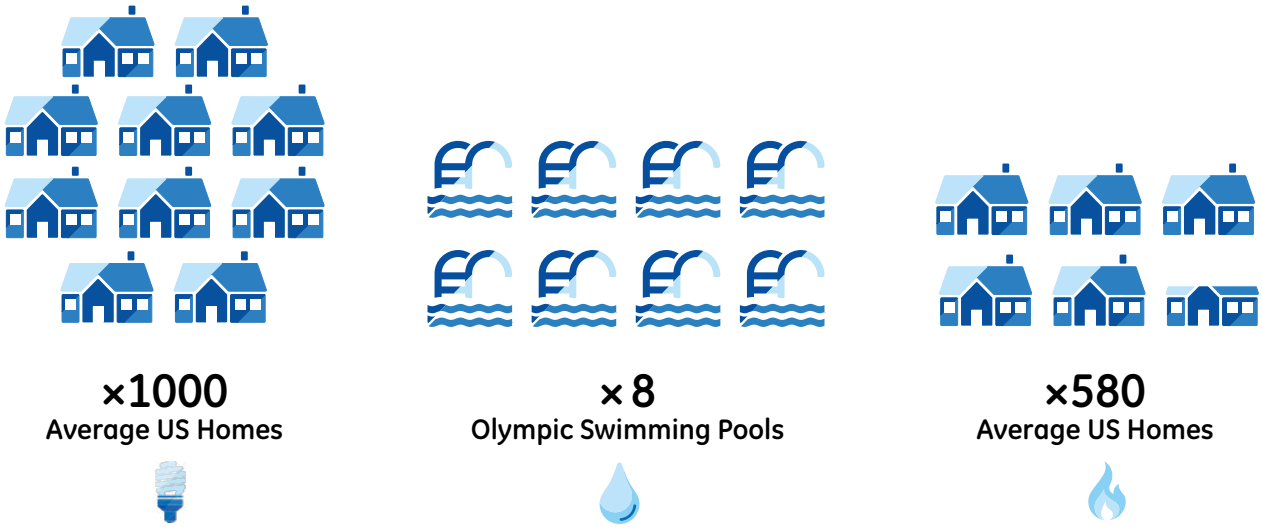
At GE, we are proud to play a role in realizing the potential of fuel cells, and we are humbled by the opportunity to help usher in a new energy era—just as we did in 1882 when Thomas Edison built the world's first power plant. Together, let's power the future.

of the high efficiency of the FC-CC will be enough to meet the space heating, water heating, and cooking needs of 580 US homes every year.

By creating GE-Fuel Cells and developing the FC-CC, we deepen our commitment to the distributed power market. At GE, we are proud to play a role in realizing the potential of fuel cells, and we are humbled by the opportunity to help usher in a new energy era—just as we did in 1882 when Thomas Edison built the world's first power plant. Together, let's power the future.

Figure 2. Ready to take the plunge?

GE is in the process of developing a 1.3 megawatt (MW) Fuel Cell-Combined Cycle (FC-CC) system en route to the eventual development of a 10 MW system. The 1.3 MW system will produce enough electricity for 1,000 homes. Compared to the US power plant average water consumption rate, it will save enough water to fill eight Olympic swimming pools every year. Further, when compared to the US average natural gas-fired power plant, the fuel savings due to the projected high efficiency of the FC-CC will be enough to meet the space heating, water heating, and cooking needs of 580 US homes every year.



Source: GE

I. INTRODUCTION

After more than 150 years of technology development, forces are now aligning to accelerate fuel cell adoption. "We've reached the tipping point," says Morry Markowitz, President of the Fuel Cell and Hydrogen Energy Association. "When it comes to fuel cells, I think the future is now. In the next decade, we are going to see a transformation in the manufacturing and use of fuel cells around the world."

The signs are everywhere. Dozens of Fortune 500 companies utilize fuel cells to power corporate buildings and data centers, and to provide back-up power to telecom towers. Apple, Google, and Walmart are among those who have adopted fuel cells. United States and South Korean utilities are adding megawatt (MW)-sized fuel cells to their portfolios. According to the US Department of Energy's *2013 Fuel Cell Technologies Market Report*, the worldwide fuel cell industry reached $1.3 billion in 2013. About 35,000 fuel cell systems were shipped in 2013, an increase of 26 percent over 2012, and 400 percent more than 2008. One hundred and fifty megawatts of stationary fuel cells shipped worldwide in 2013, an increase of 24 percent over 2012 and 244 percent over 2008.[vi]

Businesses, utilities, and municipalities have taken notice and are deploying fuel cells in a range of applications. Breakthrough Technologies Institute (BTI) Executive Director Robert Rose elaborates: "Fuel cells are diverse—from small portable devices to large megawatt-scale power plants—some of these segments are doing very well and have favorable growth prospects because, from a technology standpoint, fuels cells have arrived."

GE is always in relentless pursuit of technology innovation. Over the last decade, through our Ecomagination initiative, we've targeted our research efforts toward clean energy solutions GE's investment in fuel cells is part of our sustained effort to invest $25 billion in clean energy technologies

What Is a Fuel Cell?

A fuel cell is a device that converts the chemical energy in natural gas or hydrogen into electricity and water through an electrochemical reaction with oxygen. Fuel cells are similar to batteries in structure, except they rely upon an external fuel source instead of stored chemical reactants. While there are different types of fuel cells, each is made up of three layers: an anode, an electrolyte, and a cathode. Here's how fuel cells work:

- Hydrocarbon fuel, such as natural gas, is reformed to produce hydrogen, water, carbon monoxide, and carbon dioxide;
- both the reformate and oxygen from ambient air are fed into the fuel cell;
- the reformate flows on the anode side, a negatively charged electrode, where it combines with oxygen ions traveling through the electrolyte from the cathode side to electrochemically react and form water; and then
- the electrons create an electrical current in the external circuit that becomes the useful energy.

Fuel cells can be used in a variety of ways. For example, they can be used in cars and trucks to convert hydrogen into electricity to power the vehicle. They can be used in small, portable applications to provide electricity when and where it is needed. They can be used as stationary electricity generators or combined heat and power systems. Although fuel cells have been under development since the nineteenth century, recent innovations by GE and others promise to make fuel cells more economically competitive.

through Ecomagination. GE's new Fuel Cell-Combined Cycle (FC-CC) technology is one example of the fruits of our commitment to clean energy innovation. GE Ecomagination Global Executive Director Debora Frodl sums it up: "The Fuel Cell-Combined Cycle technology epitomizes what Ecomagination is all about—solving the world's toughest challenges by creating technologies that are both economically and environmentally beneficial."

The FC-CC is a first-of-its-kind combination of a solid oxide fuel cell (SOFC) and a GE Jenbacher reciprocating gas engine. In this configuration, natural gas is first fed into the SOFC. The FC-CC then takes advantage of the residual heating value of the fuel that exits the SOFC. This fuel is fed into a gas-fueled Jenbacher reciprocating engine, which generates even more electricity. The SOFC and the Jenbacher are combined in a capacity ratio of 2:1 to create power generation solutions in the 1.3 to 10 MW range. When configured in this manner, the SOFC and the Jenbacher will provide a projected combined efficiency of 60 to 65 percent. Efficiencies in excess of 60 percent for power generators in the size range of 10 MW and below have never before been achieved.

In the coming years, GE will begin offering the FC-CC in size ranges from 1.3 to 10 MW to provide stationary power solutions for our customers. By creating GE-Fuel Cells and developing the FC-CC, we deepen our commitment to the growing distributed power space. We are excited about the potential of the revolutionary FC-CC. That's why we created GE-Fuel Cells, a start-up company within GE that is currently developing a 1.3 MW SOFC demonstration project.

II. FUEL CELL INNOVATION

Technology innovation is the key ingredient that has led to the development of the revolutionary FC-CC. Indeed, recent technology innovations by GE and others have brought fuel cell technologies to the cusp of competitiveness. Automotive manufacturers like Honda, Toyota, and Hyundai have made a commitment to develop and commercialize hydrogen fuel cell vehicles and have achieved improved reliability, performance, and power density. GE's FC-CC is the latest fuel cell innovation. To develop the FC-CC, we've built upon a rich legacy of fuel cell innovation that dates back over 150 years. Indeed, we stand on the shoulders of giants.

FUEL CELL HISTORY

The first prototype fuel cells were conceptualized and developed in 1839 by Welsh physicist William Grove and German physicist Christian Friedrich Schönbein. In 1893, Friedrich Wilhelm Ostwald experimentally determined the interconnected roles of the various components of the fuel cell: electrodes, electrolyte, and oxidizing and reducing agents.[vii] Chemists Ludwig Mond, Charles R. Alder Wright, and C. Thompson independently built functioning fuel cells around the turn of the twentieth century. Their fuel cells produced a small electrical current but were much too costly to build. In 1896, William W. Jacques built a fuel cell with a thermoelectric efficiency of 8 percent.

In the first decades of the twentieth century, hydropower and steam turbines were able to produce large amounts of electricity at increasingly lower costs. Fuel cells couldn't compete with either, and fuel cell research retreated to the laboratory. By 1939, British engineer Francis Thomas Bacon successfully developed a 5 kilowatt (kW) stationary fuel cell. Bacon's work was put on hold due to World War II, but over the course of twenty years after the war, Bacon continued his work, which eventually led to large-scale demonstrations with alkali cells.

What is Ecomagination?

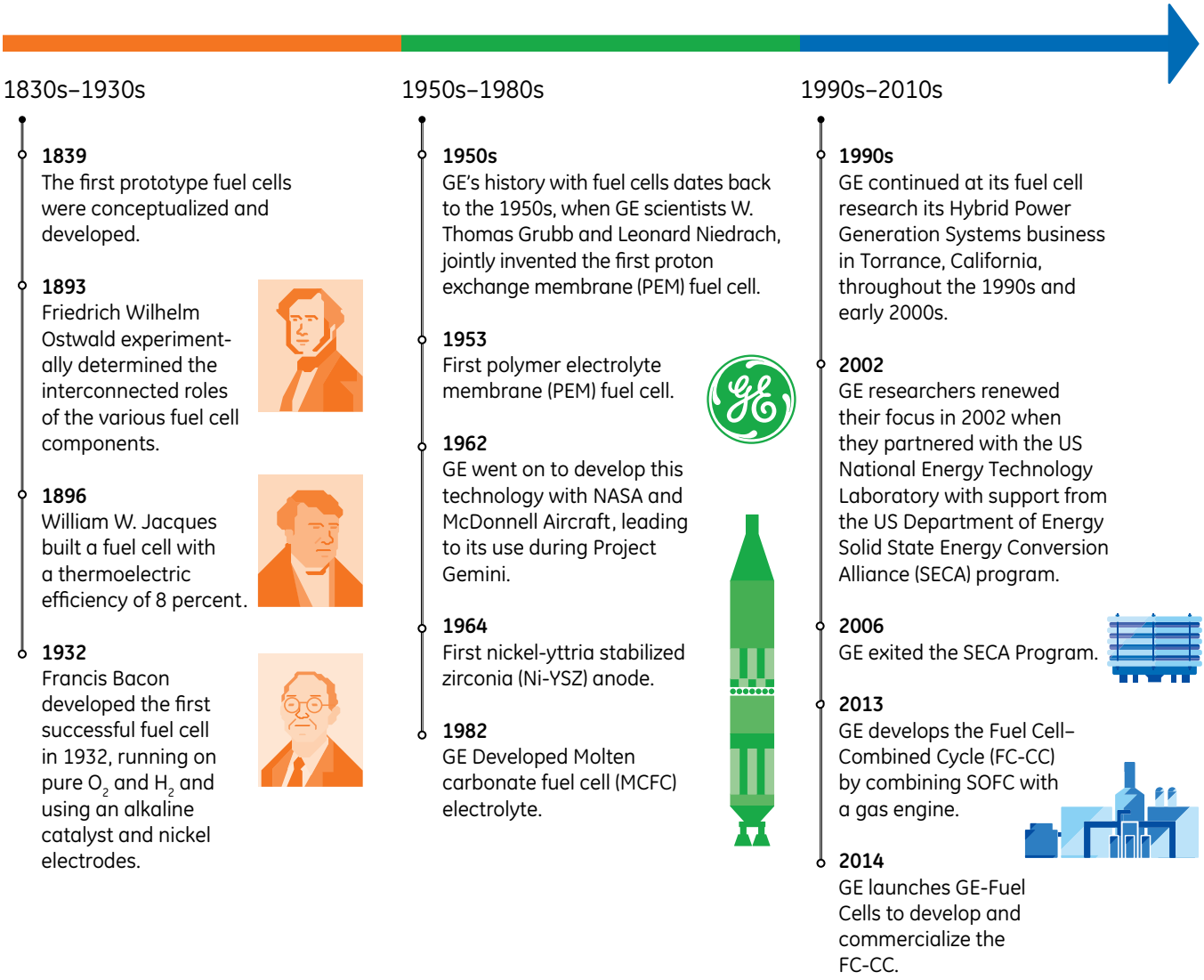
Ecomagination is GE's commitment to developing technologies that reduce our consumption of natural resources while creating economic benefits for our customers. GE's portfolio of Ecomagination technologies and services is diverse—from wind turbines to water filtration systems and everything in between. The portfolio also includes distributed power technologies such as GE's aeroderivative gas turbines and gas engines, and the new Fuel Cell-Combined Cycle (FC-CC) technology. Since its founding in 2005, the GE technologies and solutions in the Ecomagination portfolio have generated $200 billion in revenue. GE has maintained its commitment to efficient resource solutions by investing $25 billion in research and development over this period.

GE's history with fuel cells dates back to the 1950s, when GE scientists W. Thomas Grubb and Leonard Niedrach jointly invented the first proton exchange membrane (PEM) fuel cell. After developing the PEM in 1955, GE went on to develop this technology for NASA in 1962, leading to its use during Project Gemini—NASA's second human space flight program. This was the first commercial use of a fuel cell. Research on SOFC began in the late 1950s at GE's global research center in Niskayuna, New York. Scientists at Westinghouse began SOFC research in the 1960s, funded in part by the US Department of Interior. In 1964, GE developed the first nickel-yttria stabilized zirconia (Ni-YSZ) anode.

High costs and low efficiencies continued to create challenges for fuel cell researchers. Increasingly efficient large-scale technologies and low fossil fuel prices meant that researchers would have to

Figure 3. Fuel cell innovation timeline

Fuel cell developments can be traced back to 1839. By the turn of the twentieth century, researchers concluded that fuel cells were too inefficient and costly to compete with increasingly large central generation plants. After a century of gradual innovation, GE researchers are now developing the megawatt-scale Fuel Cell-Combined Cycle (FC-CC), an innovative fuel cell hybrid technology that is expected to achieve efficiency levels that have hitherto been the domain of only the largest and most efficient power plants in the world.



Source: GE and Smithsonian Natural Museum of American History, *Fuel Cells: Discovering the Science* (April 2013).

achieve cost reduction and efficiency breakthroughs to make fuel cells commercially viable. Nonetheless, GE research forged ahead. In 1982, GE developed a molten carbonate fuel cell (MCFC) electrolyte. By the end of the 1980s, GE researchers began focusing their efforts on the more promising SOFC. GE continued its fuel cell research throughout the 1990s and early 2000s at its Hybrid Power Generation Systems business in Torrance, California.

In 2002, GE researchers partnered with the US National Energy Technology Laboratory (NETL) with support from the US Department of Energy Solid State Energy Conversion Alliance (SECA) program. The challenge was to reduce manufacturing costs while improving energy density and reducing degradation. GE researchers made a major pivot in 2006 to find a lower cost manufacturing approach, and by 2012 had achieved a significant measure of success. During 2013, GE's efforts focused on fuel cell scale-up, which brought about the decision to form GE-Fuel Cells in 2014.

GE INNOVATIONS

More recently, GE researchers independently discovered a novel and significantly less expensive method to manufacture SOFCs. They took a well-known process— thermal spraying that is used on GE aircraft engines and industrial gas turbines—and reapplied it to fuel cells manufacturing. Applying thermal spray technology to the SOFC was a significant breakthrough because it opened the door to the potential of high volume, low cost manufacturing of SOFCs.

The second recent innovation involved marrying the SOFC with another mature technology that had a rich history of its own and was already an important part of GE's distributed power portfolio: GE's Jenbacher gas engine. "It was right under our nose," says Johanna Wellington, seasoned GE Technology Director and CEO of GE-Fuel Cells. "We just had to put the pieces together."

It is unrealistic to expect that every single hydrogen ion and oxygen ion will combine in perfect chemical reaction within the fuel cell stack of an SOFC system. Some amount of fuel will pass through unused. Instead of focusing their efforts on getting the exact chemistry in the fuel cell, GE researchers decided to feed the unutilized fuel or tail gas to a Jenbacher gas engine. By putting the SOFC together with a Jenbacher engine in a combined cycle configuration, GE researchers project the FC-CC efficiency to be 60 to 65 percent. Further, by directing the tail gas to the gas engine, the fuel cell system design is simplified – leading to lower costs and longer life. It's a technology win-win.

GE's FC-CC makes perfect sense. "Fuel cells are made for hybridization," according to Robert Rose, Executive Director of BTI. "It's a natural fit because hybridization makes the fuel cell system more efficient and economical." By combining two technologies into an integrated system and making fuel cells less costly and more efficient, GE has finally achieved what fuel cell researchers had been trying to accomplish for more than a century. Indeed, GE's success in this endeavor is the product of the cumulative effort of a long line of researchers stretching back over 150 years. We are tremendously proud to be part of this legacy.

What is GE-Fuel Cells?

GE-Fuel Cells is a new start-up business funded by GE Ventures. It was born from fuel cell technology that GE scientists have been developing at GE's Global Research Center in Niskayuna, New York. Led by longtime research leader Johanna Wellington, GE-Fuel Cells is focused on commercializing the Fuel Cell-Combined Cycle (FC-CC) technology, which is a hybrid system comprised of a solid oxide fuel cell (SOFC) and a Jenbacher gas engine. The FC-CC will be available in 2018.

III. FUEL CELL DRIVERS

GE is always in relentless pursuit of technology innovation. Over the last decade, through our Ecomagination initiative, we've targeted our research efforts on clean energy solutions like the new Fuel Cell-Combined Cycle.

Although innovation played a key role in bringing fuel cells to the cusp of competitiveness, other key factors are at work today in support of fuel cells. The most important trends are what we call the age of gas and the rise of distributed power.[viii] The age of gas is the phrase we use to capture the current and expected growth in natural gas production, consumption, and networks around the world. The rise of distributed power refers to the current growth in small, distributed power systems across the globe. Both of these trends positively reinforce what's happening in the fuel cell market.

THE AGE OF GAS

The first commercialized natural gas use occurred in Britain. Around 1785, the British used natural gas produced from coal to light houses and streets. In 1816, Baltimore, Maryland, used this type of manufactured natural gas to become the first city in the United States to light its streets with gas. What is new and changing today is the role of this unique resource in the global energy mix. Natural gas is shifting from a regional and often marginal fuel to becoming a focal point of the global energy landscape as it catches up and competes head-to-head with oil and coal, and complements wind and other renewable energy sources.

Gas growth is accelerating, in part because the networks that underpin the connection between supply and demand are becoming more diverse as they expand around the world. Gas network growth, coupled with technology innovation, is creating greater availability, greater flexibility, and improved economics. As a result, the world is now entering what we call the age of gas. Distributed natural gas-fueled technologies, like the FC-CC, will be one of the most prominent beneficiaries of the emerging age of gas.

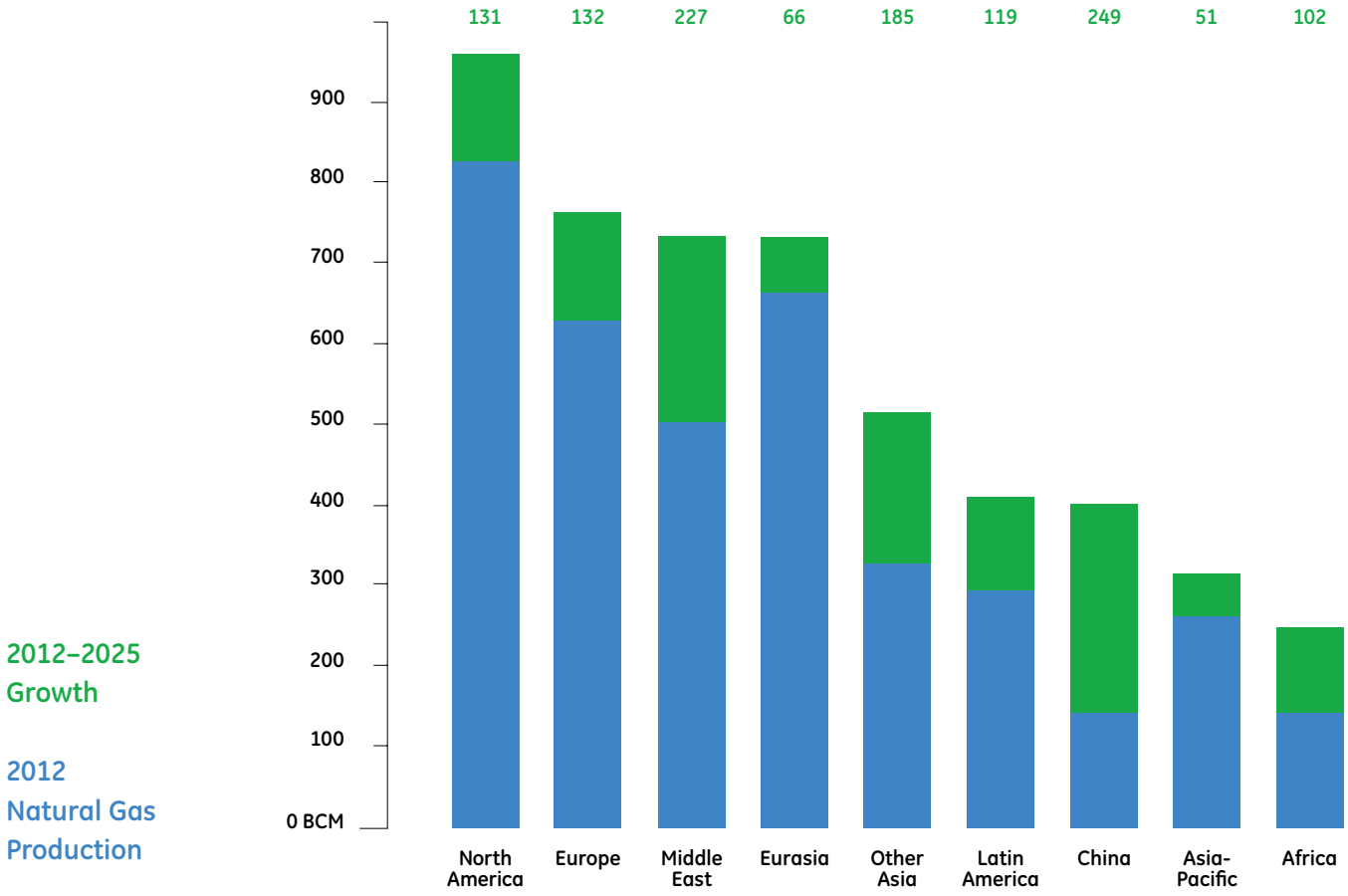
THE RISE OF DISTRIBUTED POWER

The rise of distributed power is also a driving force for fuel cell technologies. A wave of decentralization is sweeping across the globe and changing the way we live, work, and play. The organization of resources and people is moving away from centralized systems toward integrated networks that include both distributed and centralized elements. The trend is pervasive across society and the global economy. Telecommunications, computing, retail, and entertainment have all moved toward decentralization. Today, we are at the beginning stages of decentralization in higher education, healthcare, and energy. The decentralization movement has the potential to enable unprecedented productivity gains and improve living standards for all.

Electric power systems are riding the wave of decentralization through the deployment and use of distributed power technologies. These innovations, which have been around since Thomas Edison built the first power plant in 1882, are used more and more today to provide electrical and mechanical power at or near the point of use. The use of distributed power technologies creates a decentralized power system within which distributed generators meet local power demand throughout the network.

Figure 4. Natural Gas Production

Gas production and consumption is expected to increase over the next decade. According to GE's forecast, natural gas production will grow 35 percent between 2012 and 2025 to 4,780 billion cubic meters up from 3,518 in 2012. The growth in gas will be supported by an increase in both land-based pipeline and seaborne liquefied natural gas trade. Gas-fueled distributed power technologies, such as GE's new Fuel Cell-Combined Cycle (FC-CC), will be one of the primary beneficiaries of this emerging age of gas.



Source: GE

The portfolio of distributed power technologies includes diesel and gas reciprocating engines, gas turbines, fuel cells, solar panels, and small wind turbines. Although there is no standard definition, distributed power technologies are less than 100 MW in size—and typically less than 50 MW, which is the limit that distribution systems can accommodate at distribution voltages. They are highly flexible and suitable across a range of applications including electric power, mechanical power, and propulsion. Distributed power technologies can stand alone, or they can work together within a network of integrated technologies to meet the needs of both large and small energy users.

The rise of distributed power is being driven by the same forces that are propelling the broader decentralization movement: distributed power technologies are more widely available, smaller, more efficient, and less costly today than they were

just a decade ago. But the rise of distributed power is also being driven by the ability of distributed power systems to overcome the constraints that typically inhibit the development of large capital projects and transmission and distribution (T&D) lines. Because they are small, they have lower capital requirements and can be built and become operational faster, and with less risk than large power plants. In addition, distributed power systems can be incrementally added to meet growing energy needs.

Taken together, the net result is an increase in distributed power investment and capacity installations that is expected to continue over the next decade. In 2012, $150 billion was invested in distributed power technologies including gas turbines, reciprocating engines, and solar PV in electric, power, mechanical drive, and propulsion applications globally. Approximately 142 GW of distributed power capacity was ordered and installed. During the same year, GE estimates that 218 GW of central power capacity was ordered. This means that distributed power capacity additions accounted for about 39 percent of total global capacity additions.

By 2020, distributed power will play an even larger role. GE estimates that annual distributed power capacity additions will grow from 142 GW in 2012 to 200 GW in 2020. That's a 58 GW increase and represents an average annual growth rate of 4.4 percent. During this period, investment in distributed power technologies will rise from $150 billion to $206 billion. To be sure, installations of central power capacity will also increase between 2012 and 2020. GE estimates that annual central power additions will grow from 218 GW in 2012 to 272 GW in 2020. That represents an average annual growth rate of 2.8 percent. This means that on a global basis, distributed power capacity additions will grow 60 percent faster than central power additions. As a result, distributed power's share of global capacity additions will increase from 39 percent in 2012 to 42 percent in 2020.

The proliferation of distributed power systems will benefit nations, industries, and people around the world because power use is critical to human and economic development. Research has shown that increasing electricity use is positively correlated with advances in income, education, and health. This is particularly true in developing countries—such as China, India, and Brazil—that have lower per capita income levels, and this is where the demand for distributed power is the greatest today.

THE INDUSTRIAL INTERNET

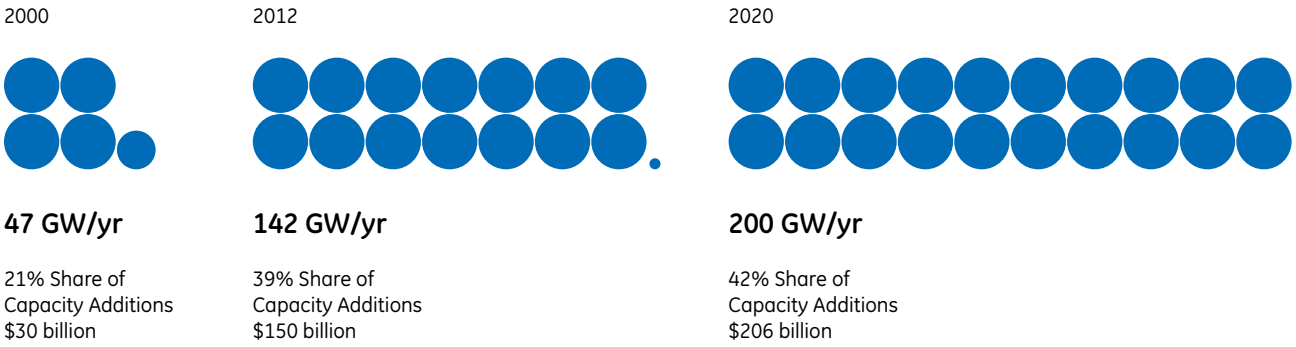
The world is in the midst of the widespread penetration of information technology hardware, software, and communications technologies into the business and social fabric of our lives. From the way we shop, to the way we receive our news and run our business operations—all aspects of our lives have been enhanced by digital technologies in the last decade. Today, the penetration of digital technologies is acting as an accelerant to the adoption of distributed power technologies around the world. Its impact on the rise of distributed power will grow over time as each of these trends gains additional momentum.

Digital control systems currently embedded in distributed power technologies enable operators to remotely optimize operations and minimize costs in ways that were not possible a decade ago. Both hardware and software have grown more sophisticated to the point where distributed power systems can be controlled from a smartphone. But that's not the whole story. The forthcoming marriage of the Internet and industrial machines, in what is known as the Industrial Internet, promises to transform isolated distributed power technologies into remotely operated and synchronized fleets of virtual power plants with extended capabilities.[ix]

Tomorrow's Industrial Internet-enabled distributed power control systems will have extended capabil-

Figure 5. Global distributed power capacity additions

Between 2012 and 2020, distributed power capacity additions will grow from 142 gigawatts (GW) to 200 GW. That's a 58 GW increase and represents an annual growth rate of 4.4 percent. During this period, investment in distributed power technologies will rise from $150 billion to $206 billion. Stationary power fuel cell applications will be part of the growing mix of distributed power solutions.



Source: GE

ity beyond today's systems. They will provide operations decision support, such as how to run, start, shut down, and buy power. This will create better investment decisions, leading to better economic returns for investments. Additional capabilities will allow distributed power operators to self-install software upgrades and eliminate the risks and costs of downtime.

Beyond enhanced control and optimization of distributed power technologies, the Industrial Internet holds the promise of coordinating distributed power systems in ways that add further value to distributed power technologies at the system level. This extended capability has the potential to further tilt the landscape in favor of distributed power systems like the FC-CC.

A virtual power plant (VPP) is a group of distributed power technologies that are aggregated and operated in unison by a centralized control system powered by the Industrial Internet. Centralized control and operation extends the capabilities of individual distributed power units by enabling groups of grid-connected plants to deliver electricity to the transmission network in unison during periods of peak demand. A VPP could serve as a substitute to a single large power plant. Further, individual distributed power units would be more flexible and quicker to react to fluctuations in electricity demand. VPPs also have the potential to coordinate distributed power system operation with options related to electricity demand, such as demand response and other load-shifting approaches.

Today's distributed power digital control systems have already enabled operators to remotely monitor and control all aspects of power plant operation. This capability has enhanced the distributed power value proposition, and it is part of the driving force behind the rise of distributed power. However, this is only the tip of the iceberg. Tomorrow's control systems will open the door to an extended range of capabilities that will further enhance the appeal of distributed power. VPPs will enable a fleet of distributed power systems to operate in a coordinated manner to facilitate fleet-wide optimization. VPPs will serve as a virtual complement to large central power plants

by providing both electricity supply and coordinating demand-side options. Together, the digital wave and the Industrial Internet will propel distributed power to new heights.

TRANSMISSION-INTEGRATED GRID ENERGY RESOURCES (TIGERS)

Technology advances have enabled the development of a new breed of distributed power technologies, like the FC-CC, that have the ability to rival the cost and performance of central station power plants, but in a much smaller package. Just as important, today's distributed power technologies now enable control and customization to occur either on-site or remotely. Thus, the operation of distributed power technologies can be synchronized within the context of broader integrated power networks that are composed of both distributed and central power plants.

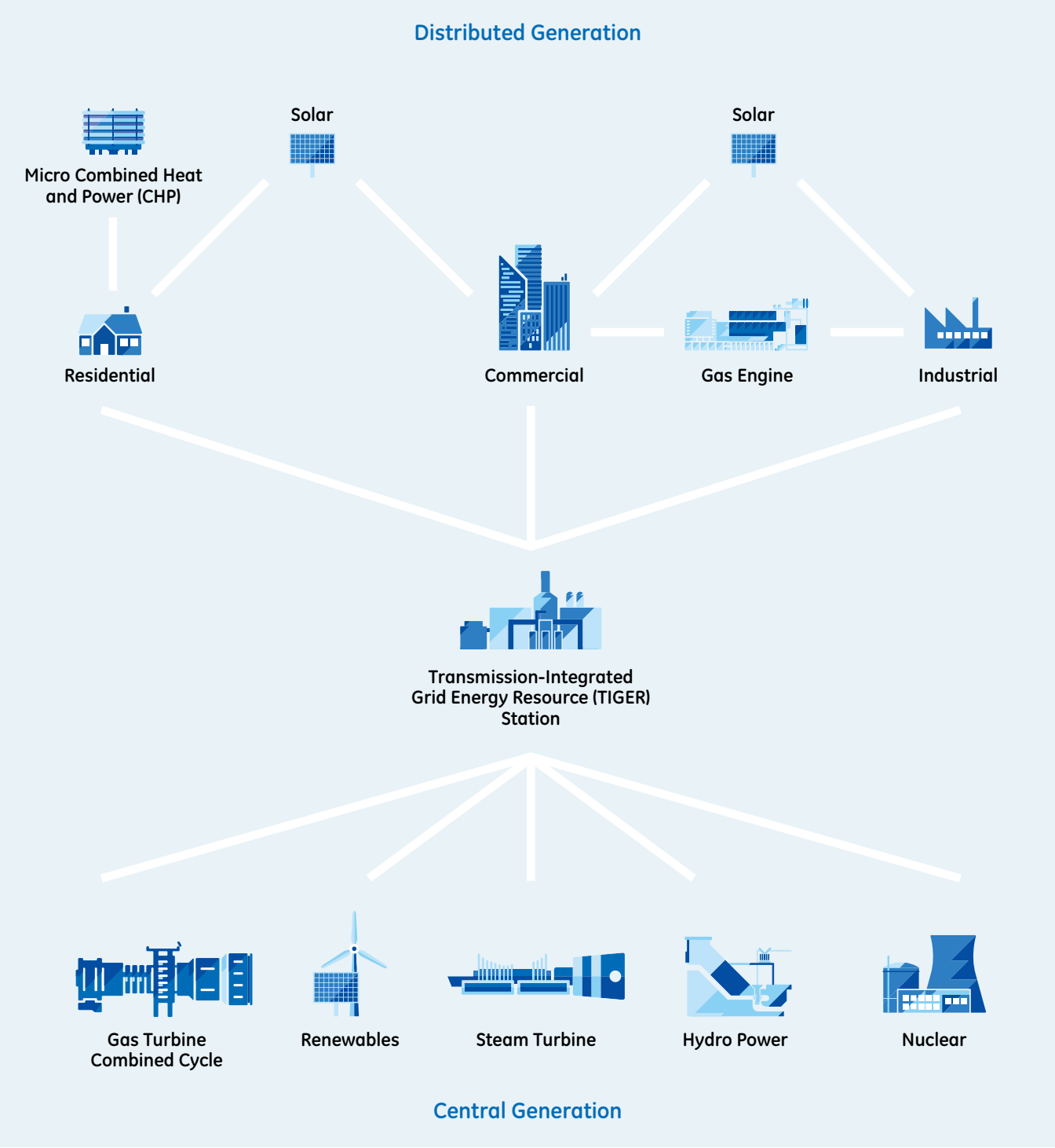
Integrated power networks are characterized by a combination of central station and distributed power systems that can operate in isolation or together within increasingly interconnected and intelligent transmission networks. Power networks across the globe will become increasingly integrated over time as distributed power technologies and intelligent T&D components are added to legacy networks. Thus, the rise of distributed power is ushering in a new power landscape where technologies work in tandem to provide a range of services that couldn't be provided by either central station or distributed technologies in isolation.

Fuel cells are ideally suited to enable integrated power networks: they have the ability to change electricity output levels to meet rapid fluctuations in electricity demand. This is extremely helpful when buffering the presence of variable generation resources such as wind power and solar; they are small-scale so they can be situated in the distribution network in locations where they provide the highest level of grid support; and they are clean-burning so they can meet strict emissions standards and be located at or close to the point of use—even in jurisdictions with the most stringent emissions requirements.

A cluster of fuel cells that is already being used in this manner is known as a transmission-integrated grid energy resource (TIGER). The world's largest fuel cell installation is the 59 MW station at the Gyeonggi Green Energy facility, in Hwaseong City, South Korea, which happens to operate as a TIGER station. In the context of the rise of distributed power, fuel cell TIGER installations in the United States and South Korea are a harbinger of things to come.

Figure 6. Transmission-integrated grid energy resource (TIGER)

A cluster of stationary fuel cells interconnected within electric transmission and distribution systems is known as a transmission-integrated grid energy resource (TIGER). The world's largest fuel cell TIGER installation is the 59 megawatt TIGER station at the Gyeonggi Green Energy facility, in Hwaseong City, South Korea.



Source: Brendan Shaffer, Brian Tarroja, and Scott Samuelsen, "Dispatch of Fuel Cells as Transmission Integrated Grid Energy Resources to Support Renewables and Reduce Emissions," *Applied Energy* 148 (2015): 178–186.

IV. FUEL CELL OUTLOOK

Experts expect stationary fuel cell installations to grow by more than 400 percent through the end of the decade.

The convergence of fuel cell innovation, the age of gas, and the rise of distributed power have brought fuel cells to the cusp of competitiveness. The growth of fuel cell TIGER installations in the context of the movement from isolated to integrated power networks indicates that the next decade will be one of growth for stationary fuel cells. Indeed, fuel cell industry experts expect stationary fuel cell installations to grow by more than 400 percent through the end of the decade.

Of course, fuel cell applications go beyond MW-scale stationary power generation applications. Other areas include kW-scale stationary CHP, transportation, and portable applications. All of these applications are expected to grow over the next decade as well.

For example, consider kW-scale residential CHP fuel cells known as fuel cell micro-CHP systems. These systems have overall efficiencies exceeding 90 percent and can be installed in both new and existing buildings. Japan's Ene-Farm program, which started in 2009, provides an incentive for residential fuel cell CHP installations. In September 2014, the program celebrated 100,000 cumulative installations along with a 50 percent cost reduction since the inception of the program.[x] The Japanese government has a national target of 1.4 million cumulative installations by 2020 and 5.3 million by 2030. Germany recently announced a similar program that provides capital grants to micro-CHP projects.

Fuels cells in transportation also represent a promising area. Major auto manufacturers Toyota, Honda, and Hyundai have announced the commercial availability of fuel cell vehicles (FCVs) in 2015. Enabled by the buildout of hydrogen fueling stations, consumers in the Japan and California markets will have the opportunity to be among the first to get behind the wheel of tomorrow's transportation. Buses are also getting into the game. In Europe, to meet greenhouse gas emissions reduction targets, countries such as Germany are supporting FCV development. Navigant Research expects one million fuel cell light duty vehicles on the road by 2027.[xi]

These are just some examples of current commercial fuel cells adoption and future expectations around future fuel cell growth. As each fuel cell application area matures, the benefits will carry over to the other fuel cell industries. Continued support policies, research and development spending, and supply chain development will collectively continue to reduced lifecycle costs for fuel cells and help ensure that the vast potential of fuel cells is realized in the years ahead.

V. FUEL CELL BENEFITS

MODULARITY

Small is Beautiful is the title of a 1973 collection of essays from British economist E.F. Schumacher. He discussed the benefits of small, appropriate technologies, in contrast to increasingly large machines. The phrase is ideally suited to describe the benefits of distributed power technologies like the new FC-CC. Distributed power technologies provide a number of distinct benefits due to their size:

- First, due to their scalability, distributed power technologies require less money to buy, build, and operate. In regions where capital is constrained, it is increasingly important to provide critical infrastructure, such as electricity, without having to raise hundreds of millions of dollars in capital to finance infrastructure projects. The capital simply isn't available in many parts of the developing world to support large projects.
- Second, because of their small size, distributed

power technologies enable energy providers to match the level of demand with the level of supply, and to increase supplies incrementally as needed. Centralized power stations require large capital investment and are available in sizes that are often not appropriate for the required level of supply. Incremental distributed power development is the appropriate development path in many parts of the world today.

- Third, because distributed power technologies are situated at or near demand, they facilitate a local level of control, operation, and maintenance that is not possible with central power stations. This enables system owners and operators to monitor and customize distributed power solutions to meet their specific needs.
- Unique to fuel cells and other clean energy-distributed energy resources, permitting is possible in congested areas due to near zero emissions.

Advantages of the FC-CC go beyond just its size alone. From high efficiency, near-zero emissions and net water production, to fuel flexibility and modularity, GE's FC-CC offers a range of benefits not available in any other generation technology—distributed or otherwise.

HIGH EFFICIENCY

The efficiency with which power plants convert fuel into electricity is the most important determinant of generation cost. High efficiency levels mean that more fuel is converted to electricity and less fuel is wasted. Consider the average conversion efficiency of the US natural gas-fired power plant fleet. The average efficiency of the US natural gas fleet in 2013 was 43 percent (average annual heat rate 7,948 Btu/kWh HHV).[xii] That means that 43 percent of the energy embedded in the natural gas was converted to electricity, while 57 percent was wasted in the conversion process. At the average natural gas price of $4.38/mmBtu HHV in 2013, the cost of converting natural gas to electricity was $35/MWh (7,948 Btu/kWh × $4.38/mmBtu HHV).[xiii] The higher net electrical efficiency of the FC-CC yields a conversion cost of $25/MWh. That's a $10/MWh cost savings simply as a result of the higher conversion efficiency of the FC-CC.

Regions where gas prices are higher, such as South Korea and Japan, rely on more expensive liquefied natural gas imports. Here, the cost savings as a result of the high efficiency level of the FC-CC are even more pronounced. With the natural gas price at $10/mmBtu, the cost of converting natural gas to electricity grows to $79/MWh at 43 percent efficiency, and just $58/MWh for the FC-CC. Thus, the impact of conversion efficiency increases at higher fuel prices.

NEAR-ZERO ENVIRONMENTAL EMISSIONS

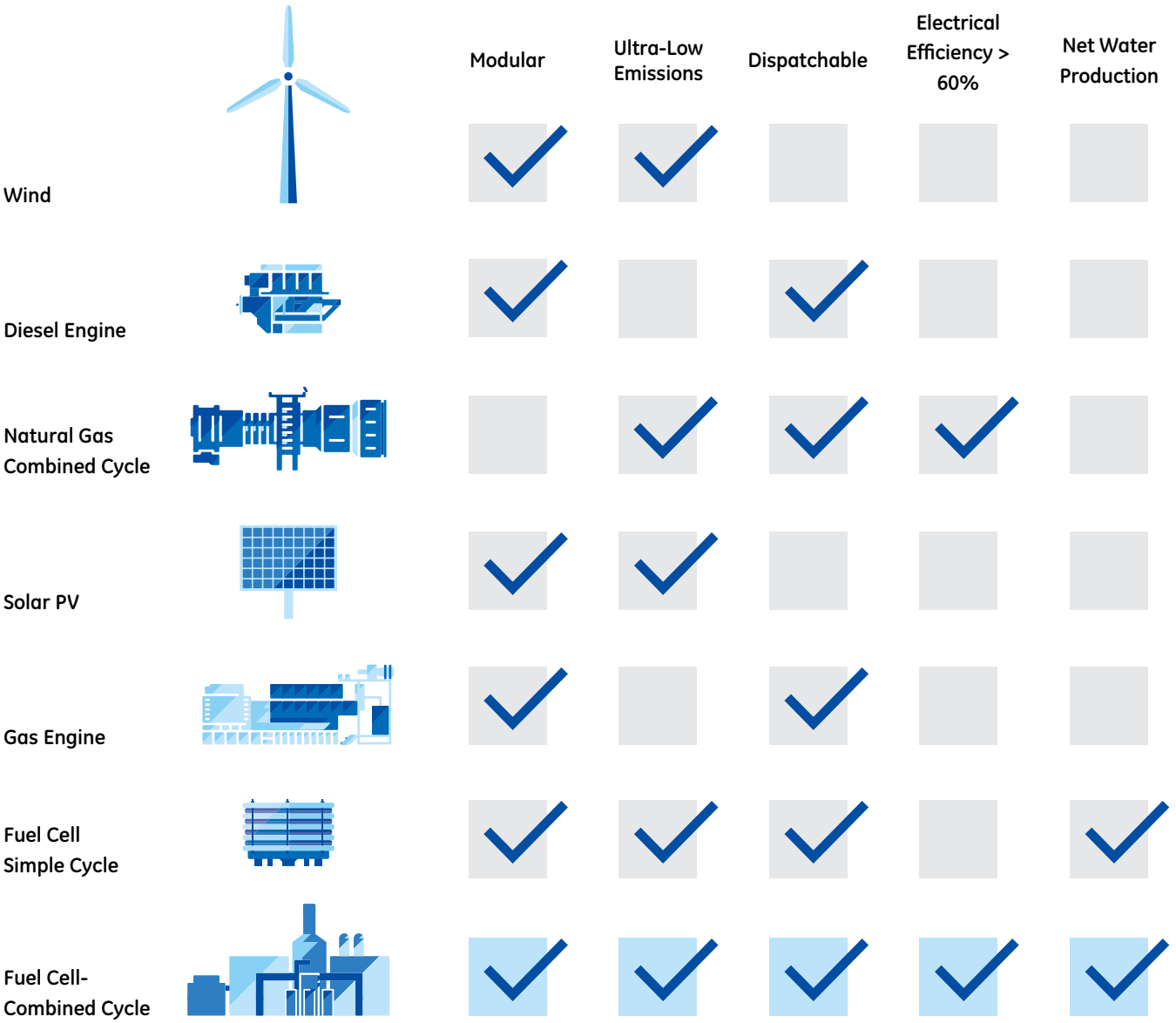
It's not just the high efficiency that makes the FC-CC a game-changer, it's also the improved environmental performance and greater level of resource productivity relative to other generation options. Within the FC-CC system, SOFC is integrated with the gas engine at a capacity ratio of roughly 2:1. For every 2 MW of SOFC, the FC-CC includes another 1 MW of gas engine capacity. We combine an ultraclean gas engine with a near-zero emissions SOFC, resulting in a 67 percent reduction in emissions relative to a standalone gas engine. When equipping the FC-CC with selective catalytic reduction technology, emissions drive down even further. GE's preliminary estimates indicate that the FC-CC greenhouse gas and particulate emissions will place it on par or better than state-of-the-art large central-station gas turbine combined cycles.

NET WATER PRODUCTION

Global water resources are becoming increasingly constrained in the face of growing economies, rising population levels, and the growing impacts of climate change. The World Resources Institute (WRI) has

Figure 7. Checking all of the boxes

From high efficiency, near-zero emissions, and net water production, to fuel flexibility, and modularity, GE's Fuel Cell-Combined Cycle (FC-CC) offers a range of benefits not available in any other generation technology— distributed or otherwise.



Source: GE

examined local water stress throughout the globe and found extreme stress in select areas across all seven continents. The most stressed regions are Africa, the Middle East, and Australia. According to the Organization for Economic Co-operation and Development (OECD), one billion people live in water-stressed regions today.[xiv] Furthermore, WRI expects water stress to intensify over the next 15 years across all scenarios.[xv] Ensuring adequate supplies of water in many parts of the world will be

Table 1. Fuel cost of generation for new and existing power plants

The Fuel Cell-Combined Cycle (FC-CC) is projected to have a combined efficiency of 60 to 65 percent, placing it alongside state-of-the-art large power plants for efficiency. Efficiency levels this high translate into reduced fuel costs and more competitively priced power, particularly in regions where fuel prices are high.

			Fuel Cost of Generation ($/MWh)				
	Heat Rate [LHV] (Btu/kWh)	Conversation Efficiency (%)	$4/ MMBtu	$6/ MMBtu	$8/ MMBtu	$10/ MMBtu	$12/ MMBtu
Existing Coal Plant (US Average)	9,609	36%	$40	$61	$81	$101	$121
Gas-Fuelled Reciprocating Engine (US Average)	8,632	40%	$38	$57	$77	$96	$115
Existing Natural Gas-fired Gas Turbine Combined Cycle (US Average)	6,913	49%	$31	$46	$61	$77	$92
Solid Oxide Fuel Cell — Simple Cycle	6,690	51%	$30	$45	$59	$74	$89
New Natural Gas-fired Gas-Turbine Combined Cycle Plant	5,503	62%	$24	$37	$49	$61	$73
GE-Fuel Cells FC-CC*	5,249	65%	$23	$35	$47	$58	$70

*Expected conversion efficiency of the new FC-CC will be 60 to 65 percent.
Source: GE and US Energy Information Administration, Form EIA-860, *Annual Electric Generator Report*.

a challenge in the face of rising population and economic output levels.

These trends tell us that it will become increasingly important to minimize water use during energy production. This holds not just for traditionally water-scarce regions like the Middle East, but also other areas that are experiencing increasing water stress.

According to Sandia National Laboratories, the electricity industry is the second largest source of freshwater withdrawals in the United States. Coal currently accounts for 52 percent of US electricity generation, and each kWh generated from coal requires withdrawal of 25 gallons of water.[xvi] This adds up fast. The average thermal power plant in the United States consumes—primarily through evaporation, which must be replaced—approximately a half gallon of water per kWh. When factoring in the evaporation from hydroelectric power plants, the weighted average water consumption per kWh in the United States is two gallons per kWh.[xvii]

This is where the FC-CC shines, because water is one of the outputs of the fuel cell electrochemical process. The SOFC component of the FC-CC is actually a net water producer, not a consumer of water for

cooling like most power plants. According to GE-Fuel Cells' preliminary analysis, the FC-CC will produce water at a rate of one half gallon per megawatthour. Compared to the average US water consumption rate for power generation, each 1.3 MW FC-CC will save enough water to fill eight Olympic swimming pools every year of operation.

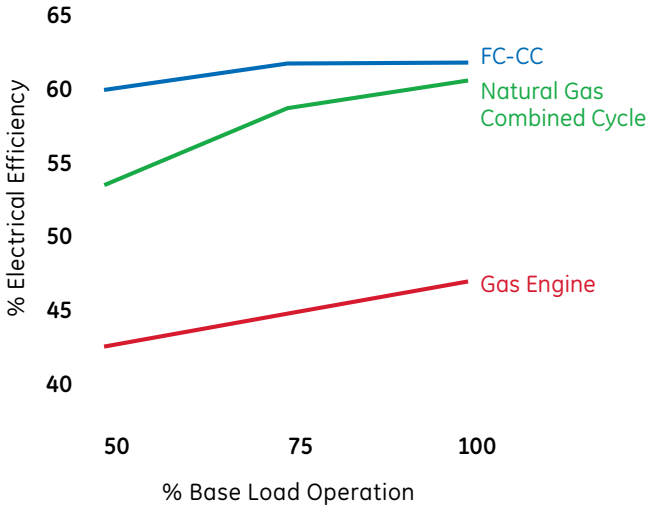
DISPATCHABILITY

Dispatchability—or the ability of an electricity generator to vary its level of electricity output in order to respond proactively to different levels of electricity demand—is an increasingly important attribute for electric generators for several reasons. First, in many jurisdictions, generators face increasingly variable demand levels due to the introduction of real-time pricing and other mechanisms that expose generators to more rapid demand changes. Second, many regions of the world are incorporating increasing levels of renewable energy resources to the grid. At high levels of penetration, renewables require increasing flexibility from other generation units within the electrical system in order to accommodate their variability. Thus, the need for—and value of—dispatchability is increasing over time in many power networks around the world.

The FC-CC is designed to be a fully dispatchable system. The addition of a flexible gas engine provides the FC-CC system with a higher level of dispatchability than other fuel cell systems. As a result, the FC-CC is able to maintain high levels of efficiency even at part-load. This is a challenge to even the most mature generation technologies available.

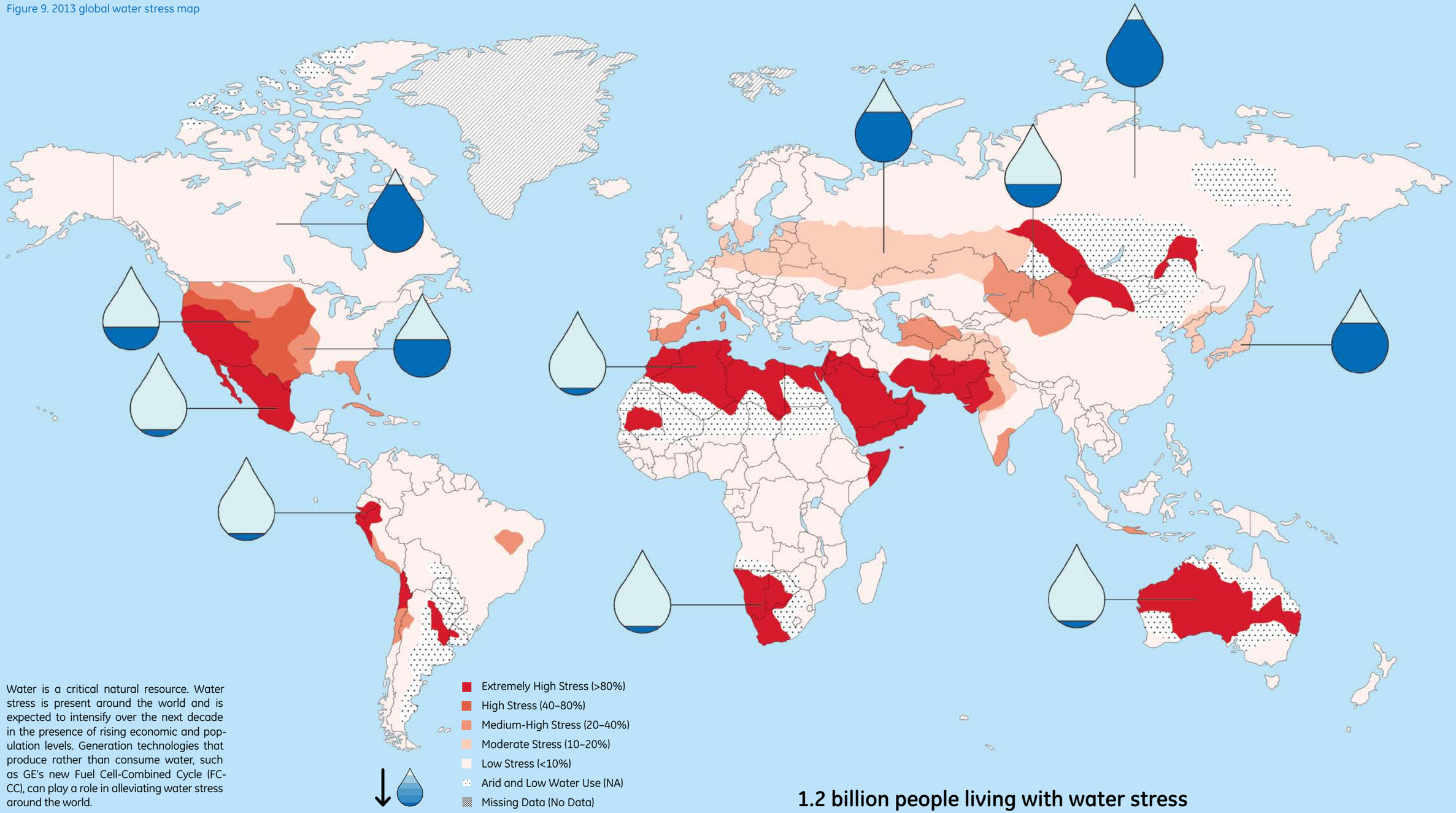
Figure 8. Full and partial load efficiencies of power generation technologies

Dispatchability—or power generation flexibility—is increasingly important as intermittent demand and variable generation resources, such as wind and solar power, are integrated into the transmission system. The Fuel Cell-Combined Cycle (FC-CC) system offers a higher level of dispatchability than existing fuel cell technologies because of the introduction of the flexible gas engine into the combined system. Unlike other generation options, the FC-CC is able to maintain a high level of efficiency even at part-load.



Source: GE.

Figure 9. 2013 global water stress map



Water is a critical natural resource. Water stress is present around the world and is expected to intensify over the next decade in the presence of rising economic and population levels. Generation technologies that produce rather than consume water, such as GE's new Fuel Cell-Combined Cycle (FC-CC), can play a role in alleviating water stress around the world.

1.2 billion people living with water stress

Source: World Resources Institute (WRI) Aqueduct Project. Data provided by the Coca-Cola Company. Hydrologic modeling performed by ISciences, LLC.

RESILIENCY

As the world grows increasingly interconnected, the infrastructure networks that deliver electricity, gas, and water to our cities have never been more important. At the same time, the reliability of infrastructure networks is increasingly challenged by a rising tide of natural disasters. The challenge is visible in the increasing number of blackouts experienced in major economies across the globe. According to Eaton, which produces an annual blackout tracker, the annual number of blackouts in just the United States alone has risen from 2,169 in 2008 to 3,634 in 2014. That's an increase of 67 percent in six years. These electrical outages and surge spikes are estimated to cost more than $150 billion in annual damages to the US economy.[xviii]

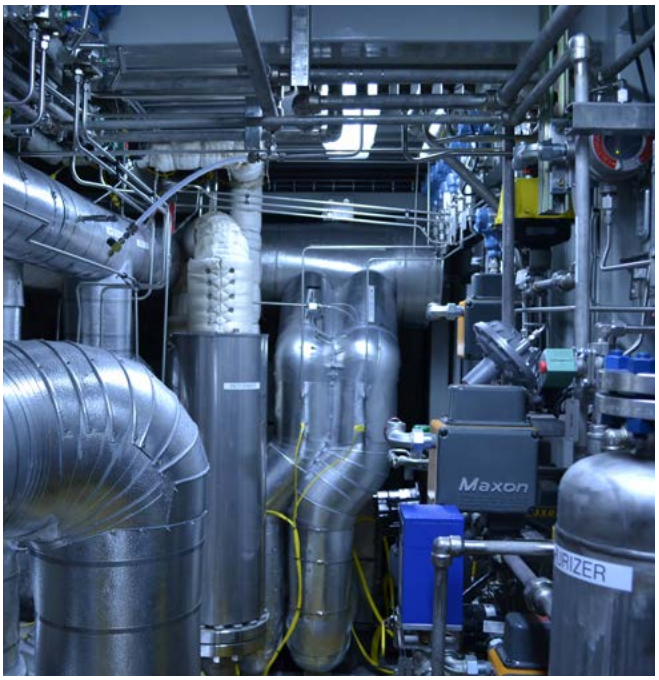
The increasing number of weather-related events appears to be the source of the growing number of outages. For example, in 2014 alone, the following weather-related events caused major system blackouts:

- February 5: An ice storm in Philadelphia left more than 750,000 customers in the dark, some for several days as they waited for power to be restored.
- March 7: Heavy rain, wind, and ice in Raleigh, North Carolina, knocked out power for 463,000.
- July 9: Some 500,000 customers experienced a blackout after a tornado struck the New York area.
- November 26: A powerful nor'easter blacked out 350,000 customers across New Hampshire, Massachusetts, and New York.
- October 2: A nasty weather front left more than 250,000 customers without electricity in Arlington, Texas. The local utility reported that a large number of downed lines and power poles made the restoration process longer than normal.

Making the power system more resilient to natural disasters is critical to protecting customers and significantly reducing the magnitude of outages, human suffering, and economic costs. Distributed or on-site power technologies like the FC-CC enhance the resiliency of the power system by providing customers with power from on-site generators, rather than from distant power plants. In addition, customers can receive electricity from gas-fueled distributed generators as long as natural gas pipelines remain intact. Natural gas pipelines are much less vulnerable to above-ground natural disasters than transmission and distribution lines. For example, when hurricanes Irene (2011) and Sandy (2012) hit the northeast United States, the natural gas transmission pipelines reported that they were able to continue to operate during the storms. Meanwhile, 6.69 million customers experienced power outages during Irene, and 8.66 million customers experienced power outages during Sandy.[xix]

Distributed power technologies are a key piece of the puzzle when it comes to strengthening the power system and improving resiliency. In a world of increasing natural disasters, fuel cell technologies will play an increasing role over time.

VI. CONCLUSION



GE proudly announces the addition of the FC-CC to its distributed power portfolio. Now, even more than before, GE's distributed power solutions give customers of all types the ability to generate reliable, sustainable power whenever and wherever it is needed.

Technology innovation continues to transform the world in new and unexpected ways. GE's new FC-CC combines two century-old technologies with the latest innovations in advanced manufacturing to produce a distributed power generation technology that offers a combination of benefits not previously available. In a world that is increasingly characterized by environmental constraints and a rising tide of natural disasters, FC-CC's benefits—such as reduced environmental emissions and net water production, high efficiency, dispatchability, and reliability—make it an ideal technology in today's changing energy landscape. Other drivers such as the age of gas and the rise of distributed power further reinforce the positive momentum for natural gas fuel cells.

The age of gas promises to make gas more widely available across the globe. The rise of distributed power promises to usher in an era of integrated power systems, which contain a combination of central and distributed resources interconnected by increasingly intelligent transmission and distribution systems. The FC-CC provides the right blend of characteristics to thrive as TIGERs. Indeed, TIGERs and self-generation fuel cell power plants have started appearing in markets as diverse as the United States and South Korea.

Taken together, these trends tell us that the outlook for fuel cells is positive. Experts believe that annual MW-scale stationary fuel cell installations will increase by 400 percent by the end of the decade. We believe fuel cells have now reached a tipping point. That's why we created GE-Fuel Cells, a start-up company within GE that is currently developing a 1.3 MW FC-CC demonstration system en route to the development of a full-size 10 MW system.

GE proudly announces the addition of the FC-CC to its distributed power portfolio. Now, even more than before, GE's distributed power solutions give customers of all types the ability to generate reliable, sustainable power whenever and wherever it is needed. At GE, we are humbled by the opportunity to help usher in a new energy era—just as we did in 1882 when Thomas Edison built the world's first power plant. Together, let's power the future.

APPENDIX: FUEL CELL TECHNOLOGIES & APPLICATIONS

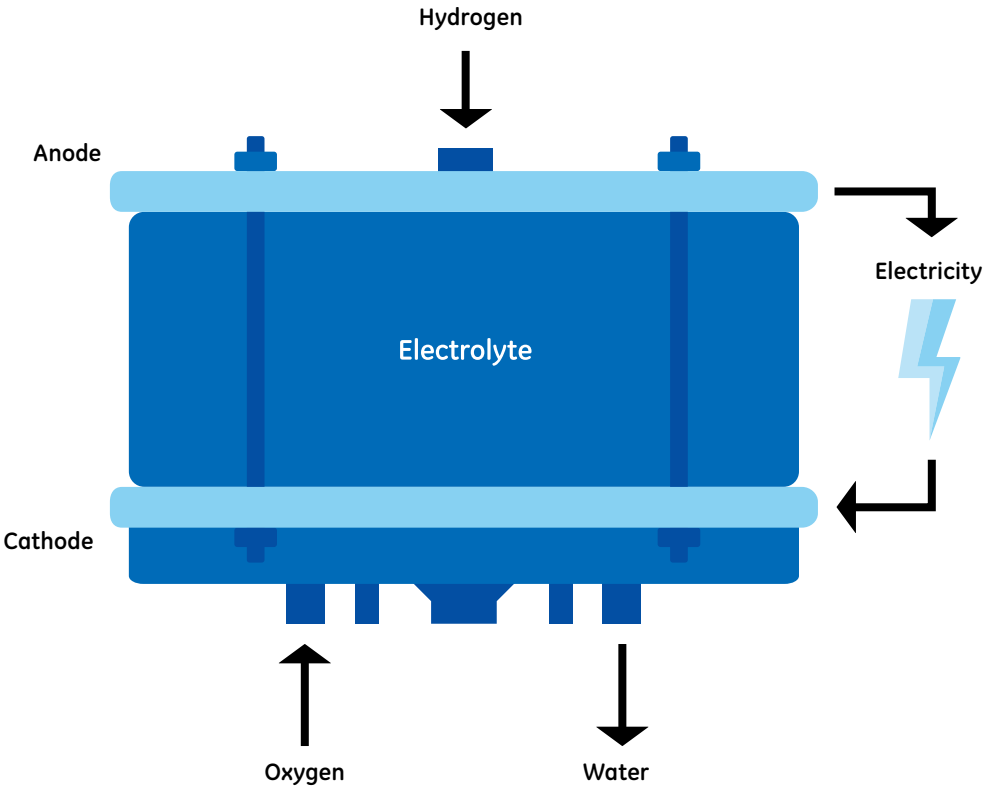
TECHNOLOGIES

A fuel cell is a device that converts the chemical energy in natural gas or hydrogen into electricity and water through an electrochemical reaction with oxygen. Fuel cells are similar to batteries, except they rely upon external fuel sources instead of stored chemical reactants. While there are different types of fuel cells, each is made up of three layers: an anode, an electrolyte, and a cathode. Here's how fuel cells work:

- Hydrocarbon fuel such as natural gas is reformed to produce hydrogen, water, carbon monoxide, and carbon dioxide;
- both the reformate and oxygen from ambient air are fed into the fuel cell;
- the reformate flows on the anode side, a negatively charged electrode, where it combines with oxygen ions traveling through the electrolyte from the cathode side to electrochemically react and form water; and
- the electrons create an electrical current in the external circuit that becomes the useful energy (electricity) desired from the product.

Figure 10. How fuel cells work

All fuel cells operate in the same manner and have the same primary components: an anode, a cathode, a catalyst, and an electrolyte. Differences in the electrolyte, the catalyst, and the operating temperatures distinguish different fuel cell types from each other.



Source: GE.

Differences in the electrolyte, the catalyst, and the operating temperatures distinguish different fuel cell types from each other. To generate the desired amount of electricity, fuel cells can be combined in stacks.

Fuel cells can be used in a variety of ways. For example, they can be used in cars and trucks to convert hydrogen into electricity to power the vehicle. They can be used in small, portable applications to provide electricity when and where it is needed. They can also be used as stationary electricity generators.

Although fuel cells have been under development since the nineteenth century, recent innovations by GE and others are making fuel cells increasingly economically competitive.

There are several types of fuel cells. Each fuel cell type has its own unique properties (e.g., type of catalyst, operating temperature), characteristics (e.g., electrical efficiency, size) and most suitable applications (e.g., power, transportation, portable). The most common fuels cells are the alkaline fuel cell (AFC), the direct methanol fuel cell (DMFC), the molten

Table 2. Fuel cell types

There are several types of fuel cells. Each fuel cell type has its own unique properties, characteristics, and most suitable applications.

Fuel Cell Type	Electrolyte	Operating Temp.	Efficiency %	Common Size	Fuels	Primary Applications	Benefits
Alkaline (AFC)	Aqueous solution of potassium hydroxide soaked in a matrix	90–100°C	60 %	10–100 kW	Hydrogen	Controlled aerospace and underwater environments	Small size, high efficiency, water production
Direct Methanol (DEMFC)	Perfluorosulfonic acid	60–130°C	30–40 %	<1–50 kW	Methanol	Portable power, small vehicles	Ease of fuel transport, energy density
Molten Carbonate (MCFC)	Solution of lithium, sodium, and potassium carbonates	600–700°C	50 %	300 kW–3MW	Reformed Hydrocarbons	Distributed power	High efficiency, fuel flexibility, combined heat and power operation
Phosphoric Acid (PAFC)	Phosphoric acid soaked in a matrix	150–250°C	40 %	100–400 kW	Reformed Hydrocarbons	Distributed power	
Polymer Electrolyte Membrane (PEMFC)	Perfluorosulfonic acid	80°C	30–40 %	1–100 kW	Reformed Hydrocarbons	Transportation	Low temperature, flexibility, higher power density
Solid Oxide (SOFC)	Yttria stabilized zirconia	700–1000°C	60 %	1 kW–10 MW	Reformed Hydrocarbons	Distributed and utility-scale power	High efficiency, fuel flexibility, combined heat and power operation, amenable to hybridization

Source: Fuel Cells 2000. (2015). *Types of Fuel Cells*. Retrieved April 2015.

carbonate fuel cell (MCFC), the phosphoric acid fuel cell (PAFC), the polymer electrolyte membrane fuel cell (PEMFC), and the solid oxide fuel cell (SOFC). Each fuel cell type is described in Table 2.

APPLICATIONS

Fuel cells are already used in a variety of applications around the world. The most common applications are portable, stationary power, and transport.

- Portable fuel cells are used to charge non-stationary products. Portable fuel cells are used in recreational settings (campers, boats, lighting), military applications such as skid mounted generators, portable products, and small personal electronics. Portable fuel cells are designed to be moved. They come in sizes ranging from 1 W to 20 kW. The primary fuel cell technology used in portable applications are PEMFC and DMFC. An estimated 22,000 portable fuel cells shipped in 2014.[xx]

- Stationary fuel cells are intended to remain fixed in a single location. Stationary fuel cells typically provide primary or backup power and sometimes heat as part of combined heat and power (CHP) applications. They include large utility, commercial, and industrial-scale power applications as well as smaller micro-CHP applications. Stationary fuel cells come in sizes ranging from kilowatts to megawatts. The primary types of fuel cells used in stationary applications include SOFC, PEMFC, MCFC, AFC, and PAFC.
- Transport fuel cells are used to provide propulsive power in transportation vehicles as primary or auxiliary power units. The types of fuel cell vehicles include fuel cell electric vehicles (FCEV), trucks, and buses. Transport fuel cells range in size from 1 kW to 100 kW. The most common fuel cell type used in transportation is PEMFC, which was the type of fuel cell used in the first fuel cell vehicle in 1966.

On a MW-basis, stationary fuel cells are estimated to have accounted for 84 percent of fuel cell shipments in 2014. Transport fuel cells accounted for 15 percent, and portable fuel cells accounted for the remaining 1 percent.[xxi] The most commercially viable fuel cell applications today include portable applications, stationary backup power applications, small auxiliary power units for recreational vehicles, and fork lifts. The economic viability of fuel cell applications will continue to evolve as fuel cell technologies mature over the next decade.

NOTES

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xvi Sandia National Laboratories, *Energy-Water Nexus Overview* (February 2015). Retrieved from http://energy.sandia.gov/climate-environment/water-security-program/water-infrastructure-security/energy-water-nexus-overview/

xvii Torcellini et al, "Consumptive Water Use."

xviii Eaton, *Blackout Tracker: United States Annual Report 2014* (2014).

xix US Department of Energy Office of Electricity Delivery and Energy Reliability, *Comparing the Impacts of Northeast Hurricanes on Energy Infrastructure* (2013). This report was prepared by the Office of Electricity

xx Fuel Cells 2000, *The Fuel Cell Industry Review 2014* (2014).

xxi Ibid.

Cyrah Caburian

From: City of Cupertino Written Correspondence
Subject: FW: PLEASE ADOPT STAFF RECOMMENDATION FOR ALL-ELECTRIC REACH CODE

From: Bruce Naegel <bnaegel@sustainablesv.org>
Sent: Friday, November 15, 2019 1:52 PM
To: Steven Scharf <SScharf@cupertino.org>; Liang Chao <LiangChao@cupertino.org>; Rod Sinks <RSinks@cupertino.org>; Darcy Paul <DPaul@cupertino.org>; Jon Robert Willey <JWilley@cupertino.org>
Subject: PLEASE ADOPT STAFF RECOMMENDATION FOR ALL-ELECTRIC REACH CODE

15 November 2019

RE: **PLEASE ADOPT STAFF RECOMMENDATION FOR ALL-ELECTRIC REACH CODE**

Dear Mayor Sharf, Vice Mayor Chao, and Council Members Sinks, Paul, and Willey:

I personally support staff's recommendation to adopt an all-electric Reach Code. I thank the Sustainability Commission to recommend an all-electric REACH code. Please proceed to move this effort forward. The REACH code is one of the best ways Cupertino can meet the ambitious carbon emission reductions in your CAP of 49% reduction by 2035, and 83% by 2050.

Below are a set of reasons why it is practical for Cupertino to adopt a REACH code, especially one that is all-electric. It does not talk about the **why** for this request. Margaret Abe-Koga, Vice Mayor of Mountain View, and board chair of Silicon Valley Clean Energy of expressed it well. She stated that her two children came to her expressing concern thy might not have a place to live here on earth. Our children and grandchildren, nieces, and nephews "GET IT". The earth has gone through several extinctions. Life bounces back, but it is not the same life that was there before. We owe a habitable planet to those who follow us.

Why it is practical to adopt an all-electric or nearly all-electric REACH code

- A home with both gas and electric appliances (mixed fuel) requires two energy supplies. A home that is all-electric only has one. Going all-electric saves new single-family home construction cost of about $6000.
- It is easier to implement an-all electric code than one for mixed fuel. This minimizes the work on the city building staff.
- All electric buildings are safer. Burning natural gas creates formaldehyde, carbon monoxide, and nitrogen dioxide.
- The world needs to stop burning fossil fuels. Buildings last about 50 years. Going all electric today means no 50 years of emitting GHGs and the poisonous substances listed above.
- Converting a building in the future is more expensive than making it all electric now.

The list of cities adopting all-electric or most electric buildings is growing. Please have Cupertino join other cities like Menlo Park, Morgan Hill, and Mountain View and San Jose in supporting electric REACH codes. Thanks for listening.

Bruce Naegel
Director, Metrics and Research

Sustainable Silicon Valley
650 996 5793 Mobile
bnaegel@sustainablesv.org

Cyrah Caburian

From: Soonie Chang <sooniec@gmail.com>
Sent: Sunday, November 17, 2019 3:47 PM
To: Steven Scharf; Liang Chao; Rod Sinks; Darcy Paul; Jon Robert Willey
Subject: Adopt a strong reach code for Cupertino

Mayor Sharf, Vice Mayor Chao, and Council Members Sinks, Paul, and Willey:

I understand there will be a discussion of the Reach Code on Tuesday's agenda and I am writing this email as I am unable to attend the meeting. I am all for Cupertino to adopt the strong reach code. As you are leaders of our community, I hope you will make the right decision to adopt a strong Reach Code for our safety and health.
Thank you!

Sincerely,

Soonie Chang

Cyrah Caburian

From: Bob Whitehair <bobwhitehair@gmail.com>
Sent: Monday, November 18, 2019 7:17 AM
To: Steven Scharf; Liang Chao; Rod Sinks; Darcy Paul; Jon Robert Willey
Subject: REACH CODES

Dear Mayor Sharf, Vice Mayor Chao, and Council Members Sinks, Paul, and Willey:

I am your neighbor in San Mateo. Sustainability issues affect all of us, and I am pleased that the City of Cupertino is considering positive, forceful action to help with the transition away from fossil fuels.

Many organizations, including Fossil Free Buildings Silicon Valley and Sustainable San Mateo County, favor what Cupertino is considering. Preventing the use a fossil fuel - natural gas - in new construction will create more affordable, cleaner, healthier, and more resilient housing and buildings throughout Cupertino. Going all-electric will give Cupertino the best chance at meeting its ambitious carbon reduction goals.

You probably know that many other local cities are taking swift action to prevent new uses of natural gas. You also probably know that what you are considering will help create a critical mass of manufacturers and suppliers offering economical options that can be used by those of us who chose to retrofit old homes such as mine. We are at the point where strong climate action is our only option to protect our communities and our housing stock.

Menlo Park adopted a nearly all-electric Reach Code in September, San Mateo this fall, and Mountain View adopted an all-electric Reach Code last week. Morgan Hill recently passed a prohibition on gas in all new buildings. On October 29, the City of San Jose banned gas in new ADUs, single family home construction, low-rise residential construction, and municipal buildings. Many other cities are now considering all-electric Reach Codes. As you have seen, an all-electric code has many advantages:

- All-electric codes avoid extra design time, are easier for building and planning staff to apply, and are easier for builders, contractors, installers, architects, developers, and consumers to understand.
- An all-electric code in force today prevents a complex, costly switch to electricity in the future, which my family, in its 70 year-old house, is facing.
- All-electric homes are less expensive to build (at least $3,300 and as much as $8,000 for a single family home), and less expensive for occupants to maintain and operate.
- All-electric buildings are healthier and safer for occupants. Gas is the leading cause of structure fires, burns, and carbon monoxide poisoning, and gas cooktops are potent sources of indoor air pollution. Cooking on a gas cooktop releases fine particulate matter, smog-like compounds, and formaldehyde, and is known to exacerbate asthma.

An all-electric Reach Code will protect your community in the short and long term. Precedent exists, and following it will serve you well. Momentum is on your side.

Please adopt an all-electric Reach Code for more affordable, cleaner, healthier, and more resilient homes and buildings throughout Cupertino. Thank you for your leadership.

Robert Whitehair
San Mateo

Cyrah Caburian

From: City of Cupertino Written Correspondence
Subject: FW: Action on Reach Codes

From: Gary Latshaw <glatshaw@gmail.com>
Sent: Monday, November 18, 2019 1:12 PM
To: City Council <CityCouncil@cupertino.org>; Cupertino City Manager's Office <manager@cupertino.org>; Gilee Corral <GileeC@cupertino.org>
Subject: Action on Reach Codes

Dear Mayor Scharf, council members, Manager Feng, and Sustainability Manager Duurvoort

We, our global society, have already emitted more greenhouse gases than is consistent with maintaining a healthy population of people on the Earth. A leading climate scientist, Dr. Jim Hansen, has calculated that the maximum allowable limit of carbon dioxide equivalent is 350 parts per million (ppm) Currently the concentration of carbon dioxide is 412 ppm, and it increases 2 or 3 ppm annually. The most recent international analyses state a requirement that mankind must soon **remove** existing greenhouse gases. Hardly a week goes by in which the news is not occupied with new records of heat or drought or sea level rise or super storms. Soon the effects of this changed weather will affect crop yields and foot availability throughout the world.

We have ignored the warnings of scientists for too long a time.

I am primarily imploring you to ban natural gas in new construction along with aggressive action on the Reach Codes.

The cost of new construction without natural gas is actually cheaper - by $6,000 for a single family dwelling.

Thus, it is totally irrational and immoral to continue to develop infrastructure for fossil fuels.

For these reasons, many cities (Berkeley, Menlo Park, Mt. View, San Jose, and others) have outlawed construction that involves natural gas. Natural gas is allowed in some special cases, and even in those circumstances there are requirements for transitioning to electrical systems in the future.

I realize that there are pressures from some suppliers of natural gas, and developers who don't want to modify their methods of business. In the interest of our children and grandchildren you must overcome the pressures from these groups.

As evidence of the national trend that the Bay Area has started I have pasted this article:

Berkeley-style gas ban gets first test on East Coast with vote in Boston suburb *EXCLUSIVE*
Monday, November 18, 2019 11:28 AM ET
By ***Tom DiChristopher***
Market Intelligence
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Lawmakers in a Boston suburb are set to vote to ban natural gas in new buildings, marking the Bay State's first foray into a climate change policy that has unsettled the industry since it was pioneered in Berkeley, Calif., earlier this year.

The 240-seat Town Meeting in Brookline, Mass., will consider the amendment to its bylaws during a Nov. 19 session. The proposed article would prohibit fossil fuel piping in new buildings or major renovations, effectively requiring electric appliances, heat and hot water systems in new construction.

The amendment's co-sponsors say the measure is necessary to achieve the town's goal of achieving net zero emissions by 2050.

"Every new building constructed with fossil fuel infrastructure makes this goal harder to achieve, by lighting a new fire that will burn, on and off, for thirty years or more," they wrote in their proposal. "It is unfair to the next generation to continue to install infrastructure that we already know will need to be replaced in a very short time."

The vote could be a bellwether for support for gas bans on the East Coast as local officials in neighboring Cambridge and Newton, Mass., advance similar measures. The momentum behind gas bans and building electrification ordinances to date has been centered on the West Coast, with several California cities following Berkeley's lead and Seattle taking up the issue.

"It's exciting to see communities stepping up to this challenge and stepping up in different ways. What Brookline is doing is one path, and one that we think is necessary. We need to stop making the problem worse," said Mark Kresowik, deputy director of the Sierra Club's Beyond Coal campaign for the eastern region.

The Brookline effort is also a test of whether Berkeley-style bans can pass statutory muster in Massachusetts. Local officials have modeled their proposals on Berkeley's ordinance, but they anticipate their legislation could clash with Massachusetts utility law and spark a legal challenge.

The first test will be a review by the Massachusetts attorney general's office, which scrutinizes all bylaw amendments. If the attorney general allows the measure to stand, Kresowik said he expects other cities beyond Brookline, Cambridge and Newton to follow their lead.

But the ban could also face a challenge from the industry on the grounds that the change undermines a key purpose of state utility law: assuring that residents can access gas service.

National Grid USA, which provides gas service in Brookline and Newton, opposes the proposed bylaw amendment.

"The urgency we all share to act now to mitigate climate change has polarized the policy conversation and obscured the fact that the gas network has a role to play in a clean energy future," Danielle Williamson, corporate affairs director for National Grid in Massachusetts, said in an email. "We disagree that the imperative to decarbonize the heating sector should be framed as an absolute prohibition on the continued use of natural gas in the short term."

Companies have typically prevailed in challenging local gas-related ordinances and fees in Massachusetts because courts have consistently ruled state law preempts them, according to a study conducted by the city law department in Newton, Mass.

However, the ban borrowed from Berkeley is a novel approach because it does not seek to regulate any part of utility distribution systems from the fuel's point of origin to the gas meter. Instead, it prohibits the city from issuing building permits to structures that would include fossil fuel piping inside the home, including gut renovations. As written, the amendment would take effect on June 1, 2020.

"We believe that it will withstand a challenge, but the only way to find out for sure is to pass it," the co-sponsors of the bill wrote in their proposal. "A crucially important strategy in fighting the fossil fuel industry is to win in court in defending new legal approaches to decarbonization."

Town Meeting member Jesse Gray laid the groundwork for the bylaw, which now has 11 co-sponsors, including three of the legislative body's five Select Board members, who serve as the town's chief executives. The full Select Board voted to support the bylaw, and Brookline staff helped develop the policy in recent months.

This article was published by S&P Global Market Intelligence and not by S&P Global Ratings, which is a separately managed division of S&P Global.

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> ***Rachel Golden*** *(she/her)*
> *Deputy Director, Building Electrification*
> *Sierra Club*
> *2101 Webster, Suite 1300*
> *Oakland, CA 94612*
> *(C): 415-756-3068*
> *@RachelEGolden*

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Fight for Renewable Energies! Save the global ecology; create jobs; eliminate dependence on foreign oil; reduce military requirements

Gary Latshaw, Ph.D.
408-499-3006

Cyrah Caburian

From: City of Cupertino Written Correspondence
Subject: FW: PLEASE ADOPT STAFF RECOMMENDATION FOR ALL-ELECTRIC REACH CODE
Attachments: FFBSV Comment Letter Cupertino Reach Code 111919.pdf

From: IdaRose Sylvester <idarose@menlospark.org>
Sent: Monday, November 18, 2019 2:08 PM
To: Steven Scharf <SScharf@cupertino.org>; Liang Chao <LiangChao@cupertino.org>; Rod Sinks <RSinks@cupertino.org>; Jon Robert Willey <JWilley@cupertino.org>; Darcy Paul <DPaul@cupertino.org>
Cc: aduurvoort@cupertino.org; knomura@cupertino.org; asalvador@cupertino.org; dfeng@cupertino.org; Anna Weber <aweber@cupertino.org>; Gilee Corral <GileeC@cupertino.org>; City Clerk <CityClerk@cupertino.org>
Subject: PLEASE ADOPT STAFF RECOMMENDATION FOR ALL-ELECTRIC REACH CODE

(inline and in attachment)

Dear Mayor Sharf, Vice Mayor Chao, and Council Members Sinks, Paul, and Willey:

On behalf of the Campaign for Fossil Free Buildings in Silicon Valley ("FFBSV"), this letter expresses our strong support for staff's recommendation to adopt an all-electric Reach Code. We thank staff for their thoughtful analysis. We also thank the Sustainability Commission for their all-electric recommendation, and applaud their diligent thought process. We are pleased you are hosting a study session on Reach Codes Tuesday, and encourage you to move forward to quickly adopt them.

The Campaign for Fossil Free Buildings in Silicon Valley is comprised of the organizations listed above, working together to support an accelerated phase out of fossil fuels in buildings. A swift transition away from fossil fuel use is necessary to avoid the very worst and irreversible impacts of climate change. Preventing the use of fossil fuels, including natural gas, in new construction will create more affordable, cleaner, healthier, and more resilient housing and buildings for communities throughout Cupertino. And all-electric code will give Cupertino the best chance at meeting the ambitious carbon emission reductions in your CAP of 49% reduction by 2035, and 83% by 2050. All-electric construction will lower your building impact to zero ongoing emissions considering the carbon free electricity procured by SVCE.

Many local cities are taking swift action to prevent new uses of natural gas, a fossil fuel, realizing we are at the point where strong climate action is our only option to protect our communities.

Menlo Park adopted a nearly all-electric Reach Code in September, and Mountain View adopted an all-electric Reach Code last week to prohibit gas in all but a few specific building types (such as laboratories). Morgan Hill recently passed a prohibition on gas in all new buildings. On October 29, the City of San José, the tenth largest in the nation, banned gas in new ADUs, single family home construction, low-rise residential construction, and municipal buildings. Many other cities are now considering all-electric Reach Codes. Cities are recognizing how important going fossil-free is to our community's health, safety, climate, and future. As you have seen, an all-electric code has many advantages:

- All-electric code avoids extra design time, is easier for building and planning staff to apply, and is easier for builders, contractors, installers, architects, developers, and consumers to understand. All-electric buildings are also generally faster to design, permit, and build.
- All-electric code today prevents a complex, costly switch to electricity in the future, when the price of gas goes up, due to diminishing demand, and when regulations beyond the city level will dictate it. PG&E has asked for a 24% gas rate increase and SoCal Gas, a 42% increase, over the next couple years, and this is just the beginning. Do not strand your new building owners and renters with expensive and outmoded gas infrastructure.
- All-electric homes are less expensive to build (usually $6,000-8,000 for a single family home), and cheaper for occupants to maintain and operate, saving the typical residential customer up to $100 a year.

- All-electric buildings are healthier and safer for occupants. Gas is the leading cause of structure fires, burns, and carbon monoxide poisoning, and gas cooktops are potent sources of indoor air pollution. Cooking on a gas cooktop releases fine particulate matter, smog-like compounds, and formaldehyde, and is known to exacerbate asthma.

An all-electric Reach Code will protect your community in the short and long term. Precedent exists, and following it will serve you well. Momentum is on your side.

Please adopt an all-electric Reach Code for more affordable, cleaner, healthier, and more resilient homes and buildings throughout Cupertino. Thank you for your leadership.

Sincerely,

IdaRose Sylvester, Fossil Free Buildings Silicon Valley Campaign
Hoi Y. Poon, board member, Bay Area for Clean Environment; co-founder, SV Youth Climate Action
Abhimanyu Jayaraman, FUHSD student, Cupertino Youth Climate Action, SV Youth Climate Strikes
Tara Sreekrishnan, Cupertino Youth Climate Action Team
Susan Butler-Graham, Mothers Out Front South Bay
Monica Mallon, SV Youth Climate Action
Sven Thesen, CEO & Founder Project Green Home
Diane Bailey, Menlo Spark
Bruce Hodge, Carbon Free Palo Alto
Justine Burt, Co-Chair, Green Sanctuary Committee, Unitarian Universalist Congregation of Palo Alto
Barbara Fukumoto, Sunnyvale Cool
Bruce Naegel, Sustainable Silicon Valley and Carbon Free Silicon Valley
Bruce Karney, The Climate Reality Project
Suzanne Emerson, San Carlos Green
Carlos Davidson, Pacifica Climate Committee
Janelle London, Coltura
Jamie Minden, SFHS Student, Silicon Valley Youth Climate Strikes
Debbie Mytels, Chair, Peninsula Interfaith Climate Action
Carol Cross, Fossil Free Mid-Peninsula
Peter Pham; Student Project Lead at Vasconcellos Institute for Democracy in Action, De Anza College
Helen Deng, AMHS Student, Silicon Valley Youth Climate Strikes
James Tuleya, Chairperson, Carbon Free Silicon Valley
Gary Latshaw, Chair of the Guadalupe Group of the Loma Prieta Chapter of the Sierra Club

IdaRose Sylvester | Fossil Free Buildings Campaign Manager Silicon Valley
MENLO SPARK
idarose@menlospark.org | 408-504-9860
Visit us: www.fossilfreebuildings.org and www.menlospark.org
Find us on Facebook
Follow us on Twitter

MENLO SPARK
Climate Neutral for a Healthy, Prosperous Future

The Campaign for Fossil Free Buildings in Silicon Valley

350 Silicon Valley, Acterra, Bay Area for Clean Environment, Carbon Free Silicon Valley, Carbon Free Palo Alto, Carbon Free Mountain View, Citizens' Climate Lobby San Mateo County, Citizens Environmental Council of Burlingame, Clean Coalition, Climate Reality Santa Clara County, Coltura, Fossil Free Mid-Peninsula, Kitchen for Life, Menlo Spark, Menlo Together, Mothers Out Front South Bay, Pacifica Climate Committee, Peninsula Interfaith Climate Action, Project Green Home, SIDCO Homes, San Carlos Green, Sierra Club Loma Prieta Chapter, Sustainable San Mateo County, Sustainable Silicon Valley, Sunnyvale Cool, Silicon Valley Youth Climate Action, and Silicon Valley Youth Climate Strike.

19 November 2019

Mayor Steven Sharf
Vice Mayor Liang Chao
Councilmember Rod Sinks
Councilmember Darcy Paul
Councilmember Jon Willey

City Hall
10300 Torre Ave
Cupertino, CA 95014

Via email: sscharf@cupertino.org, lchao@cupertino.org, rsinks@cupertino.org, dpaul@cupertino.org, jwilley@cupertino.org

RE: PLEASE ADOPT STAFF RECOMMENDATION FOR ALL-ELECTRIC REACH CODE

Dear Mayor Sharf, Vice Mayor Chao, and Council Members Sinks, Paul, and Willey:

On behalf of the Campaign for Fossil Free Buildings in Silicon Valley ("FFBSV"), this letter expresses our strong support for staff's recommendation to adopt an all-electric Reach Code. We thank staff for their thoughtful analysis. We also thank the Sustainability Commission for their all-electric recommendation, and applaud their diligent thought process. We are pleased you are hosting a study session on Reach Codes Tuesday, and encourage you to move forward to quickly adopt them.

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- All-electric code today prevents a complex, costly switch to electricity in the future, when the price of gas goes up, due to diminishing demand, and when regulations beyond the city level will dictate it. PG&E has asked for a 24% gas rate increase and SoCal Gas, a 42% increase, over the next couple years, and this is just the beginning. Do not strand your new building owners and renters with expensive and outmoded gas infrastructure.
- All-electric homes are less expensive to build (usually $6,000-8,000 for a single family home), and cheaper for occupants to maintain and operate, saving the typical residential customer up to $100 a year.
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Please adopt an all-electric Reach Code for more affordable, cleaner, healthier, and more resilient homes and buildings throughout Cupertino. Thank you for your leadership.

Sincerely,

IdaRose Sylvester, Fossil Free Buildings Silicon Valley Campaign
Hoi Y. Poon, board member, Bay Area for Clean Environment; co-founder, SV Youth Climate Action
Abhimanyu Jayaraman, FUHSD student, Cupertino Youth Climate Action, SV Youth Climate Strikes
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Helen Deng, AMHS Student, Silicon Valley Youth Climate Strikes
James Tuleya, Chairperson, Carbon Free Silicon Valley
Gary Latshaw, Chair of the Guadalupe Group of the Loma Prieta Chapter of the Sierra Club

Cc:

Andre Duurvoort, Sustainability Manager, aduurvoort@cupertino.org

Katy Nomura, Assistant to the City Manager, knomura@cupertino.org
Albert Salvador, Assistant Director of Community Development/Building Official, asalvador@cupertino.org
Deborah Feng, City Manager, dfeng@cupertino.org
Anna Weber, Chair of the Sustainability Commission, aweber@cupertino.org
Gilee Corral, Sustainability Program Coordinator, gileec@cupertino.org
Grace Schmidt, cityclerk@cupertino.org

Cyrah Caburian

From: City of Cupertino Written Correspondence
Subject: FW: PLEASE ADOPT ALL-ELECTRIC REACH CODE PER STAFF RECOMMENDATION

From: Bruce Naegel <bnaegel@sustainablesv.org>
Sent: Monday, November 18, 2019 9:30 PM
To: Steven Scharf <SScharf@cupertino.org>; Liang Chao <LiangChao@cupertino.org>; Rod Sinks <RSinks@cupertino.org>; Darcy Paul <DPaul@cupertino.org>; Jon Robert Willey <JWilley@cupertino.org>
Subject: PLEASE ADOPT ALL-ELECTRIC REACH CODE PER STAFF RECOMMENDATION

Dear Mayor Sharf, Vice Mayor Chao, and Council Members Sinks, Paul, and Willey:

As resident of Santa Clara County for over 38 years, I am happy to see a study session on the Reach Code on Tuesday's agenda. I urge the city to move forward quickly to adopting an all-electric code ASAP. Adopting an all-electric Reach Code will make our buildings safer, healthier, and better for the climate.

Please join Menlo Park, Mountain View, Morgan Hill, San José, Pacifica, and others in championing building electrification. Cities are recognizing how important a fossil-free future is to our community's health, safety, climate, and future, and I don't want our city left behind.

Before discussing the advantages of the all-electric reach code, let's think about why we are doing this. Many of us will not see the worst parts of climate change. However, our children, grandchildren, nieces, and nephews will likely see this. One can see climate change today in Venice Italy with its massive flooding. One can also see it in Indian reservations in the Southwest, where water supplies have dried up. We owe it to future generations to pass on a world they can live in and thrive.
The staff recommended all-electric Reach Code has MANY advantages:

- Easier. All-electric code can be contained in a few as two pages. It is much simpler to implement than other methods, making it easier for your staff to implement.
- Future Proof. If you go with all electric today, you avoid conversion expenses in the future when gas is less available and more expensive. PG&E has asked for a 24% gas rate increase and So Cal Gas, a 42% increase. Do not strand your buildings with expensive and outmoded gas infrastructure.
- Cheaper. All-electric are cheaper to build, usually $6,000-$8,000 for a single-family home, and cheaper for occupants to maintain and operate, saving the typical residential customer money on their utility bills due to the remarkable efficiency of modern electrical appliances.
- Healthier and Safer. All-electric buildings are healthier and safer for occupants. Gas is the leading cause of structure fires, burns, and carbon monoxide poisoning. Gas cooktops are potent sources of indoor air pollution. Cooking on a gas cooktop releases fine particulate matter, smog-like compounds, and formaldehyde, and is known to exacerbate asthma.

I look forward to Cupertino moving forward as quickly as possible.

Thank you for your climate leadership.

Bruce Naegel
Carbon Free Silicon Valley and Sustainable Silicon Valley
Bruce Naegel
Director, Metrics and Research

Sustainable Silicon Valley 

650 996 5793 Mobile
bnaegel@sustainablesv.org

Cyrah Caburian

From: City of Cupertino Written Correspondence
Subject: FW: Please Adopt an All Electric Reach Code

From: Tom Kabat <tomgkabat@gmail.com>
Sent: Monday, November 18, 2019 11:26 PM
To: Steven Scharf <SScharf@cupertino.org>; Liang Chao <LiangChao@cupertino.org>; Rod Sinks <RSinks@cupertino.org>; Darcy Paul <DPaul@cupertino.org>; Jon Robert Willey <JWilley@cupertino.org>
Subject: Please Adopt an All Electric Reach Code

Dear Cupertino City Council Members,

As a long time energy professional I strongly support the **elimination** of methane (often referred to as natural gas) in new construction as a way to actually improve the resilience of homes. We are seeing that all-electric homes are more resilient in cases of power outages, gas outages and water outages and in combinations of those.

It's a little unintuitive to folks, but modern heating and water heating appliances have evolved rapidly in the last few years and the old inefficient but simple gas water heaters and wall heaters are no longer efficient enough or clean enough to be close to modern code compliant and cannot be installed in new construction.

Their modern gas alternatives are dependent upon electricity for the igniters and combustion blowers and for fan forced distribution. They also cannot store hot water like a heat pump water heater that always have a tank of hot water to deliver in an outage or to be used as fresh emergency water in a water outage.

Modern Home Resilience even without Electric Backup

New code compliant homes will have either two dependencies (electric and water) or three dependencies (electric, water and gas for mixed fuel). The All-Electric home needs only electricity and water to deliver all services. It also carries 80 gallons of hot water that us useful for the first day(s) of a power outage. That water is also useful as your emergency fresh water for you and your pets after a quake.

The gas fired home will lose its heating, water heating and cooking in a gas outage and those tend to be long outages. Ironically the gas home will loose its water heating immediately in a power outage as it has an electrically ignited and fan forced combustion exhaust system that stops as the power goes out. The tankless water heater holds less than a gallon of water and it's not hot.

Meanwhile, the electric neighbor basks in another 50-80 gallons of stored hot water.

The gas home looses all heating and cooling in a power outage as the furnace igniter and blower and the combustion system blower all loose power. Gas fireplaces can't provide heat to a home without an electric circulation blower and would be difficult or dangerous to operate even if you could override safety measures. Both homes need a little camp stove, like a propane fired folding camp stove for cooking in gas outages for the gas home and in electric outages for the all electric home.

To summarize, gas homes leave you vulnerable to gas leaks and fires and don't provide an emergency fresh water supply. They need a camp stove and only let you keep from practicing with it in a pure electric outage.

A backup battery connected to the basic new code required solar system is becoming the clean safe form of electric backup. I volunteer for a non-profit solar installer and some of our clients pick a $100 "secure plug" option that lets them have daytime electricity during power outages from a pair of specially-switched outlets in the garage. More solar and battery backup systems will be available soon making the electric home option even more superior to the gas one.

Thank you for considering these observations of modern homes and how all electric construction provides improved resiliency and safety.

Sincerely,

Tom Kabat
Mechanical Engineer and Environmental Quality Commissioner

Cyrah Caburian

From: danibfoster@hushmail.com
Sent: Tuesday, November 19, 2019 1:47 PM
To: Steven Scharf; Liang Chao; Rod Sinks; Darcy Paul; Jon Robert Willey
Subject: PLEASE ADOPT ALL-ELECTRIC REACH CODE

Dear Mayor Sharf, Vice Mayor Chao, and Council Members Sinks, Paul, and Willey:

Hello. As step-mother to two boys and a resident of Cupertino, I am very glad to see a study session on the Reach Code on today's agenda, and I urge the city to move forward quickly to adopting an all-electric code ASAP. Adopting an all-electric Reach Code will make our buildings safer, healthier and better for the climate.

Please join Menlo Park, Mountain View, Morgan Hill, San José, Pacifica, and others in championing building electrification. Cities are recognizing how important a fossil-free future is to our community's health, safety, climate, and future, and I don't want our city left behind.

The staff recommended all-electric Reach Code has MANY advantages:

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- Future Proof. All-electric code today prevents a complex, costly switch to electricity in the future, when the price of gas goes up, due to diminishing demand, and when regulations beyond the city level will dictate it. PG&E has asked for a 24% gas rate increase and So Cal Gas, a 42% increase, over the next couple years, and this is just the beginning. Do not strand your buildings with expensive and outmoded gas infrastructure.
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I look forward to Cupertino moving forward as quickly as possible.

Thank you for your climate leadership.

Danielle Burnett-Foster

Cyrah Caburian

From: Linda Sell <lndsell@gmail.com>
Sent: Tuesday, November 19, 2019 4:39 PM
To: City Council
Cc: Gary Latshaw; Hoi Poon; Tara Sreekrishnan
Subject: Study Session - 2019 California Energy & Green Building Standards Codes - Reach Codes,
Attachments: 11-19_BACE-Reach-Codes-Cupertino-Letter-.pdf

Dear Mayor Scharf, Vice Mayor Chao, Councilmember Paul, Councilmember Sinks, and Councilmember Willey,

Attached is a letter from Bay Area for Clean Environment (BACE).

The attached letter discusses why all-Electric buildings are absolutely necessary and why the climate crisis demands urgency.

We Strongly Support the City Staff and the Sustainability Commission Recommendations of an All-Electric Reach Code (Option 1).

I have also copied BACE Chairman Gary Latshaw and Hoi Poon and Tara Sreekrishnan who are both BACE Board members.

Sincerely,

Linda Sell
Vice Chair, Bay Area for Clean Environment

November 19th, 2019
Cupertino City Council
10350 Torre Avenue, Cupertino

RE: Study Session - Adoption of Local Amendments to 2019 California Energy & Green Building Standards Codes - Reach Codes,

Dear Mayor Scharf, Vice Mayor Chao, Councilmember Paul, Councilmember Sinks, and Councilmember Willey,

We Strongly Support the City Staff and the Sustainability Commission Recommendations of an All-Electric Reach Code (Option 1).

We are living in a climate crisis. In 2019 we experienced the hottest June, July, September, and October on record. July was the hottest month ever recorded in human history. California's climate fueled wildfires are getting larger and deadlier. The planet is hurtling towards an irreversible tipping point; after a 2 degrees Celsius temperature increase over pre-industrial levels, the planet will begin an unstoppable self-warming cycle. The future of our children and of organized life on Earth is at stake.

Bay Area for Clean Environment, or **BACE**, is a local non-profit that has been fighting for 10 years to hold local polluters to higher clean air and water standards in coordination with the Bay Area Air Quality Management District and other agencies. BACE is committed to encouraging regulatory agencies to vigorously defend the public's interest to bring about a cleaner and safer neighborhood! To this end, BACE is proud to stand in support of All-Electric "Reach Codes".

Other cities have already gone all-electric:

Mountain View has adopted a fully all-electric Reach Code. Morgan Hill passed an ordinance prohibiting natural gas in all new buildings. San Jose has banned natural gas in new low-rise buildings, ADUs, and municipal buildings. San Jose is currently working on an additional ordinance that will prohibit gas in even more building types.

All-Electric homes are healthier to live in:

Gas cooking in the home is an extremely hazardous source of indoor air pollution. Gas stoves release carbon monoxide, nitrogen dioxide, formaldehyde, and ultrafine particles into our homes. This increases asthma rates and can lead to a variety of long-term health impacts. The levels of indoor air pollution from gas stoves are so extreme that those pollution levels from regular use could be found illegal according to the EPA if they were recorded outside.

All-Electric Reach Codes avoid the installation of gas pipelines, which saves money and reduces emissions:

The Staff Report notes that "natural" gas represents 38.2% of Cupertino's City-wide greenhouse gas emissions as recorded in 2018, making it the single largest source of emissions. "Natural" gas emissions have increased from 2015 to 2018, and have also become a larger percentage of Cupertino's emissions in that same timeframe. Simultaneously, emissions associated with electricity have drastically shrunk to only 1.7%.

Reducing gas emissions by requiring all-electric new buildings is one of the most important climate actions that Cupertino can take. Thanks to the clean electricity sourcing offered by Silicon Valley Clean Energy, all-electric buildings will significantly reduce emissions in Cupertino's largest emissions sector.

Because gas pipelines constantly leak methane into our atmosphere (a phenomenon called “fugitive emissions”), the most effective way to reduce emissions is to avoid building new gas pipelines altogether. The lack of pipelines is one of the main reasons that an all-electric code is superior to an electric preferred code. If a gas line is run to a home for just one or two appliances, that gas line will be a source of constantly leaking methane, which is 84 times more potent of a greenhouse gas than carbon dioxide. Furthermore, developers will save a significant amount of money from avoiding the cost of a gas hookup.

Homeowners will save money too from all-electric homes. As more and more cities pass all-electric Reach Codes and other ordinances prohibiting gas, this will accelerate the decline in the number of people using gas. As a shrinking population of users is burdened with the cost of maintaining archaic gas infrastructure, their gas rates will rise. All-electric homes, on the other hand, will be immune from gas rate hikes and will benefit from renewable technologies such as solar panels and battery storage.

We would like to thank City Staff and Members of the Sustainability Commission for their hard work and their excellent recommendation. We ask that City Council support the staff recommendation of an All-Electric Reach Code.

Sincerely,

Bay Area for Clean Environment Board of Directors
www.BayAreaCleanEnvironment.com

CC 11-19-19
SS #1

Cyrah Caburian

From: Linda Sell <lndsell@gmail.com>
Sent: Tuesday, November 19, 2019 4:39 PM
To: City Council
Cc: Gary Latshaw; Hoi Poon; Tara Sreekrishnan
Subject: Study Session - 2019 California Energy & Green Building Standards Codes - Reach Codes,
Attachments: 11-19_BACE-Reach-Codes-Cupertino-Letter-.pdf

Dear Mayor Scharf, Vice Mayor Chao, Councilmember Paul, Councilmember Sinks, and Councilmember Willey,

Attached is a letter from Bay Area for Clean Environment (BACE).

The attached letter discusses why all-Electric buildings are absolutely necessary and why the climate crisis demands urgency.

We Strongly Support the City Staff and the Sustainability Commission Recommendations of an All-Electric Reach Code (Option 1).

I have also copied BACE Chairman Gary Latshaw and Hoi Poon and Tara Sreekrishnan who are both BACE Board members.

Sincerely,

Linda Sell
Vice Chair, Bay Area for Clean Environment

November 19th, 2019
Cupertino City Council
10350 Torre Avenue, Cupertino

RE: Study Session - Adoption of Local Amendments to 2019 California Energy & Green Building Standards Codes - Reach Codes,

Dear Mayor Scharf, Vice Mayor Chao, Councilmember Paul, Councilmember Sinks, and Councilmember Willey,

We Strongly Support the City Staff and the Sustainability Commission Recommendations of an All-Electric Reach Code (Option 1).

We are living in a climate crisis. In 2019 we experienced the hottest June, July, September, and October on record. July was the hottest month ever recorded in human history. California's climate fueled wildfires are getting larger and deadlier. The planet is hurtling towards an irreversible tipping point; after a 2 degrees Celsius temperature increase over pre-industrial levels, the planet will begin an unstoppable self-warming cycle. The future of our children and of organized life on Earth is at stake.

Bay Area for Clean Environment, or **BACE**, is a local non-profit that has been fighting for 10 years to hold local polluters to higher clean air and water standards in coordination with the Bay Area Air Quality Management District and other agencies. BACE is committed to encouraging regulatory agencies to vigorously defend the public's interest to bring about a cleaner and safer neighborhood! To this end, BACE is proud to stand in support of All-Electric "Reach Codes".

Other cities have already gone all-electric:

Mountain View has adopted a fully all-electric Reach Code. Morgan Hill passed an ordinance prohibiting natural gas in all new buildings. San Jose has banned natural gas in new low-rise buildings, ADUs, and municipal buildings. San Jose is currently working on an additional ordinance that will prohibit gas in even more building types.

All-Electric homes are healthier to live in:

Gas cooking in the home is an extremely hazardous source of indoor air pollution. Gas stoves release carbon monoxide, nitrogen dioxide, formaldehyde, and ultrafine particles into our homes. This increases asthma rates and can lead to a variety of long-term health impacts. The levels of indoor air pollution from gas stoves are so extreme that those pollution levels from regular use could be found illegal according to the EPA if they were recorded outside.

All-Electric Reach Codes avoid the installation of gas pipelines, which saves money and reduces emissions:

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CC 11/19/19
SS #1

November 19th, 2019
Cupertino City Council
10350 Torre Avenue, Cupertino

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Sincerely,

Bay Area for Clean Environment Board of Directors
www.BayAreaCleanEnvironment.com

CC 11/19/19
SS #1

Introduction

We're the **Cupertino Youth Climate Action Team!**

- Students from Cupertino, Homestead, Monta Vista High Schools and Harker
- Representatives from the Cupertino Teen Commission
- Representatives from the Cupertino High School Environmental Club

Silicon Valley Youth Climate Strike

- Thousands of youth and adults marched for climate action
  - All-Electric Reach Codes were on our list of demands for local governments

All Electric Reach Codes

- Electric Vehicle Charging Infrastructure
- Building Appliance Electrification
- **All-Electric Option**
- Allows for Exemptions on Certain Commercial Uses

Consequences of New Gas Lines

- Gas Rates/Cost of Maintenance Continues to Rise
- Huge Financial Liability to our Community
- Constant Methane Leaks
- Difficult to Retrofit

Thank you!

- Mountain View and Menlo Park Passed All-Electric Reach Codes
- Cupertino should continue to be a Climate Leader!

We ask that the Cupertino City Council to pass an All-electric Reach Code that:

- Requires electric heating/cooling, water heater, clothes dryer, cooking appliances, fireplaces, and firepits for all building types.

- Allows for Commercial restaurants to apply for a waiver for an exemption for gas cooking in situations where no electric alternative is available (Menlo Park and Mountain View use similar waivers)

- Allows for some exemptions for certain commercial building types: [Mountain View allows gas for F (factory industrial), H (hazardous materials), and L (laboratories).]

- Require pre-wiring for the future installation of electric appliances where gas is installed.

- Allows multi-family buildings within ¼ mile of transit (defined as frequent bus service or a light rail station, in a Planned Development Area, with a Transportation Demand Management Plan) to have no parking requirements, thus reducing the cost of EV infrastructure.

CC 11-19-19 Oral Communications

Written Comments

West Valley Community Services Presentation to Cupertino City Council

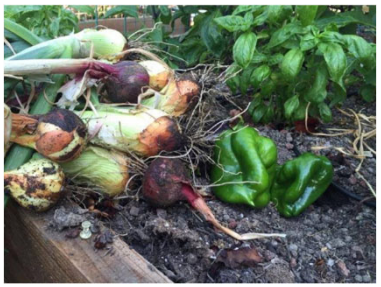
November 19, 2019


Our mission:
Uniting the community to fight hunger and homelessness


Our vision:
A community where every person has food on the table and every person has a roof over their head

CELEBRATING 45 YEARS OF SERVICE!
HEALTH • HOME • HEART
West Valley Community Services

FOOD PANTRY & COMMUNITY GARDEN



HOUSING PROGRAMS

Vista Village – one & two bedroom apartments

Greenwood Court – three bedroom apartments

Housing Specialist – housing advocate for clients

Rapid Rehousing – case management & rental assistance

Homeless Supportive Services – referrals & emergency financial assistance

CELEBRATING 45 YEARS OF SERVICE!
HEALTH • HOME • HEART
West Valley Community Services

SUPPORTIVE SERVICES

Emergency Financial Assistance

Special Programs

Case Management & Referrals

Financial coaching

Celebrating 45 Years of Service
HEALTH • HOME • HEART
West Valley Community Services

EDUCATION PROGRAMS & FINANCIAL WORKSHOPS

Cooking classes

Health Fair

Job Fair

552 individuals participated in education programs

-Thirty percent of Silicon Valley households rely on public or private, informal assistance in order to get by

-Ten percent of Silicon Valley residents lack consistent access to food that is nutritionally adequate.

Santa Clara County Homeless Point in Time Survey 2019

- **9,706 homeless in Santa Clara County**- 25% increase in Cupertino
- The number of people living unsheltered in **vehicles increased** nearly threefold from 591 in 2017 to 1,747 in this count
- More than **1/3** of survey respondents indicated they were experiencing homelessness for the **first time**, and 67% had been homeless for a year or longer
- People indicated that assistance with **rent/mortgage payments**, employment assistance, and alcohol/drug counseling may have prevented them from becoming homeless

CELEBRATING 45 YEARS OF SERVICE!
HEALTH • HOME • HEART
West Valley Community Services

Program Highlights

3,273 men, women, and children received critical help from WVCS

958,840 lbs of food were distributed in the food pantry

2,311 individuals visited the food pantry and the mobile food pantry

$ 539,794 in emergency financial assistance was given to prevent homelessness

1070 people came to WVCS for the first time for help

215 children in K-12th grade received clothing, shoes and backpacks

900 people will receive clothing, toys, and appliances at Gift of Hope

330 families will receive Thanksgiving meal baskets

20, 584 Volunteers Hours

Highlights 2018-2019

- 9% increase in new clients
- 13% increase in the poundage of food distributed
- 23% increase in client accessing WVCS services.
- $539,794 in Financial Assistance helped prevent homelessness and rapidly rehouse client's facing homelessness
- Laundry quarter assistance that helps homeless clients to maintain personal hygiene nearly doubled in 2018-2019.
- 96% of households remained housed 3 months after receiving financial assistance

Ian Greenside's Oral Communication

TED J. HANNIG (SB #111691)
H. ANN LIROFF (SB #113180)
PETER W. DANIEL (SB #179107)
HANNIG LAW FIRM LLP
2991 El Camino Real
Redwood City, CA 94061
Telephone: (650) 482-3040
Facsimile: (650) 482-2820

Attorneys for Plaintiff
Rosanne S. Foust

FILED
SAN MATEO COUNTY
JAN 28 2004
Clerk of the Superior Court
By _____ DEPUTY CLERK

SUPERIOR COURT OF THE STATE OF CALIFORNIA

COUNTY OF SAN MATEO - UNLIMITED JURISDICTION

Summons Issued

ROSANNE S. FOUST,

Plaintiff,

vs.

RAY WANG, and DOES 1 through 10, inclusive,

Defendants.

Case No. CIV-432736

BY FAX

FIRST AMENDED VERIFIED COMPLAINT FOR DAMAGES FOR: (1) NUISANCE; (2) TRESPASS; (3) DEFAMATION; (4) IDENTITY THEFT; (5) HARASSMENT AND STALKING

Plaintiff alleges as follows:

ALLEGATIONS COMMON TO ALL CAUSES OF ACTION

1. Plaintiff Rosanne S. Foust is now, and at all times material herein, was an individual residing in Redwood City, California.

2. Defendant RAY WANG is an individual who resided in San Mateo County during the times described in this complaint.

3. Plaintiff does not know the true names and capacities of defendants named herein and fictitiously sued as DOES 1 through 10, inclusive, and therefore sues them by those fictitious names. The names, capacities, and relationships of DOES 1 through 10, inclusive, will be alleged by amendment to this Complaint when the same are known to Plaintiff.

4. Plaintiff is informed and believes and thereon alleges, that at all times material to this Complaint, defendants, and each of them, were the agents of their co-defendants and in doing the things alleged in this First Amended Complaint, were acting within the course and scope of that agency.

5. The events which form the basis of this lawsuit took place in San Mateo County, California.

6. Plaintiff was the victim of identity theft when a person or persons repeatedly impersonated her on the internet resulting in a barrage of unwanted e-mail messages to her home computer, including explicit pornographic images. This 'cyber assault' was a political smear tactic against Plaintiff, who at the time of the attacks was a member of the Planning Commission and a candidate for City Council in Redwood City, California.

7. The harassment began on about June 26, 2003, and continued, when Plaintiff received the first of a number of unwanted e-mail solicitations from a variety of sources on her family home computer. The messages continued to arrive for the next few days, and then on June 27, 2003 came the first of numerous pornographic solicitations with sexually explicit images that were displayed on Plaintiff's computer and which were highly offensive to Plaintiff, who is the mother of two small children.

8. Had either of her young children been with her at the computer they would have been exposed to the graphic sexual images. The text of the messages indicate that the senders believed that they were replying to a request or posting by Plaintiff seeking images and information as these messages are sent only to a person who actively requested such images and information. Plaintiff promptly objected to several individual senders of the messages and requested that such messages cease, but the messages continued to arrive at her computer.

9. Plaintiff is informed and believes and thereon alleges that that an individual or individuals inserted Plaintiff's e-mail address on one or more web sites in order to have the offensive images sent to her. Another of the business solicitation replies contains Plaintiff's name, including her maiden name, and her mailing address. The perpetrator(s)

falsely used this information to impersonate plaintiff and falsely request the business solicitations.

10. Plaintiff is informed and believes and thereon alleges that Defendants WANG, and DOES 1 through 10, inclusive, caused the unwanted electronic messages to be sent to her. At least one of the pornographic confirmation requests received by Plaintiff contained an IP address which was later confirmed to belong to Defendant WANG's home computer. Plaintiff also received confirmation that at least two of the other messages originated from the computer with the same IP address.

11. Defendant Wang and DOES 1 through 10, inclusive, have been vociferous political opponent(s) of Plaintiff who has vigorously campaigned against her in the past. Plaintiff is informed and believes and thereon alleges that Defendants RAY WANG, and DOES 1 through 10 planned the cyber attack in order to place Plaintiff in a false light and damage her reputation in the community and as a candidate in the pending City Council election, and also to harass and annoy Plaintiff and her family.

12. On or about July 4, 2003, Plaintiff's computer was infected with a virus attached to an e-mail. The virus attacked Plaintiff's computer and caused e-mails to be sent to everyone on Plaintiff's electronic address book with the virus attached.

13. This virus infected and damaged Plaintiff's computer and may have consequently infected and damaged computers of Plaintiff's friends and associates. Plaintiff ultimately closed her e-mail address as a result of the cyber attack and the virus.

14. Because of the proximity in time of the virus attack to the cyber attack, Plaintiff is informed and believes and on that basis alleges that Defendants WANG, and DOES 1 through 10 were responsible for the virus attack as well.

15. As a direct and proximate result of the acts of Defendants WANG, and DOES 1 through 10, and each of them, Plaintiff was forced to immediately retain legal counsel to investigate the source of the attack, to take time from her business and expend costs to formulate a campaign response and to repair damage to her computer system. As a result she has incurred legal fees and costs, in an amount according to proof.

FIRST CAUSE OF ACTION
Nuisance

16. Plaintiff refers to and incorporates by reference as if fully set forth herein the allegations contained in paragraphs 1 through 15, inclusive.

17. Plaintiff is informed and believes and thereon alleges that Defendants WANG, and DOES 1 through 10, and each of them, intentionally or negligently caused unwanted electronic communications and pornographic images to be sent into Plaintiff's home, which caused substantial interference with Plaintiff's private use and enjoyment of her property in that she could no longer feel secure in her own home or allow her children to access the computer unsupervised.

18. As a result of the conduct of Defendants, and each of them, Plaintiff has suffered general damages in an amount to be proven at trial.

19. The acts as set forth above were oppressive, malicious, and fraudulent and done with a conscious disregard for the rights and safety of plaintiff. As a result, Plaintiff is entitled to an award of punitive and exemplary damages in an amount sufficient to punish and make and example of Defendants, and each of them.

20. As a result of the conduct of Defendants, and each of them, Plaintiff has incurred and will continue to incur special damages including loss of use of property and account(s) in an amount that will be proven at trial.

SECOND CAUSE OF ACTION
Trespass

21. Plaintiff refers to and incorporates by reference as if fully set forth herein the allegations contained in paragraphs 1 through 20, inclusive.

22. Plaintiff is informed and believes and thereon alleges that Defendants WANG, and DOES 1 through 10, and each of them, intentionally and negligently caused unwanted

electronic communications and a virus to be sent to Plaintiff's home computer, causing damage to the computer itself and impairing its functioning.

23. As a result of the conduct of Defendants, and each of them, Plaintiff has suffered general damages in an amount to be proven at trial.

24. The acts as set forth above were oppressive, malicious, and fraudulent and done with a conscious disregard for the rights and safety of plaintiff. As a result, Plaintiff is entitled to an award of punitive and exemplary damages in an amount sufficient to punish and make and example of Defendants, and each of them.

25. As a result of the conduct of Defendants, and each of them, Plaintiff has incurred and will continue to incur special damages including loss of use of property and account(s) in an amount that will be proven at trial.

WHEREFORE, Plaintiff prays for judgment as set forth below.

THIRD CAUSE OF ACTION
Defamation

26. Plaintiff refers to and incorporates by reference as if fully set forth herein the allegations contained in paragraphs 1 through 25, inclusive.

27. Plaintiff is informed and believes and thereon alleges that Defendants WANG, and DOES 1 through 10, and each of them, intentionally and maliciously caused to be published a false and unprivileged writing concerning Plaintiff, to wit: the writing or insertion of her e-mail address and personal information in a manner that gave the false appearance that she was requesting that pornographic material be provided to her.

28. Plaintiff is informed and believes and thereon alleges that Defendants WANG, and DOES 1 through 10, and each of them, ascribed false statements to Plaintiff in writing with knowledge that the statement was false and of its defamatory meaning and acted with reckless disregard of these matters. This false publication presented Plaintiff in a

false light, and exposed her to embarrassment the electronic publication further injured Plaintiff in respect to her office, profession, trade and business, by imputing to Plaintiff general disqualification in those respects which the offices or occupations she held and those she sought generally require.

29. As a result of the conduct of Defendants, and each of them, Plaintiff has suffered general damages in an amount to be proven at trial.

30. The acts as set forth above were oppressive, malicious, and fraudulent and done with a conscious disregard for the rights and safety of plaintiff. As a result, Plaintiff is entitled to an award of punitive and exemplary damages in an amount sufficient to punish and make and example of Defendants, and each of them.

31. As a result of the conduct of Defendants, and each of them, Plaintiff has incurred and will continue to incur special damages including loss of use of property and account(s) in an amount that will be proven at trial.

WHEREFORE, Plaintiff prays for judgment as set forth below.

FOURTH CAUSE OF ACTION
Identity Theft

32. Plaintiff refers to and incorporates by reference as if fully set forth herein the allegations contained in paragraphs 1 through 31, inclusive.

33. Plaintiff is informed and believes and thereon alleges that Defendants, and each of them, appropriated Plaintiff's identity and falsely represented themselves to be Plaintiff on the internet for their own purposes, which included political gain, harassment, and to solicit business under false pretenses, and without Plaintiff's consent.

34. The theft of her identity caused damage to Plaintiff's reputation and caused her to incur attorney's fees and expend costs to investigate the source of the attacks and rectify the situation.

35. As a result of the conduct of Defendants, and each of them, Plaintiff has suffered general damages in an amount to be proven at trial.

36. The acts as set forth above were oppressive, malicious, and fraudulent and done with a conscious disregard for the rights and safety of plaintiff. As a result, Plaintiff is entitled to an award of punitive and exemplary damages in an amount sufficient to punish and make and example of Defendants, and each of them.

37. As a result of the conduct of Defendants, and each of them, Plaintiff has incurred and will continue to incur special damages including loss of use of property and account(s) in an amount that will be proven at trial.

WHEREFORE, Plaintiff prays for judgment as set forth below.

FIFTH CAUSE OF ACTION
Harassment / Stalking

38. Plaintiff refers to and incorporates by reference as if fully set forth herein the allegations contained in paragraphs 1 through 37, inclusive.

39. Plaintiff is informed and believes and thereon alleges that Defendants WANG, and DOES 1 through 10, and each of them, engaged in a pattern of conduct showing a continuity of purpose to harass, caused unwanted electronic communications and pornographic images to be sent into Plaintiff's home, which caused Plaintiff to fear for her safety and the safety, well-being and security of her family.

40. Plaintiff felt scared and suffered substantial emotional distress that an anonymous person would harass her. Plaintiff was especially alarmed, shocked and offended because Plaintiff's child has access to the computer and could be exposed to the pornography. The harassing messages continued to arrive despite plaintiff's objections to the business solicitors.

41. As a result of the conduct of Defendants, and each of them, Plaintiff has suffered general damages in an amount to be proven at trial.

42. The acts as set forth above were oppressive, malicious, and fraudulent and done with a conscious disregard for the rights and safety of plaintiff. As a result, Plaintiff is entitled to an award of punitive and exemplary damages in an amount sufficient to punish and make and example of Defendants, and each of them.

43. As a result of the conduct of Defendants, and each of them, Plaintiff has incurred and will continue to incur special damages including loss of use of property and account(s) in an amount that will be proven at trial.

44. As a result of the conduct of Defendants, and each of them, Plaintiff has incurred and will continue to incur legal fees and costs in an amount to be proven at the trial herein. Plaintiff requests an award of attorneys' fees.

WHEREFORE, Plaintiff prays for judgment against Defendants, and each of them, as set forth below.

1. For compensatory damages in an amount according to proof;

2. For special damages, in an amount according to proof;

3. For punitive and exemplary damages according to proof;

4. For attorneys' fees and costs;

5. For costs of suit incurred herein; and

6. For such other and further relief as this Court deems just and proper.

Dated: January 26, 2004

HANNIG LAW FIRM LLP

By: _____
H. Ann Liroff
Attorneys for Plaintiff
Rosanne S. Foust

VERIFICATION

I, ROSANNE S. FOUST, make the following verification:

I have read the First Amended Complaint and know the contents thereof. The contents of this document are true of my own knowledge, except as to those matters stated on information and belief, and as to those matters, I believe them to be true.

I declare under penalty of perjury that the foregoing is true and correct.

Executed this 27 day of January, 2004, at Redwood City, California.

Rae S. Foust

ROSANNE S. FOUST

CC 11-19-19 #16

Library Expansion

Written Communications

CC 11-19-19 # 16

Comparison Matrix

CUPERTINO LIBRARY FOUNDATION

	Oct 24's Option 1 – Two story w/o elevator	Oct 24's Option 2 – Single Story
Cost	$9M	$5.63**
# new program spaces	4 extra event areas	0-1 depending on design
SqFt new program space	2472 (1425+1547-500*)	1473 (1973-500*) half available
Adult overflow	Connected to adult area	Connected to childrens area
Future use options	Repurpose part of 1st floor	Teardown/loss of new room
Multiday events	Many options, small/med/large	One small option
Safety	Issue with site lines for restrooms on 2nd floor	Adult in childrens. Restrooms when divided
Off hours	First floor, No 2nd floor No elevator for ADA	Available, prob not extended days
Conference rooms	No small or medium conferences rooms	None

* Est of existing story room. Includes space used for transferring of books.
** provided outside of the Workgroup sessions