"A clear explanation of global warming and its primary cause."

CAPITALISM & CLIMATE CHANGE

The Science and Politics of Global Warming

DAVID KLEIN

Illustrated & edited by
Stephanie McMillan

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Foreword

2014 was the hottest year on record. If we don't quickly find a way to stop global warming, we're cooked. This ghastly reality is now staring us right in the face.

It's finally become fashionable for the leftish intelligentsia—public intellectuals, paid activists, liberal editors—to bend themselves, with much concern and expressions of urgency (albeit a bit late for some), to the challenge of global warming. But most of them seem constitutionally incapable of dealing with the underlying situation that drives it. They identify the problem variously as corporate greed, sociopathic elites, brainwashed consumers, corrupt politicians. When they can no longer avoid mentioning capitalism, they unfailingly qualify it: "capitalist excess," "corporate capitalism," "crony capitalism," "the broken system."

But the culprit is capitalism, period. Qualifiers let capital off the hook, protect it as the one unassailable permanent condition that must be worked around in the quest to solve the crises that it in fact causes. That this is an exercise in futility is a tragic understatement. But as one of its staunchest defenders (Dick Cheney) famously declared, this way of life is non-negotiable.

Because these "broken system" advocates restrict their critique to symptoms and not cause, they accordingly suggest measures—technical fixes, legal restraints, political reforms, economic restructuring, shifts, upgrades, adjustments—that may slightly help in (very briefly) staving

off the inevitable, but can't possibly solve the problem. We don't need to fix capitalism. It's not broken; it's doing what it does. We need to destroy it.

Capitalism is a global mode of production that is inherently, structurally, inescapably, ever-expanding. Its sole aim is constant capital accumulation. The machine must be fed; consequences are merely collateral damage. It has an inexorable motion of its own that is utterly heedless of human will, desires, or needs (never mind those of other forms of life, who are reduced to mere "resources").

Capital dominates everything; it enchains humanity to the task of its continuance. It reproduces and accumulates through the exploitation of labor in the production of surplus value, crystallized in commodities. And thus it is voracious in its intake of raw materials (forests, wildlife, soil), burns fuel insatiably (coal, oil, natural gas), and then spits its foul wastes into the air and waters, in a cycle of production that is unrelenting. It also happens to be suffocating and cooking us.

Professor David Klein is rare in academia, in that he's able and willing to acknowledge that capitalism and a healthy planet are totally incompatible. This is the real inconvenient truth; saying it out loud can be hard on one's career. But he has the objectivity and integrity not to turn away from it. Instead, he has assumed the responsibility to help others understand it too, so that they can join the struggle to save the planet. The phrase "save the planet" has been co-opted into a cliché, an insult to our intelligence—a meaningless phrase employed to reduce our agency to recycling aluminum cans and lowering thermostats two degrees. But David takes saving the planet seriously, and he's determined to figure out what needs to be done to really accomplish that, and bend his efforts accordingly.

I met David in the fall of 2013, when I was invited by Edie Pistolesi (Professor of Art) to speak at California State University, Northridge (CSUN). I arrived prepared with my speech about what capitalism is and why it's irredeemable, with accompanying slides of comics intended to make that information less ignorable. She arranged for David to speak first. She called his talk "The Scary Speech." "It'll be like a one-two punch," she explained. "He'll tell the students what kind of big trouble we're in, and you'll provide the reason and point the way out."

The combination worked so well that we presented it again a year later. This book is an expanded version of David's "Scary Speech," along with some analysis based on my own talk and book, *Capitalism Must Die!*

Edie described the reactions of some of her students to the talks: "stunned," "scared to death." One started crying. Many didn't appear affected at all. But others opened up to face the challenge.

One of David's students told me that he's the only professor who ever told her the truth about capitalism. Now she's made a commitment to becoming an organizer in her own right, one more precious fighter for a living world. She'll gather others. If this book can arm them with some of the information they need to convince more people to join the struggle, then it will have done its job. Together, we'll build a movement strong enough to forcibly escort this ecocidal system off the stage of history.

Capitalism is dynamic, resilient and adaptable—it won't collapse on its own. Capitalists are ruthless and heavily militarized—they won't let go of power easily. Our recognition of these sobering facts clarify our responsibilities. We need to build organizations at all levels: a broad mass movement to weaken and slow down capitalism's destructiveness, along with revolutionary organizations working for its overthrow and for a

viable alternative. The struggle against ecocide is an integral part of class struggle. It can only be won in the context of the fundamental struggle of the working class against exploitation, for emancipation, for the demise of capitalism.

Facing today's environmental emergency may seem overwhelming and even terrifying, but we can't let it defeat us before trying everything necessary to stop it. Nothing else we can do with our lives is more important. This is not a moment for passive resignation or paralysis of grief, but for summoning all our courage and determination for the difficult fight ahead.

Stephanie McMillan
January 4, 2015

Introduction

Many people, perhaps most, can more easily imagine the end of the world than the end of capitalism. This book aims to help the reader understand both possibilities more clearly, with an emphasis on avoiding the former by making the latter a reality.

Potential cataclysms that could wipe out humanity and devastate the natural world range from astronomical to terrestrial in origin, but the most menacing are of human invention. In 2009 a group of leading environmental and earth-system scientists presented a holistic framework for the examination of how humanity is pushing the earth system to its limits and beyond. They proposed nine planetary boundaries, perilous to cross, for the following processes: climate change; biodiversity loss; the nitrogen and phosphorus cycles; stratospheric ozone depletion; ocean acidification; global fresh-water use; land use change; chemical pollution; and atmospheric aerosol loading. These processes are interdependent, and some boundaries may have been already crossed [Rockström].

Of these nine processes, climate change arguably poses the greatest and most pressing danger and it is closely related to the others. Climate change is the primary focus of this book, though connections are made to the other threats. The first part of this book, Part 1, gives a non technical overview of the science of global warming and climate change. Included is an explanation of the greenhouse effect, the carbon cycle and the role of fossil fuels. Climate predictions, based on scenarios for the future, are given using everyday language, but they closely follow peer reviewed

scientific research. Part 1 concludes with a chapter on renewable energy and policy changes that could avert the worst dangers, and identifies the capitalist system as the barrier to implementation.

The economic, political, and cultural strands of capitalism are so integrated into our thinking that real intellectual effort is required to recognize it as a threat to survival and to acknowledge the possibility of sustainable alternatives. This needs to become obvious.

Capitalism is waging a war against nature. This war includes exploding mountain tops for the cheapest possible extraction of coal. It includes expanding dead zones in the ocean, poisoning, flooding, and burying vast swaths of the biosphere for the extraction of fossil fuels and minerals. The ever-increasing efficiency in waging this war serves to lower costs, increase consumption, and accelerate global warming and devastation of the planet.

The goal of Part 2 is to clarify and illuminate the role of capitalism in creating and perpetuating the climate crisis and related dangers. Evidence and arguments are presented there to demonstrate the impossibility of adequately addressing this crisis within the framework of capitalism. But the first step is to understand the scientific basis of global warming and climate change, and how that will affect us.

Part 1: What does climate science tell us?

1. Scientific consensus

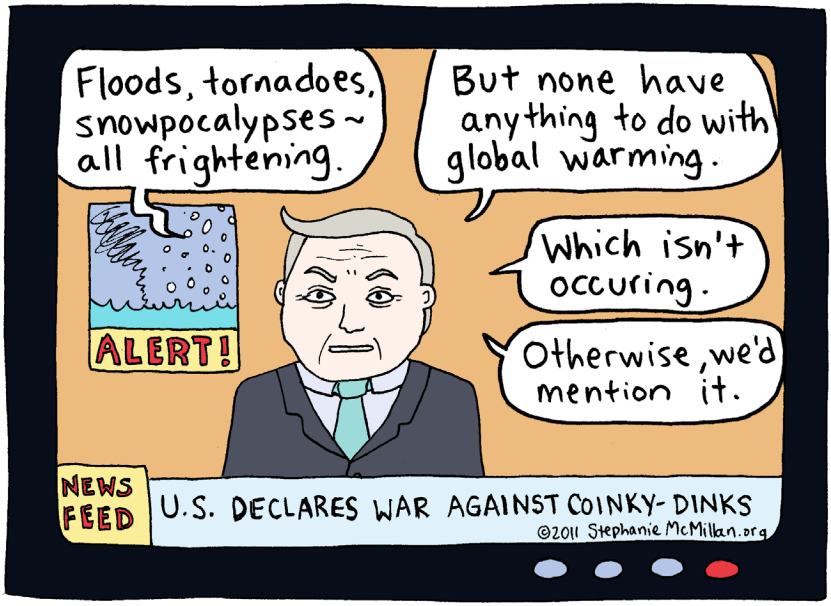
There is a disconnect between the opinions of the general public and the findings of scientists who study the climate. Opinion polls of U.S. adults on the subject of climate change vary with time and the phrasing of questions, but a sizable minority has been steadfast in its denial that global warming is occurring and that it is caused by human activity.

A December 2013 *USA Today*-Stanford University poll found that 73% of Americans think that global warming is "probably happening." Imagine a society in which only that percentage thought that the earth is "probably round."

A spring 2013 Gallup poll found that 79% of U.S. adults say they understand the issue of global warming fairly well or very well, but only 57% thought that global warming is caused by human activities. One-third of Americans surveyed in that poll thought that most scientists think global warming is not occurring or that they are unsure. A March 2014 Gallup poll found the lowest percentage of Americans who worry about the environment "a great deal" since 2001.

What do the climate scientists think? There's a long list of scientific organizations weighing in on this.

The scientific consensus is that global warming is incontrovertible, and at least 97% of climate scientists agree that the global warming of the past century is very likely due to human activities [Anderegg]. The



Intergovernmental Panel on Climate Change, or IPCC, is the leading organization of climate scientists worldwide. It has a membership of thousands of climate scientists from more than 150 countries, and the organization has repeatedly articulated this consensus in its reports. According to its 2013 report, "It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century" [IPCC1].

The national science academies of Brazil, Canada, China, France, Germany, Italy, India, Japan, Mexico, Russia, South Africa, the United Kingdom, and the United States issued a joint public statement in 2009 [G8+5] which warned:

> Climate change and sustainable energy supply are crucial challenges for the future of humanity. It is essential that world leaders agree on the emission reductions needed to combat negative consequences of anthropogenic climate change.

A similar joint statement was also released in 2007 by the science academies of Cameroon, Ghana, Kenya, Madagascar, Nigeria, Senegal, South Africa, Sudan, Tanzania, Uganda, Zambia, Zimbabwe, as well as the African Academy of Sciences. [Africa]. Worldwide, some 200 scientific organizations have issued statements warning of the dangers of climate change, and attribute it to human activities [World].

Virtually all major U.S. scientific societies have also issued strong public statements about climate change. These include the American Association for the Advancement of Science, American Chemical Society, American Medical Association, American Meteorological Society, American Physical Society, The Geological Society of America, U.S. Global Change Research Program, and the National Academy of Sciences.

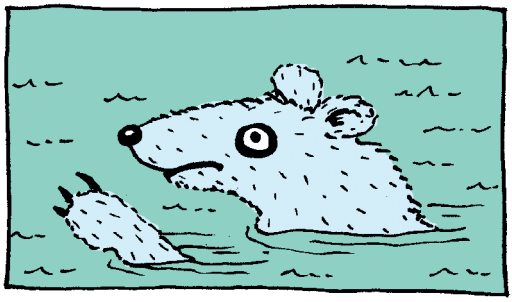
The position of the American Geophysical Union, reaffirmed in 2013, is that, "Humanity is the major influence on the global climate change observed over the past 50 years. Rapid societal responses can significantly lessen negative outcomes." [AGU]

A joint statement from 18 U.S. scientific associations in 2009 [Joint18] reinforced other warnings,

> Observations throughout the world make it clear that climate change is occurring, and rigorous scientific research demonstrates that the greenhouse gases emitted by human activities are the primary driver... If we are to avoid the most severe impacts

of climate change, emissions of greenhouse gases must be dramatically reduced.

The worldwide consensus of climate scientists is that human activity is warming the planet at a rapid rate, and the consequences are potentially catastrophic.



Organized attacks against climate scientists

A deliberate and organized effort to undermine the science has been funded and directed by powerful corporations, primarily ExxonMobil and Koch Enterprises as well as the Scaife Foundations. Their goal has been to misdirect public discussion and distort people's understanding of climate change. Conservative think tanks, trade associations, and advocacy organizations such as the Cato Institute, Americans for Prosperity, and the Heartland Institute are the key components of a well-organized climate change counter-movement [Brulle, McKie]. Their activities include "political lobbying, contributions to political candidates, and a large number of communication and media efforts that aim at undermining climate science" [Brulle].

A study of 91 "climate change counter-movement" organizations revealed an annual income of just over $900 million between 2003 and 2009, but with only $64 million that can be traced back to identifiable donors. The remainder of the corporate donations passes through clandestine channels and is untraceable [Brulle].

A tiny minority of scientists, supported by corporations and right wing foundations, have played disproportionately influential roles in the spread of confusion about global warming. Not surprisingly some of these same scientists previously opposed the consensus on the dangers of cigarette smoke and the ozone hole over the South Pole [Oreskes].

Widespread attacks against individual climate scientists have been vicious. A feature article in *Popular Science* [Clynes] documents examples:

> A climate modeler at Lawrence Livermore National Laboratory answered a late-night knock to find a dead rat on his doorstep and a yellow Hummer speeding away. An MIT hurricane researcher found his inbox flooded daily for two weeks last January with hate mail and threats directed at him and his wife. And in Australia last year, officials relocated several climatologists to a secure facility after climate-change skeptics unleashed a barrage of vandalism, noose brandishing and threats of sexual attacks on the scientists' children.
>
> Those crude acts of harassment often come alongside more-sophisticated legal and political attacks. Organizations routinely file nuisance lawsuits and onerous Freedom of Information Act (FOIA) requests to disrupt the work of climate scientists. In 2005, before dragging Mann and other climate researchers into congressional hearings, Texas congressman Joe Barton ordered the scientists to submit voluminous details of working procedures, computer programs and past funding—essentially demanding that they reproduce and defend their entire life's work. In a move that hearkened back to darker times, Oklahoma senator James Inhofe, the ranking member of the Senate's Environment and Public Works Committee, released a report in 2010 that named 17 prominent climate scientists, including Mann, who, he argued, may have engaged in 'potentially criminal behavior.' Inhofe outlined three laws and four regulations that he said the scientists may have violated, including the Federal False Statements Act—which, the report noted, could be punishable with imprisonment of up to five years.

Even a politically conservative atmospheric scientist, Katharine Hayhoe, at Texas Tech University, whose scientific findings agreed with the scientific

consensus, was not immune from attack. "I can delete the hate mail I got calling me a 'Nazi bitch whore climatebecile,'" Hayhoe says, "but responding to nuisance lawsuits and investigations takes up enormous amounts of time that could be better spent teaching, mentoring, researching, doing my job." "When I get an e-mail that mentions my child and a guillotine," Hayhoe says, "I sometimes want to pull a blanket over my head. The intent of all this is to discourage scientists. As a woman and a mother, I have to say that sometimes it does achieve its goal. There are many times when I wonder if it's worth it" [Clynes].

In psychological studies of conservative bloggers—a category that surely includes authors of extreme actions such as described in the previous paragraphs—it has been found that "people's rejection of climate science is associated with an embrace of laissez-faire free-market economics. There is little doubt that people's personal ideology—also often referred to as worldview or cultural cognition—is a major predictor of the rejection of climate science" [Lew].

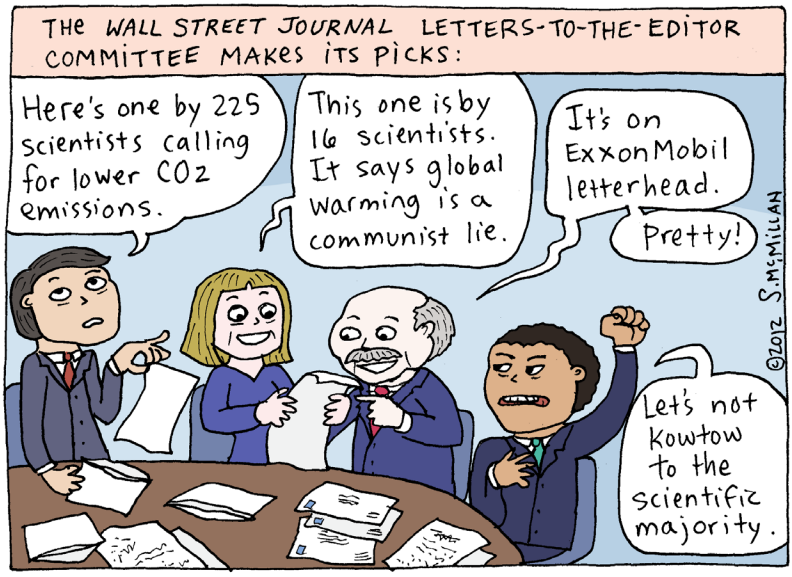
Political defense of climate science

Responding to attacks on the science of climate change and against individual climate scientists, 255 members of the U.S. National Academy of Sciences, including 11 Nobel laureates, published an open letter entitled "Climate Change and the Integrity of Science" in 2010 [Gleick]. The authors represented those sections of the National Academy of Sciences most directly connected to the study of the climate. Their letter includes these excerpts:

> There is compelling, comprehensive, and consistent objective evidence that humans are changing the climate in ways that threaten our societies and the ecosystems on which we depend.

> Warming the planet will cause many other climatic patterns to change at speeds unprecedented in modern times, including increasing rates of sea-level rise and alterations in the hydrologic cycle. Rising concentrations of carbon dioxide are making the oceans more acidic.
>
> The combination of these complex climate changes threatens coastal communities and cities, our food and water supplies, marine and freshwater ecosystems, forests, high mountain environments, and far more.
>
> Much more can be, and has been, said by the world's scientific societies, national academies, and individuals, but these conclusions should be enough to indicate why scientists are concerned about what future generations will face from business-as-usual practices. We urge our policy-makers and the public to move forward immediately to address the causes of climate change, including the unrestrained burning of fossil fuels.
>
> We also call for an end to McCarthy-like threats of criminal prosecution against our colleagues based on innuendo and guilt by association, the harassment of scientists by politicians seeking distractions to avoid taking action, and the outright lies being spread about them. Society has two choices: We can ignore the science and hide our heads in the sand and hope we are lucky, or we can act in the public interest to reduce the threat of global climate change quickly and substantively.

Prior to its publication in *Science*, "Climate Change and the Integrity of Science" was submitted to, and rejected by, the *Wall Street Journal*.



Reflecting the broad opposition of corporate power to the field of climate science, the *Wall Street Journal* chose instead to publish an opposing opinion piece entitled, "No Need to Panic about Global Warming," with 16 authors. From these 16, only four had published peer-reviewed research related to climate change, and six of the authors had been linked to fossil fuel interests [Media].

Scientists and academics from a wide range of fields increasingly express alarm. An open letter signed by 93 Harvard faculty members in April 2014 (which later increased to more than 200 faculty signers), urging divestment from the fossil fuel industry, included this stark warning [Harvard]:

> Our sense of urgency in signing this Letter cannot be overstated. Humanity's reliance on burning fossil fuels is leading to a marked

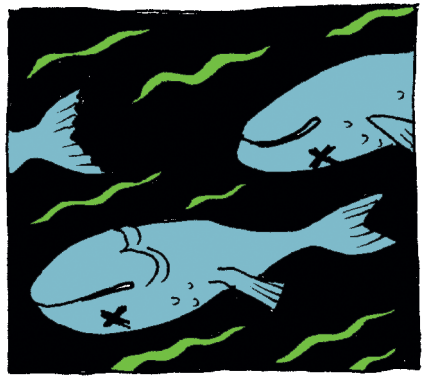
> warming of the Earth's surface, a melting of ice the world over, a rise in sea levels, acidification of the oceans, and an extreme, wildly fluctuating, and unstable global climate. These physical and chemical changes, some of which are expected to last hundreds, if not thousands, of years are already threatening the survival of countless species on all continents. And because of their effects on food production, water availability, air pollution, and the emergence and spread of human infectious diseases, they pose unparalleled risks to human health and life.

On the same day, March 31, 2014, that the IPCC released a major report warning of the effects of climate change, Exxon Mobil issued its own report on the risks that climate change policies could pose to its future profitability. The company reassured investors that it would continue as in the past, arguing that the world needs vastly more energy, and new climate policies are "highly unlikely" to stop it from selling fossil fuels far into the future [Fahey], [Elgin].

Supporting corporate interests, the US House of Representatives passed a bill, HR 2413 on April 1, 2014 requiring the National Oceanic and Atmospheric Administration (NOAA) and federal weather agencies to focus more on predicting storms and less on climate studies. According to Representative Jim Bridenstine, who introduced the bill in 2013, the intent of the measure was "shifting funds from climate change research to severe weather forecasting research" [Reuters].

Why do powerful corporations and the mainstream media undermine science in these ways? In Part 2, we will discuss not only the reasons for capitalism's assault on climate science, but also the fundamental incompatibility of addressing the climate crisis and surrendering to

capitalism's requirements. But we first turn to the science of the climate to understand just how serious the climate crisis is.



2. Climate vs weather, what is the difference?

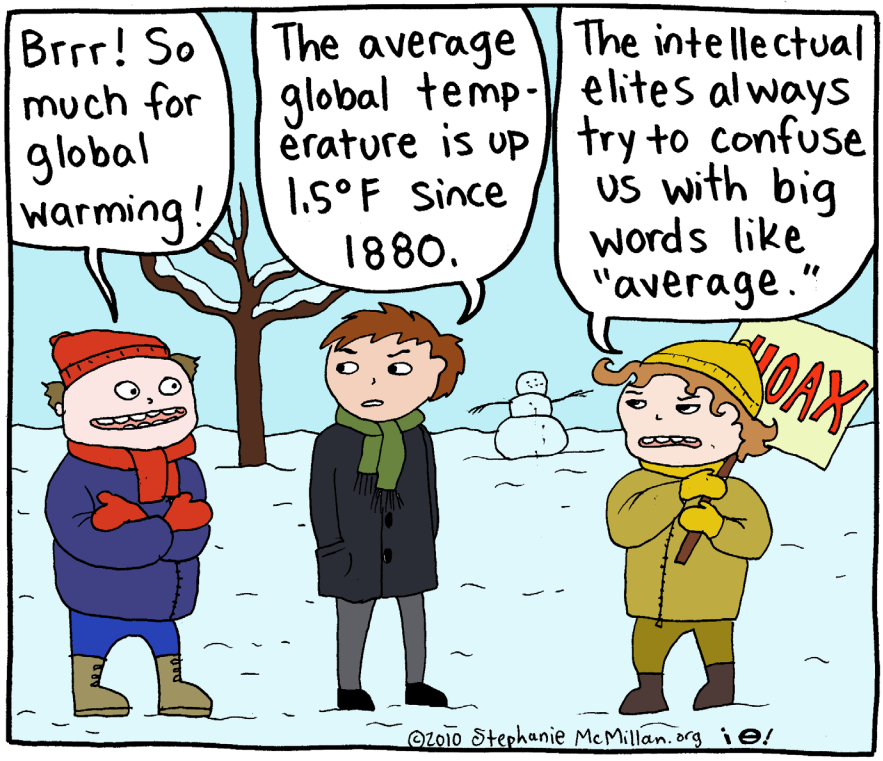
What is the difference between climate and weather?

This question is important because people can confuse the two. Some people wonder, "How can scientists talk about global warming a hundred years from now, when they can't even predict the weather 10 days ahead?" or "How could there be global warming when it's so cold outside, like today?"

Weather describes conditions of the atmosphere in a particular place, like rain, snow, cloudiness, humidity, and pressure, over short periods of time, day by day and even minute by minute. Useful weather predications cannot be made beyond two weeks or so into the future because weather prediction involves a branch of mathematics called chaos theory. You might have heard of the so-called "butterfly effect." In metaphorical terms, a butterfly flapping its wings now in China, might later cause (or prevent) tornados in Kansas. Weather is very sensitive to small changes in the atmosphere. That makes it hard to predict.

Climate refers to a statistical average of weather at some location, typically over a period of 10 years or more. Climate information includes average precipitation, average temperature, average wind velocity, etc. Unlike weather, climates can be predicted far into the future, and climates of the past can be deduced from physical evidence. Here is an analogy for

weather vs. climate. Before you flip a coin, you don't know if it will come up heads or tails. But if you flip that coin a hundred times, you expect to get heads half the time and tails the other half. Climate is what you expect based on averages; weather is what you get.



3. What is global warming and what causes it?

Global warming refers to the increase in average worldwide temperatures since the beginning of the industrial revolution. The main cause of global warming is the *greenhouse effect* due to *greenhouse gases* in the atmosphere. To understand the greenhouse effect requires knowing how light, heat, and matter interact.

Light, heat, and matter

Visible light comes in colors. The lowest frequency light that we can see is red, and the highest is violet. But there are other frequencies of light (from the sun and elsewhere) that we cannot see. Light with frequency lower than red light is called *infrared* radiation, while light with frequency greater than violet light is called *ultraviolet* radiation (at even higher frequencies, there are x-rays and gamma rays, and at frequencies lower than infrared there are radio waves, but that will not concern us).

Most, though not all, of the light (in terms of intensity) that reaches Earth from the sun is visible to humans and animals. That is why we evolved with the ability to see the colors we do. Combinations of the pure colors in Figure 1 make other colors, including white. We can't see infrared and ultraviolet light, but they are important. Infrared light plays a critical role in climate change.

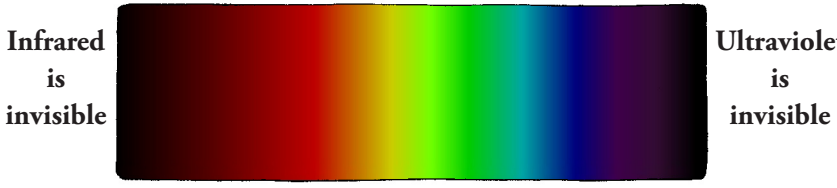


Figure 1 The visible spectrum from low frequency (left) to high frequency (right): Red, Orange, Yellow, Green, Blue, Indigo, Violet. Infrared radiation *is light whose frequency is lower than that of red light.* Ultraviolet radiation *is light with higher frequency than violet's. We cannot see infrared or ultraviolet "colors".*

We all know from experience that you warm up when you stand in sunlight. When light is absorbed by something, it is heated. The reverse is also true. A heated object radiates light (including invisible infrared light). Any material, even air, emits radiation (i.e., light), and the frequencies of the emitted light depend on the temperature of the object. The hotter an object is, the higher the frequencies are of the radiated light.

Have you ever heard the phrase "red-hot"? For example, an electric stove burner turns red if it's hot enough. In other words, it emits red light if it has a high enough temperature. If it was hotter still, it would emit more yellow light. Take a look at Figure 1, and notice that yellow light has a higher frequency than red light. Objects even hotter emit more blue light (which has a higher frequency than yellow light), but we see the light as white because the colors combine. Figure 2 illustrates this with a metal bar that is hottest at the far end.

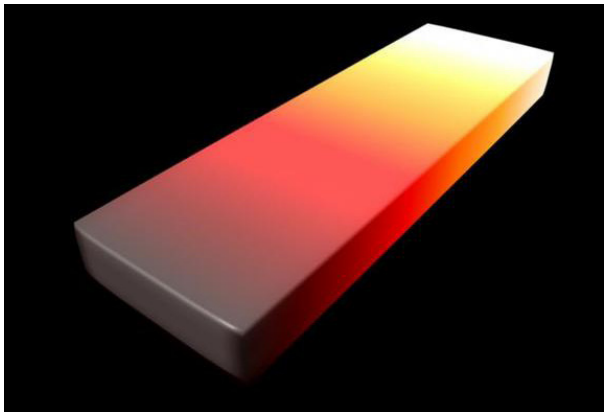


Figure 2 A metal bar, dark, red-hot, yellow, and white-hot. The color depends on temperature.

The surface of the earth and the atmosphere also emit light when they are heated, but since they are much cooler than a red-hot electric stove burner, the frequencies of light they emit are lower than the frequency of red light. The invisible light they emit is infrared.

Greenhouse gases

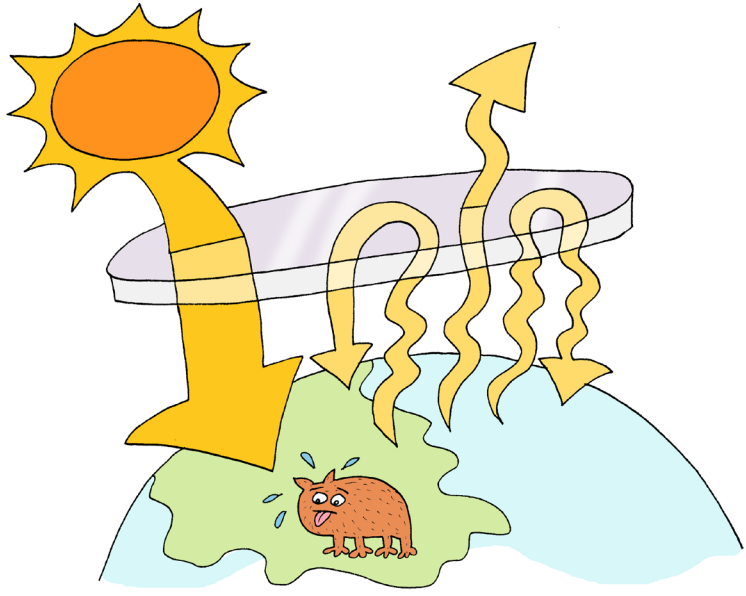
The atmosphere absorbs almost no sunlight, which is mostly visible light. Visible light passes through air much like it passes through a window. That is why we can see the sun in the daytime and the stars at night.

The atmosphere consists of many different gases, mostly nitrogen (78%) and oxygen (21%), but also small quantities of other gases. Some of these are greenhouse gases. A greenhouse gas is a gas that absorbs infrared light (but not visible light). The most important greenhouse gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3),

fluorinated gases (F-gases), and water vapor (H_2O). Nitrogen and oxygen (in its usual molecular form, O_2) are not greenhouse gases.

Greenhouse gases heat the planet. Here is how it works. Sunlight, which is mostly visible, passes through the atmosphere and heats the surface of the earth, both the ground and the ocean surface. Once it is heated by the sun, the surface emits infrared radiation back out to the atmosphere.

Some of infrared radiation goes all the way back out into space, but some is absorbed by the greenhouse gases, making them warmer. The heated greenhouse gases can then warm the surrounding air or re-radiate infrared light in random directions. The infrared light emitted by the greenhouse gases that is sent back to the ground heats the ground more, and the process repeats. This is the greenhouse effect.



The average surface temperature of Earth for the first decade of the 21st century was about 59°F. If our atmosphere had no carbon dioxide nor any other greenhouse gases, the average global temperature would only be about 0°F, well below the 32°F freezing point, and Earth would likely be a lifeless planet. So some carbon dioxide in the atmosphere is good.

Too much carbon dioxide, methane, or other greenhouse gases in the atmosphere can heat the planet to dangerous levels. This will be explained in greater detail below, but an extreme example of the power of the greenhouse effect comes from two other planets in our solar system.

Mercury is the closest planet to the sun, followed by Venus which is twice as far from the sun. On that basis, one would expect Mercury to be the hotter of the two planets, but Venus is actually hotter than Mercury. Venus has a global temperature of more than 860°F and does not cool even at night. This is mainly because its dense atmosphere is almost entirely carbon dioxide, so heat is trapped by the greenhouse effect. Mercury's atmosphere, by contrast, is very thin with almost no greenhouse gases.

More on greenhouse gases

Some greenhouse gases are more powerful than others. According the the 2013 IPCC report, the global warming potential of methane is 86 times that of an equal weight of carbon dioxide over a 20 year period. The reason for the 20 year period is that, while carbon dioxide is very stable, methane slowly decays in the atmosphere into carbon dioxide and water and so its power as a greenhouse gas decreases with time. The factor of 86 is the *global warming potential* of methane for a 20 year period. Over a ten year period, methane has a global warming potential of 108, and on that time scale, "the current global release of methane from all anthropogenic

sources exceeds (slightly) all anthropogenic carbon dioxide emissions as agents of global warming" [Howarth2].

Methane is the main ingredient in natural gas and if it is burned for fuel it changes into carbon dioxide and water vapor, which are less powerful greenhouse gases. However, methane leaks from fracking (hydraulic fracturing) and other processes pose extremely serious risks to the climate.

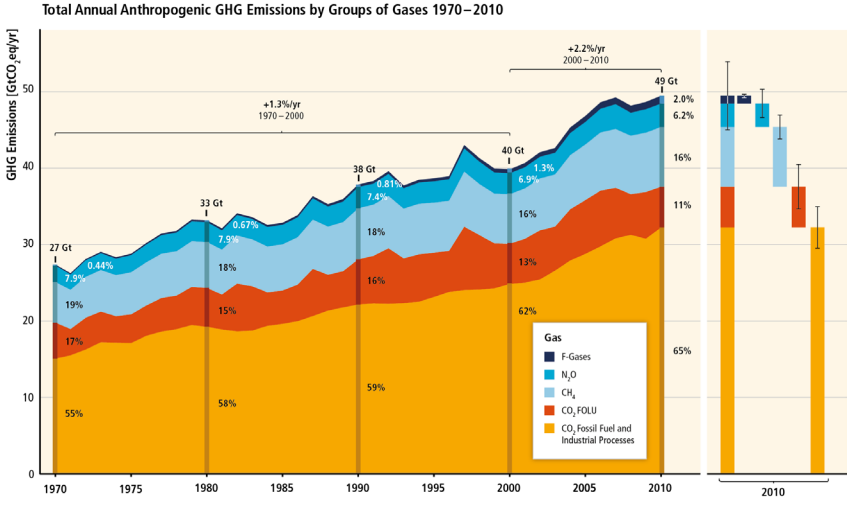


Figure 3. Taken from the 2014 IPCC report [IPCC-SPM]. Total annual anthropogenic greenhouse gas (GHG) emissions in gigatons of equivalent CO_2 emissions per year($GtCO_2eq/yr$) by groups of gases 1970-2010: CO_2 from fossil fuel combustion and industrial processes; CO_2 from Forestry and Other Land Use (FOLU); methane (CH4); nitrous oxide (N2O); fluorinated gases (F-gases). At the right side of the figure GHG emissions in 2010 are shown again broken down into these components with the associated uncertainties (90% confidence interval) indicated by the error bars. Emissions are converted into CO_2-equivalents based on GWP100 from the IPCC Second Assessment Report. The emission data from FOLU represents land-based CO_2 emissions from forest fires, peat fires and peat decay. Average annual growth rate over different periods is highlighted with the brackets.

Some other greenhouse gases have even greater global warming potential than methane. Nitrous oxide is 268 times stronger than an equal weight of carbon dioxide, and one of the chlorofluorocarbons, CFC-11, is 7020 times stronger, both over a 20 year period. Fortunately the most powerful greenhouse gases are rare in the atmosphere and that limits their potential damage.

However, according to the 2013 IPCC report, "The atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased to levels unprecedented in at least the last 800,000 years. Carbon dioxide concentrations have increased by 40% since pre-industrial times, primarily from fossil fuel emissions and secondarily from net land use change emissions." In 2011, the concentration of methane exceeded pre-industrial levels by 150%, and nitrous oxide concentration increased by 20% [IPCC1]. The figure above from a 2014 IPCC report shows a timeline of greenhouse gas emission rates in terms of CO_2 equivalent mass by taking into account global warming potentials [IPCC3].

Climate feedbacks

The current unprecedented rate of greenhouse gas emissions into the atmosphere is the primary driver of climate change on Earth, but because the climate system is complicated, many other factors must also be taken into account. As the planet warms, the climate system responds in many different ways. One important type of response is called a *feedback*.

For example, as the planet warms, more water evaporates from oceans and lakes. Because the water vapor in the air is also a greenhouse gas, the planet is warmed further by this evaporation, which causes even more evaporation and therefore more warming. This is an example of a positive feedback, positive because the warming is reinforced.

Another example is the ice-albedo feedback. *Albedo* is a number between zero and one. It measures the fraction of light reflected from a surface. A white colored surface has an albedo that is almost 1, because it reflects most of the incoming incident light. Dark colored surfaces absorb most of the incident light and are heated by that absorbed light. Very little of the light is reflected back, so a dark surface has an albedo that is nearly zero.

You can feel how this works on a sunny day. Stand barefoot on a white sidewalk, and then step onto the black asphalt on the street. It will feel much hotter. The light colored sidewalk has a high albedo because it reflects most of the light and stays cool, but the dark asphalt reflects very little light (that's why it's dark!) and instead absorbs the light and turns it into heat, and then also radiates invisible infrared light.

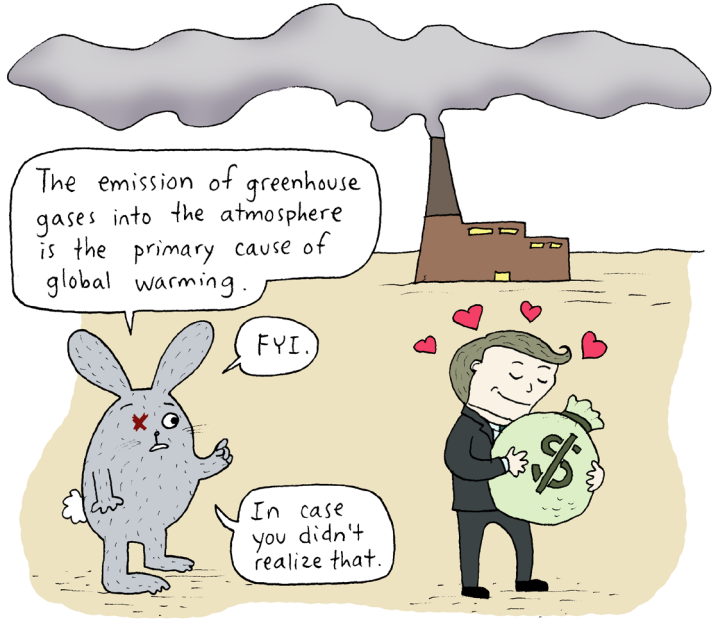
Arctic ice has an albedo even higher than a sidewalk. It reflects sunlight back into space and helps to keep the planet cool. But as the planet warms up from greenhouse gases, ice melts, and the ground or dark sea water underneath absorbs more sunlight and heats the planet. That in turn causes more ice to melt which heats the planet more. This is another example of a positive feedback.

There are other positive feedbacks and also negative feedbacks. For example, as the planet warms evaporation increases, as discussed above, but the moisture in the air can become part of a cloud which reflects incoming sunlight back into space because of its high albedo.

Clouds cover roughly two-thirds of the globe and play a complicated role in the climate system. They reflect light from the sun back to space, and that cools the planet, but they also reflect some infrared radiation from the ground and atmosphere back toward the ground, and that has a

warming effect. The balance of these two processes for a particular cloud depends on many factors, including the height of the cloud above the ground and microphysical processes. Collectively, the clouds of the world have a net cooling effect on the current climate, but that cooling effect weakens with increasing carbon dioxide concentrations.

Summing up, the emission of greenhouse gases into the atmosphere is the primary cause of global warming.



4. The disruption of Earth's carbon cycle

Carbon is the building block of life. The carbon cycle is critical to life on Earth and is an integral part of the climate system. There are four major planetary carbon depositories: sedimentary rocks and solid earth; the land surfaces; the oceans; and the atmosphere. The carbon cycle moves carbon between these reservoirs.

The ocean, soil and life on land, and sedimentary rocks all hold and exchange carbon with the atmosphere on different time scales, from annual cycles to changes over millions of years. Of these, the atmosphere holds the least carbon, but even in dilute quantities, carbon in the atmosphere has a powerful influence on the climate, because of the greenhouse effect described in the previous chapter.

Plants, animals, and soil

Think of the earth as a giant battery whose energy sustains life on the planet. One pole of the battery is organic carbon, and the other is the oxygen in the atmosphere. When the two are combined in the right way, energy is produced and carbon dioxide is released as a byproduct. This happens slowly when animals eat or plants decay, and rapidly when fossil fuels are burned.

Plants charge this "battery" through *photosynthesis*, a reaction in which energy from the sun is used to separate carbon (C) and oxygen (O) from carbon dioxide molecules (CO_2) in the surrounding air, in order to make organic carbon and oxygen. The organic carbon is stored by the plant, and the oxygen is released back to the atmosphere. Phytoplankton in the ocean produce about as much organic carbon and oxygen this way as plants do on land.

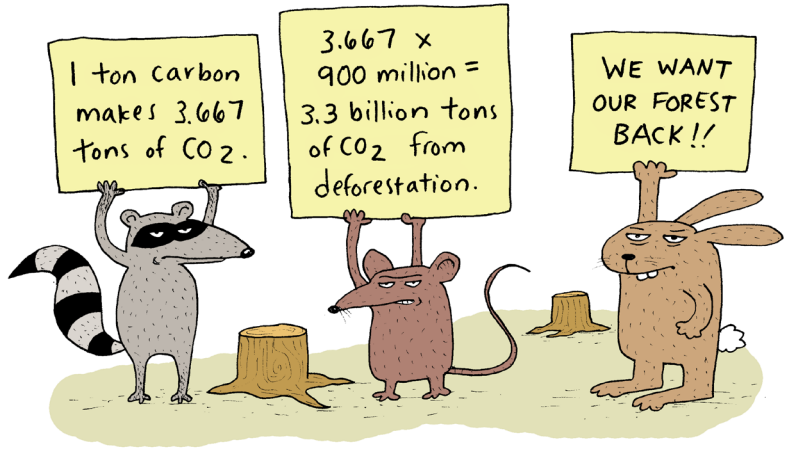
The high-energy carbon biomolecules created in photosynthesis can be used by the plant that created them or by an animal or person that eats the plant, through a reaction called *respiration*. In this reaction, organic carbon is food and the oxygen needed to turn it to energy is captured by breathing. The products are carbon dioxide and water, which are exhaled. Plants also respire at night, when they are not engaged in photosynthesis.

Trees and other plants remove carbon dioxide from the atmosphere, but only temporarily, and a lot depends on what happens to the plants after they die. Nearly all of the organic carbon produced from photosynthesis is eventually respired. In other words, nearly all of the carbon dioxide captured by plants is returned later to the atmosphere. Once a tree dies,

its organic carbon is transformed back to carbon dioxide through decay, although dry wood can last centuries before that happens.

When a forest is destroyed, trees are killed and not replaced, and the carbon they hold is released to the atmosphere. Most forests in the temperate latitudes have long since been cut down, but deforestation in the tropics continues.

According to the 2013 IPCC report, annual carbon emissions from human land use change was 900 million tons per year between 2002 and 2011. By comparison, 8.3 billion tons of carbon were emitted per year during that same period from fossil fuel combustion and cement production, and in 2011 this increased to 9.5 billion tons [IPCC1]. Deforestation and land use change on a planetary scale is a major source of carbon emissions into the atmosphere, second only in magnitude to the burning of fossil fuels.



Land plants and soils absorb about a quarter of human carbon dioxide emissions, and this helps to reduce the greenhouse gas concentration in the atmosphere. But the capacity of the land to absorb carbon is likely to decrease as the world heats up and tropical climate regions expand.

Soils actually hold more carbon than plants and animals collectively, but there is great variation. Soils in tropical regions hold very little carbon dioxide, whereas soils in the higher latitudes, especially permafrost soils hold vast amounts. As the planet warms, tropical regions will expand and the soils capable of holding more carbon will retreat toward the poles and therefore decrease in land area [Archer]. This feedback increases atmospheric greenhouse gas concentrations and global warming.

Oceans and acidification

There is 50 times as much carbon dissolved in the oceans as there is in the atmosphere. Most of this is inorganic carbon, and only a tiny portion (about one billion tons) is in the form of living carbon.

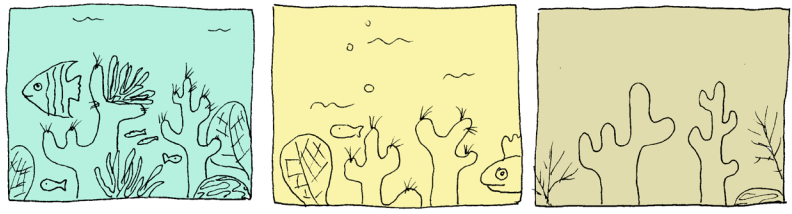
The oceans contain 97% of the earth's water. Since oceans cover 71% of Earth's surface, the contact area between the ocean and atmosphere is enormous and the two continually exchange massive amounts of carbon. Carbon is released from the ocean to the air in some parts of the world and, conversely, carbon dioxide from the air is dissolved in the ocean in other parts. This rate of exchange is comparable to the rate of exchange of carbon dioxide back and forth between the atmosphere and the land.

Scientific models predict that it takes centuries for the exchange of carbon between the atmosphere and the oceans to reach equilibrium. That means it will take centuries for the oceans to absorb their full portion of the carbon emitted into the atmosphere from fossil fuel emissions. This is

because it takes that long for all the oceans' waters to come to the surface somewhere and participate in the exchange with the atmosphere [Archer].

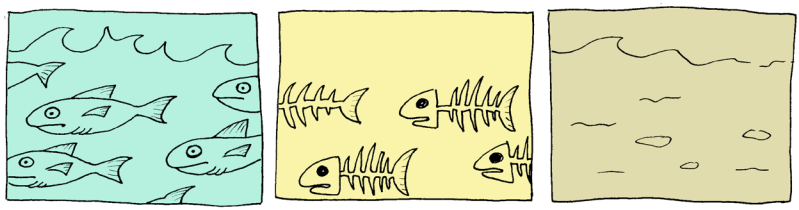
The oceans have absorbed about 30% of the carbon dioxide emitted since pre-industrial times [IPCC1]. This absorption of carbon dioxide from the atmosphere mitigates what would otherwise be even more extreme greenhouse warming than we have, but it also introduces a new danger.

When carbon dioxide is dissolved in water the two react to form an acid called carbonic acid. This is the same acid in carbonated soft drinks that gives the tingling sensation to your tongue. In the ocean, carbonic acid attacks coral reefs, certain kinds of phytoplankton (coccolithophorids), and swimming animals with shells (pteropods) which are important food sources for many fish [Archer].



Coral reefs are the rainforests of the ocean with a rich biodiversity estimated to hold more than a million species. Warming of ocean waters is causing coral bleaching as overheated coral expel symbiotic algae. Ocean acidification, now worse than in the past several million years, is reducing calcification of corals. The combined effects have resulted in mass mortality of ocean life [Hansen2]. The IPCC reports a 26% increase in hydrogen ion concentration, or acidification, of the world's oceans since the beginning of the industrial era [IPCC1].

In addition to the deadly effects of acidification, the warming of the ocean waters has a tendency to stratify the oceans according to temperature and decrease circulation, thereby lowering oxygen levels. According to the 2013 IPCC report, "Ocean warming dominates the increase in energy stored in the climate system, accounting for more than 90% of the energy accumulated between 1971 and 2010."



Chemical fertilizer runoff into the oceans also has the effect of depleting ocean waters of oxygen. The result of oxygen depletion is the appearance of dead zones in the ocean devoid of life. The State of the Ocean 2013 report [Queally] described a "deadly trio of impacts", acidification, ocean warming and deoxygenation of the world's oceans as follows:

> We are entering an unknown territory of marine ecosystem change, and exposing organisms to intolerable evolutionary pressure. The next mass extinction event may have already begun. Developed, industrialised human society is living above the carrying capacity of the Earth, and the implications for the ocean, and thus for all humans, are huge.

Fossil fuels

All fossil fuels—coal, petroleum, and natural gas—contain carbon in a form that can be combined with oxygen to produce energy. Carbon

dioxide is released in the process. Fossil fuels store the energy of ancient sunlight, extracted through photosynthesis of plants that lived millions of years ago. They are created naturally but only under very special circumstances and over geologic times.

Coal is the most abundant and least expensive fossil fuel. It is also the most carbon intensive, meaning that the combustion of coal releases the most carbon dioxide of the fossil fuels, for the same amount of generated power. It also releases mercury and sulfur compounds into the air, both poisons, and the latter causes acid rain. In addition, soot and black carbon released to the atmosphere from burning coal absorb radiant energy from the sun and heat the atmosphere. A nineteenth century version of this air pollution was called London fog, and at present it poses serious health risks in China, which burns as much coal as the rest of the world combined.

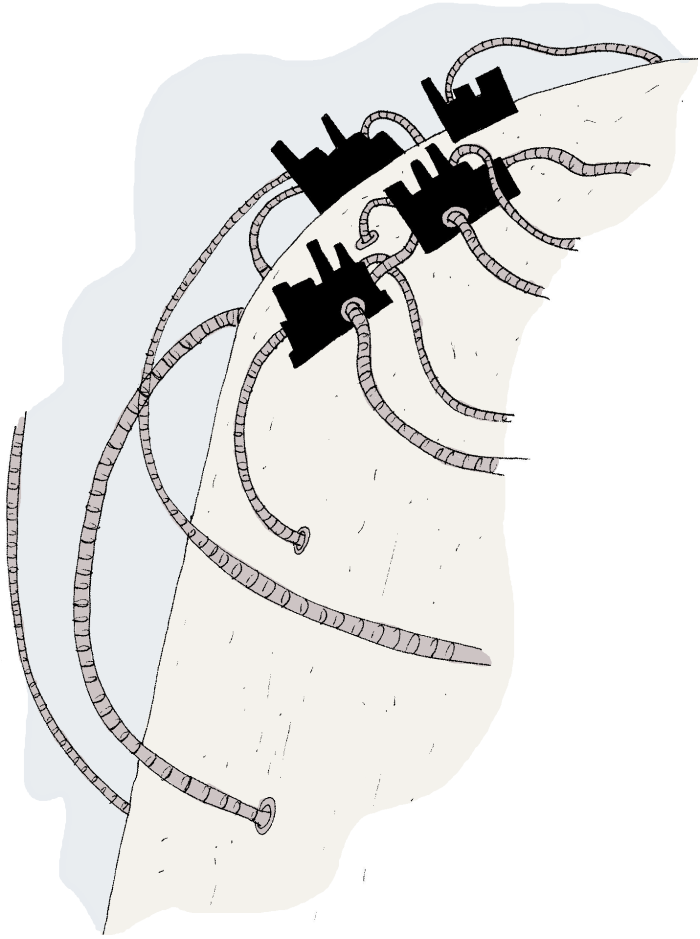
The main ingredient of natural gas is methane, which when burned produces the least amount of carbon dioxide of the fossil fuels, about 60% of the carbon dioxide emissions of coal. However, methane is increasingly extracted from the ground through a process called hydraulic fracturing, or "fracking."

Because of methane leakage into the atmosphere during this process, this form of energy production is cumulatively worse than the use of coal. So, even though methane burns cleaner than coal or oil, it has a larger "carbon footprint" when the extraction process is taken into account [Howarth1], [Howarth2]. Fracking also poisons ground water, pollutes the surrounding air, and the underground storage of the waste water it generates can precipitate earthquakes.

Oil is the most expensive fossil fuel. It is convenient for use in transportation because it is in liquid form. By contrast, methane is a gas and must be compressed for transport and use. For this reason methane found in the same locations as oil is often intentionally burned off in gas flares. For the sake of profit, it is both wasted as a fuel and contributes to greenhouse gas emissions through burning and leakage. In addition to its carbon dioxide emissions, burning oil also produces smog.

Generation of electricity and heat constitute the single greatest category of carbon dioxide emissions. In 2011 this accounted for 42% of worldwide emissions of CO_2, according to the International Energy Agency. Coal is the primary fuel. Australia, China, India, Poland and South Africa, for example, produce between 68% and 94% of their electricity and heat through the combustion of coal [IEA].

In the U.S., electric power plants contributed 41% of all U.S. emissions of carbon dioxide in 2011. Coal-fired power plants were responsible for almost 80% of the greenhouse gases produced by electric power plants, even though they produced only 42% of the nation's electricity. "If the 50 most-polluting U.S. power plants were an independent nation, they would be the seventh-largest emitter of carbon dioxide in the world,



behind Germany and ahead of South Korea. These power plants emitted carbon dioxide pollution equivalent to more than half the emissions of all passenger vehicles in the United States in 2010" [Schneider].

The response of the global capitalist system to its exponentially increasing emissions, and to unprecedented concentrations of greenhouse gases, has been a frenetic search for more fossil fuels to burn. In Bill McKibben's words,

> [The fossil fuel industry has] learned to frack (in essence, explode a pipe bomb a few thousand feet beneath the surface, fracturing the surrounding rock). They've figured out how to take the sludgy tar sands and heat them with natural gas till the oil flows. They've managed to drill miles beneath the ocean's surface. And the hyperbolic enthusiasm has gushed even higher than the oil. The Wall Street Journal has declared North Dakota a new Saudi Arabia. The New York Times described a new shale-oil find in California as more than four times as large as North Dakota's." [McKibben1]

In 2012 alone, the top 200 oil and gas and mining companies allocated $674 billion to find and develop more carbon reserves and new ways of extracting them. The Carbon Tracker Initiative reports that at the current rate of capital expenditure, the next decade will see over $6 trillion allocated for developing fossil fuels.

Capitalism has disrupted a component of the carbon cycle that helped to create the stable climate in which human civilization was born. At various times in Earth's ancient history carbon dioxide concentrations in the atmosphere have spiked to extremely high levels. This occurred because of astronomical influences and complex planetary feedbacks.

For example, during the early Eocene, 52 to 48 million years ago, atmospheric CO_2 concentration is believed to have been more than twice the current concentration (about 1000 parts per million then, compared to about 400 now), and the global average surface temperature was 16°F to 25°F higher than now [IPCC2].

One of many planetary responses was the removal of atmospheric CO_2 through photosynthesis, along with burial and heating of dead plant matter in the absence of oxygen. Billions of tons of carbon have been stored safely underground over periods of millions of years, in deposits of what we now blithely call fossil fuels. When these carbon deposits are burned, the ancient energy stores of the biosphere and captured carbon are sent back to the atmosphere at rates unprecedented in Earth's history, undoing one of nature's great gifts to humanity.

Can rocks save us?

Another component of the carbon cycle is *chemical weathering*. This is a reaction in which carbon dioxide from the atmosphere and rain water transform igneous rocks (silicates) into sedimentary rocks (limestones and dolomites), absorbing carbon in the process. Bits of the sedimentary rocks dissolve in rivers and eventually flow into the oceans.

In this way, carbon dioxide is removed from the atmosphere and new carbon compounds end up in the ocean where corals and shell-forming plankton make shells from those compounds. Eventually much of the carbon compounds are dragged along the ocean floor where they are subducted through plate tectonics into the interior of the earth. The cycle is completed when carbon dioxide is emitted into the atmosphere through volcanic eruptions.

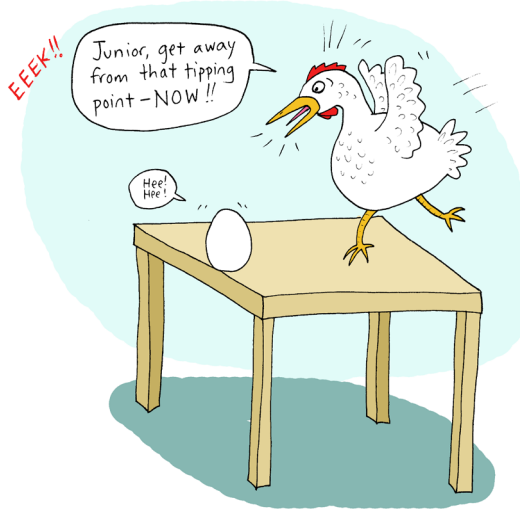
This process serves as a kind of global thermostat. When atmospheric carbon dioxide levels are high, the earth warms, increasing evaporation, and there is more rain. That speeds up the extraction of carbon dioxide from the atmosphere through weathering and lowers temperatures. Conversely, when atmospheric carbon dioxide levels are low, temperatures are cooler and there is less precipitation, thereby retarding the chemical weathering process, and carbon dioxide levels gradually build up from volcanic eruptions.

Can this planetary thermostat, through the process of chemical weathering, undo the damage caused by capitalism? Can it significantly reduce atmospheric carbon dioxide concentrations? The answer is yes it can, but only over time scales of hundreds of thousands of years, much longer than human civilization has existed. To save ourselves and the rest of the biosphere, rapid and focused actions are needed. Actions involving masses of people. We consider this in Part 2, but we have not yet fully exposed the urgency of the climate crises, the subject of the remaining chapters of Part 1.

5. Tipping points

Imagine an egg sitting on a table near the edge. If you nudge the egg a little closer to the end of the table, not much will change. You can easily push it back to its original position and return the "egg-and-table-system" to its previous state.

Imagine now that after several nudges, the egg sits on the table, partly hanging over the edge. If you give it just one more tiny push past this "tipping point," the egg will teeter over the edge and fall to the floor, making a big mess. The "egg-and-table-system" has been pushed beyond its tipping point, and is in a new state that cannot be returned to its previous condition.



Earth's climate system also has tipping points. The National Research Council describes the idea this way:

> Studies of past climates show that Earth's climate system does not respond linearly to gradual CO_2 forcing, but rather responds by abrupt change as it is driven across climatic thresholds. Modern climate is changing rapidly, and there is a possibility that Earth will soon pass thresholds that will lead to even larger and/or more rapid changes in its environments. Climate system behavior whereby a small change in forcing leads to a large change in the system represents a "tipping phenomenon" and the threshold at which an abrupt change occurs is the "tipping point." [NRC]

There have been rapid shifts to Earth's climate in the past, and the current changes are accelerating past all previous rates of change in Earth's history. For example, the shift from the last glacial period to the current warmer climate ended about 11,000 years ago. An abrupt transition occurred when 30% of the land surface changed from ice-covered to ice-free in just a few thousand years. Consider that in only a few hundred years, humanity has converted about 43% of the world's land to agricultural or urban landscapes [Levitan].

There are a variety of possible tipping points. Increases in ocean acidity and rising ocean temperatures might reach a threshold that would precipitate the rapid loss of coral reef ecosystems and massive extinctions. The Amazon rainforest has been subjected to droughts of increasing severity, so much so that for periods of time it has been a source of atmospheric carbon rather than a "sink" that absorbs atmospheric carbon. The rainforest system is in danger of reaching a tipping point that will result in the widespread die-back of the trees and desertification of the region.

Climate records from Siberian caves suggest that 1.5° C (or 2.7° F) of warming would be enough to thaw permafrost, which covers 24% of the land surface of the northern hemisphere, and holds an estimated 17 trillion metric tons of organic carbon. The release of carbon dioxide and methane at this temperature is then a possible tipping point for continuous permafrost to start thawing and releasing vast quantities of greenhouse gases [Vaks].

The Greenland or West Antarctic ice sheets might have already crossed tipping points beyond which they are doomed to shrink and disappear altogether within a few centuries. James Hansen, one of the world's leading climatologists, warned in 2008,

> The warming that has already occurred, the positive feedbacks that have been set in motion, and the additional warming in the pipeline together have brought us to the precipice of a planetary tipping point. We are at the tipping point because the climate state includes large, ready positive feedbacks provided by the Arctic sea ice, the West Antarctic ice sheet, and much of Greenland's ice. Little additional forcing is needed to trigger these feedbacks and magnify global warming. If we go over the edge, we will transition to an environment far outside the range that has been experienced by humanity, and there will be no return within any foreseeable future generation.

Scientific studies published in 2014 suggest that the loss of some Antarctic glaciers may already be unstoppable, even with a complete cessation of greenhouse gas emissions [Carrington], [Goldenberg].

6. How bad is it? Scientific predictions and global consequences

Predicting the climate requires taking into account the physics and chemistry of the atmosphere and oceans, the biology of plants and animals, the locations and topography of land masses, snow and ice coverage, astronomical influences, and human activity.

There are two general strategies. One is to study conditions associated with past climates in order to make inferences about the effects of existing conditions. The other way is to use mathematical climate models. Current

measurements of climate forcings also help to make predictions, and all these methods can also be used together and compared.

A key measure of climate is average temperature. Climate scientists generally use the Celsius temperature scale, rather than the Fahrenheit scale that is popular in the U.S. The relationship is:

1 degree Celsius increase = 1.8 degrees Fahrenheit increase

or more succinctly, "1°C = 1.8°F".

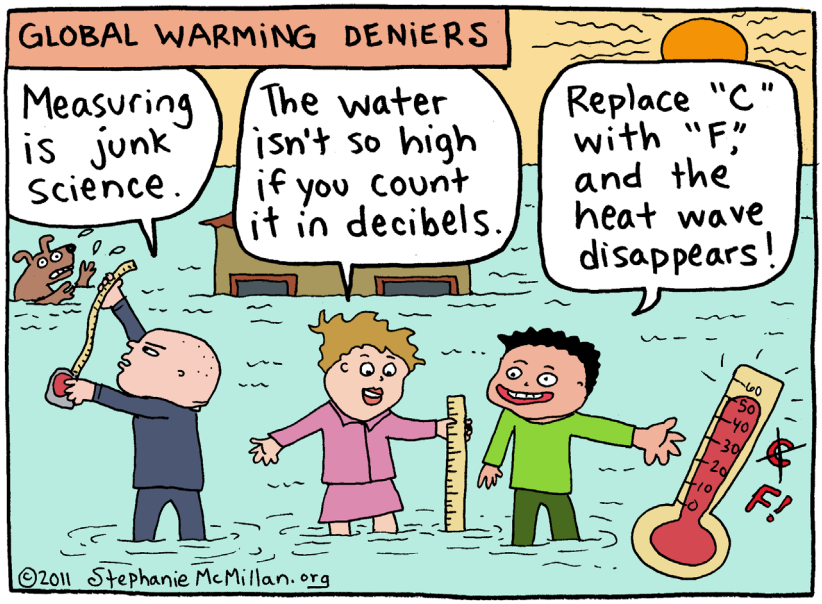
Global warming so far

How much hotter is the world now (2014) than before the industrial revolution? The average global surface temperature has increased by 0.8°C since pre-industrial times. Most of the increase has been recent, with a rise of 0.6°C since the 1970s.

The 0.8°C increase doesn't seem like much at first glance. After all, there are bigger temperature changes from day to night and from one day to the next than that. But 0.8°C is larger than it looks.

To understand the magnitude of warming so far, consider that global average temperature was only about 1°C cooler during the little ice age (1350 to 1800) and about half a degree warmer during the Medieval warm period (800 to 1200) compared to pre-industrial averages. Associated with those small average temperature changes were climate shifts that had major impacts on human civilization [Archer].

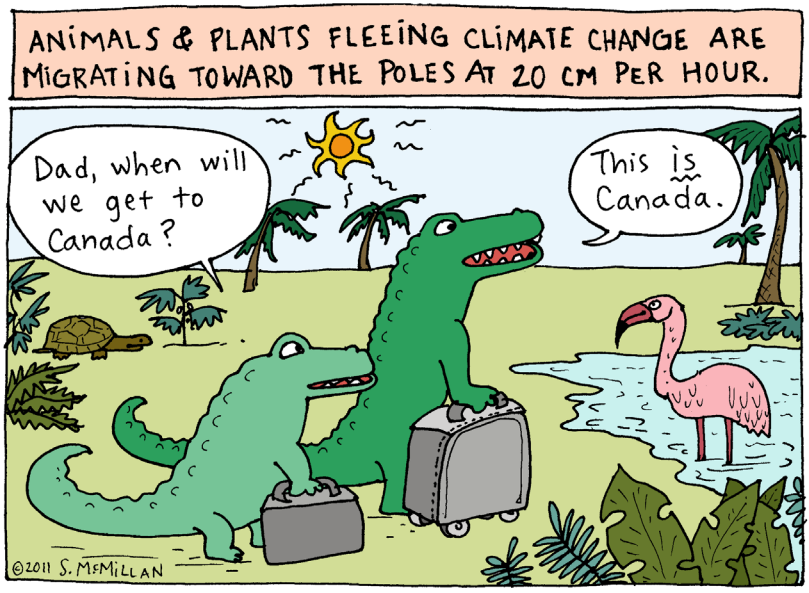
The increase of 0.8°C has already had serious consequences. Higher ocean temperatures have changed the characteristics of hurricanes. Between



1970 and 2004 there was a worldwide increase in frequency of category 4 and 5 cyclones. Despite a decrease in the total number, there was a near doubling of the number of the strongest, most destructive cyclones [Lynas].

Mega-heatwaves driven by global warming such as those in Europe in 2003, the Moscow region in 2010, Texas and Oklahoma in 2011, Greenland in 2012, and Australia in 2013 have increased in frequency [Hansen2]. These are not mere inconveniences. The 2003 heat wave in Europe, for example, caused over 70,000 excess deaths.

Long term feedbacks have already been set in motion with the rapid disappearance of arctic sea ice, the melting of the Greenland and Antarctic ice sheets at a rate of several hundred cubic kilometers per year, receding



mountain glaciers, and the decrease of reef-building corals at a rate of 1 to 2% per year.

Land animals have responded to the climate change by shifting ranges toward the poles by as much as 600 kilometers and by increasing elevation (when possible) by 400 meters. Marine species have also shifted poleward by as much as 1000 kilometers. With increasing warming many species will eventually have nowhere to go.

How much hotter will it get?

The answer to this question depends on human activities. The four general scenarios considered by the IPCC collectively predict a 1.5°C to 4.8°C increase in the average global temperature by 2100, relative to the period 1850 to 1900 [IPCC1]. The planet could suffer serious consequences from

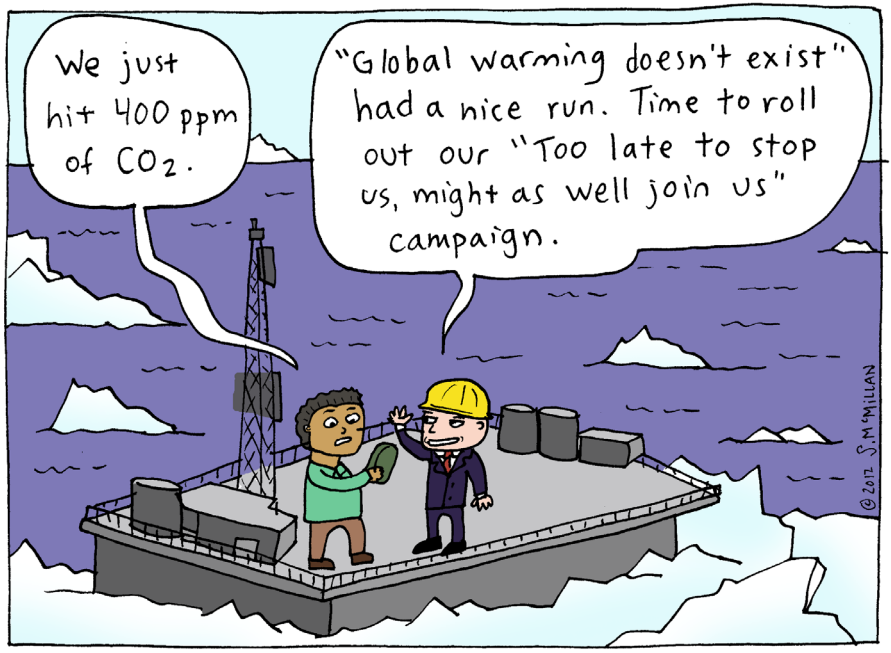
warming within this range (described below), but the IPCC estimates, as alarming as they are, may be too conservative [Bagley], [Gillis], [Scherer].

Even so, only one of the IPCC scenarios (called "RCP 2.6") consistently yields a temperature increase below the United Nations target of 2°C (discussed below) by the end of the century, and this scenario requires extremely rapid reductions of worldwide greenhouse gas emissions, barely imaginable under capitalism. Half of the models for this best case scenario assumed not merely zero emissions by the end of the century, but a net removal of carbon dioxide from the atmosphere (for example via geoengineering carbon dioxide extraction methods). The remaining models assumed zero or near zero emissions by 2100 with rapid reductions well beforehand. All the models consistent with this scenario require global emissions to be substantially below 1990 levels no later than 2050 [IPCC1]. Most of these simulations were preformed with prescribed CO_2 concentrations of 421 ppm by 2100. Taking into account other greenhouse gases, the combined CO_2-equivalent prescribed concentrations were 475 ppm. In Chapter 7 we outline the technical means by which zero global emissions can actually be achieved.

Turning to other predictions, Jeffrey Sachs, director of Columbia University's Earth Institute, said during a July 16, 2014 Democracy Now interview (Pacifica Radio),

> We're on a trajectory of some 4 degrees Centigrade or more, depending on exactly the assumptions that one makes. And all of the evidence is that the business-as-usual path would be an absolutely reckless and unforgivable gamble with this planet.

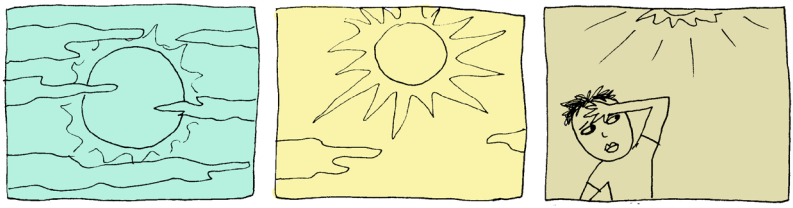
A study by researchers at MIT, Penn State, the Marine Biological Institute in Massachusetts, and the U.S. Environmental Protection Agency forecast



a global temperature increase of 5.1°C by 2100 under the assumption of business as usual greenhouse gas emissions [Webster]. According to the Tyndal Center for Climate Research, "a growing body of academics and researchers are allying current emission trends with 4°C to 6°C futures" [Tyndal].

The lead author of a 2014 study published in *Nature* predicts the "most-likely warming of roughly 5°C above modern [i.e. current] temperatures or 6°C above preindustrial" temperatures this century [Romm].

Predicting global warming only to the end of the century understates the eventual dangers. Without drastic action, temperatures will continue to rise well beyond 2100. James Hansen together with researchers



from Columbia University and NASA Goddard Institute for Space Studies published a 2013 study in which they considered the long term consequences, including slow feedbacks, if humanity burns all existing fossil fuels on the planet. Here are some key excerpts from that paper [Hansen3]:

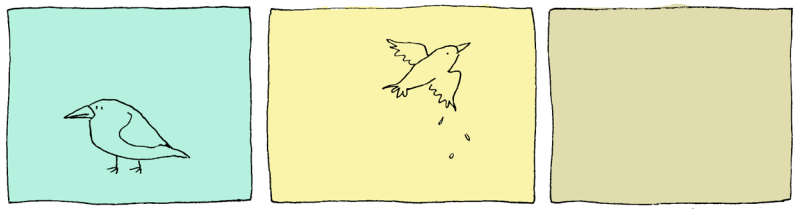
> Burning all fossil fuels would produce a different, practically uninhabitable, planet.
>
> Our calculated global warming in this case is 16°C, with warming at the poles approximately 30°C. Calculated warming over land areas averages approximately 20°C. Such temperatures would eliminate grain production in almost all agricultural regions in the world.
>
> More ominously, global warming of that magnitude would make most of the planet uninhabitable by humans. The human body generates about 100 W of metabolic heat that must be carried away to maintain a core body temperature near 37°C, which implies that sustained wet bulb temperatures above 35°C can result in lethal hyperthermia.
>
> A warming of 10–12°C would put most of today's world population in regions with a wet bulb temperature above 35°C.

> Whether governments continue to be so foolhardy as to allow or encourage development of all fossil fuels may determine the fate of humanity.

Consequences of 1°C to 6°C warming

One way to appreciate how much a temperature difference of only a few degrees affects the planet is to look to the past. The scientific literature places global average temperature within the range of 3°C to 6°C *cooler* during the Last Glacial Maximum, about 20,000 years ago [Hansen3].

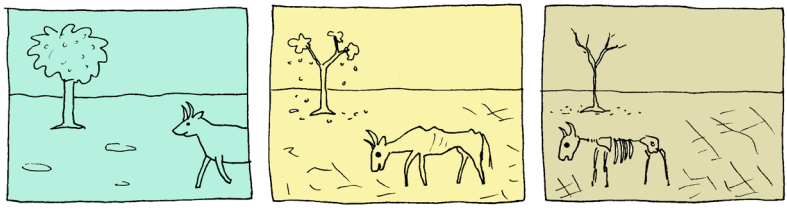
At that time ice sheets covered Canada and stretched across much of the United States. New York City was buried under ice more than a mile thick. Sea level was 120 meters (394 feet) below where it is now. A change of only a few degrees of global average temperature has major world-altering consequences.



What would a warmer world look like? In a 3°C warmer world, the Brazilian rainforest would burn down and turn to desert, according to some studies, and could be much like the Sahara desert today. Hurricanes of unprecedented ferocity could obliterate entire cities. Billions of people in the tropics and subtropics would suffer drought and famine. In a chapter entitled, "Three Degrees," of his book, *Six Degrees*, Mark Lynas describes this stark scenario,

"With structural famine gripping much of the subtropics, hundreds of millions of people will have only one choice left other than death for themselves and their families: They will have to pack up their belongings and leave. The resulting population transfers could dwarf those that have historically taken place owing to wars or crop failures. Never before has the human population had to leave an entire latitudinal belt across the whole width of the globe.

"Conflicts will inevitably erupt as these numerous climate refugees spill into already densely populated areas. For example, millions could be forced to leave their lands in drought-struck Central American countries and trek north to Mexico and the United States. Tens of millions more will flee north from Africa toward Europe, where a warm welcome is unlikely to await them; new fascist parties may make sweeping electoral gains by promising to keep the starving African hordes out. Undaunted, many of these new climate refugees will make the journey on foot, carrying what they can, with children and old people trailing behind. Many of them will die by the wayside. Uprooted, stateless, and without hope, these will be the first generation of a new type of people: climate nomads, constantly moving in search of food, their varied cultures forgotten, ancestral ties to ancient lands cut forever." [Lynas]



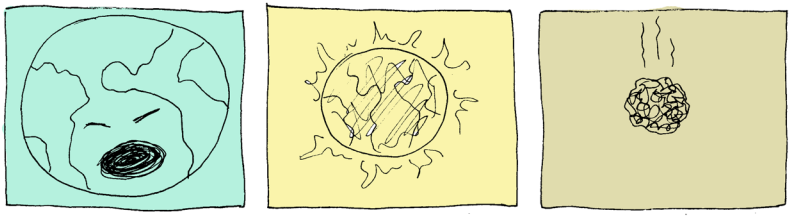
During the early Pliocene (a few million years ago), Earth was only 3°C warmer and sea level attained heights as much as 15–25 meters higher than today [Hansen2].

In a 4°C warmer world, the hot climates of North Africa will likely jump across the Mediterranean and spread north into the heart of Europe with typical searing summer temperatures of 120°F. With 5°C of global warming, the world will be almost unrecognizable. Temperatures actually reached that level 55 million years ago during a period referred to as the *Paleocene-Eocene Thermal Maximum*, or PETM. Fossils of crocodiles dating to the PETM have been found in Canada.

A 5°C warmer world would eventually melt all the ice from both poles. Rainforests would have long since burned down and vanished. Average inland temperatures would be 18°F higher than pre-industrial temperatures, bringing severe droughts in large areas and massive flooding to others. The Southern half of the U.S. likely becomes a desert, along with Australia, the Southern half of Europe, Central America, and many other parts of the world. Zones of habitability for humans would contract drastically toward the poles. Warming of the oceans would decrease oxygen levels and lead to mass extinctions of ocean species. Billions of people would die, de-populating the planet.

A 6°C warmer world might lead to the extinction of humanity. Perhaps a handful of people would find ways to survive, but we are so poorly adapted for such an environment that humanity might never recover.

Worse yet, a temperature rise of 3°C to 6°C would probably be unstable. Such temperature increases could set in motion feedbacks that would eventually drive temperatures even further upward. Permafrost regions—areas where the ground is frozen all year—as noted in the previous

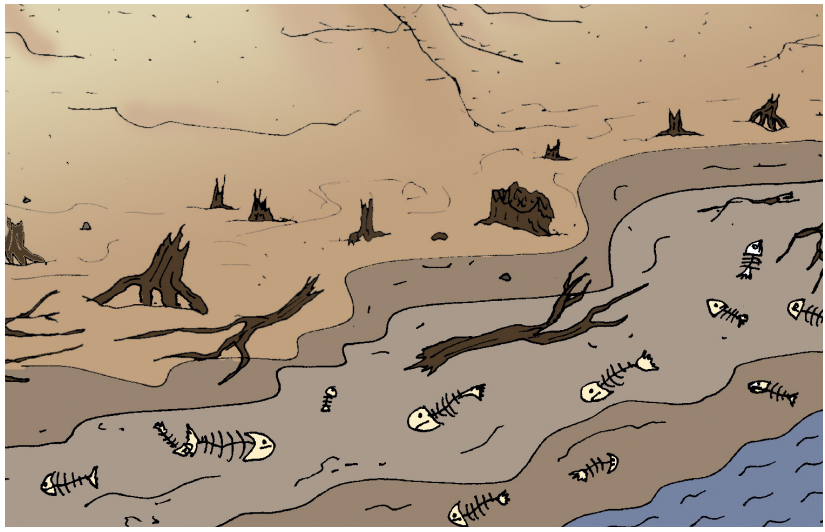


chapter cover 24% of the northern hemisphere land surface and hold 1700 billion metric tons of organic carbon. When permafrost thaws it releases carbon dioxide and methane, changing the land from a "carbon sink" into a source of greenhouse gases [Vaks]. Warmer temperatures will melt the permafrost, leading to still higher temperatures. According to the 2013 IPCC report, "Release of carbon from thawing permafrost is *very likely* to provide a positive feedback, but there is limited confidence in quantitative projections of its strength" [IPCC2].

Methane hydrates

A less immediate though important source of methane lies in the oceans. Close to the continental plates, methane gas at high pressure and low temperature naturally crystallizes into individual methane molecules locked inside molecular cages of ice. These structures are called *methane hydrates* or *clathrates*. Most of the methane hydrate deposits are found in deep waters, but in the frigid Arctic oceans, they are found in much shallower seas and also in permafrost on land.

Heating the ocean waters enough to melt the hydrates and release the vast amounts of methane would create a powerful flux of greenhouse gases to the atmosphere. Such releases are conjectured to have precipitated drastic climate swings in Earth's past. However, climate scientists don't anticipate crossing this tipping point any time soon. The 2013 IPCC



report judged it "very unlikely" this century, but the release of carbon into the atmosphere though this process would irreversibly heat the planet over periods of thousands of years.

More ominously, fossil fuel companies are exploring ocean deposits of methane hydrates for the purpose of extracting it for fuel. In 2012 a team of researchers from the U.S. Department of Energy, the U.S. Geological Survey, ConocoPhillips, Japan, and Norway conducted experiments for the mining of methane from the hydrates. In 2013 a Japanese research vessel became the first to extract natural gas from methane hydrates in the sea. The race is on and the stakes are enormous. A recent estimate suggests that the hydrates along the coasts of the contiguous United States hold the equivalent of 2000 years of natural gas supply at the current rate of consumption in the U.S. Globally, methane hydrates under the sea hold at least as much carbon as all coal, oil, and natural gas reserves in the world [Margonelli].

The 2°C limit

In 1996, the European Union proposed to limit global warming to 2°C relative to pre-industrial times, because of the dangers posed by greater warming. The 2°C target was reaffirmed by the 2009 Copenhagen Accord with specific language:

> We agree that deep cuts in global emissions are required according to science, as documented in the IPCC Fourth Assessment Report with a view to reduce global emissions so as to hold the increase in global temperature below 2 degrees Celsius...

Although the 2°C limit has been widely embraced, almost nothing has been done to hold global temperature to that level, and even this amount of global warming poses serious dangers.

Human civilization came into existence and has evolved only during the last 12,000 years, in what is called the *Holocene* epoch. During this period of the planet's history the climate has been stable and humanity is adapted to it. The present global temperature is near the upper end of the temperature range of the Holocene. Global warming of 2°C would be well outside that range.

If global temperatures exceed 1.6°C above preindustrial temperatures, it is expected that 9–31% of species will face extinction and a warming of 2.9°C would cause an estimated 21–52% of all existing species to disappear forever (more than million species) [Hansen2], [Thomas].

An assessment by leading scientist finds that, "warming of 1°C relative to 1880–1920 keeps global temperature close to the Holocene range,

but warming of 2°C "could cause major dislocations for civilization" [Hansen2].

The *Eemian interglacial period* (120,000 years ago) was about 2°C warmer than the decades 1880–1920. Geologic evidence suggests a rapid sea level rise of a few meters late in the Eemian period eventually reaching 9 meters above present sea level. This raises a serious possibility that a critical stability threshold was crossed at this temperature that resulted in polar ice sheet collapse. However, there remains debate within the research community about the interpretation of the geologic evidence of that period [Hansen2].

In the coming decades a net increase in global temperature of at least 1°C to 2°C is virtually impossible to avoid. Once set in motion, the climate, like a giant ocean liner, has enormous inertia. It cannot suddenly be stopped or turned around. IPCC researchers predict that if concentrations of greenhouse gases were held constant at present day levels, the the global surface temperature would continue to rise by about 0.6°C over the 21st century, relative to the year 2000 [IPCC1]. Even if all emissions stopped, increased global temperatures would persist for many centuries because of the heat retained by the ocean. We are already committed to higher temperatures in the future.

2°C and a trillion tons of carbon

If all emissions of greenhouse gases suddenly stopped, it would take a long time for atmospheric concentrations to return to pre-industrial levels. Each greenhouse gas has a different lifetime in the atmosphere. The IPCC finds that "methane concentration would return to values close to pre-industrial level in about 50 years, N2O concentrations would need several centuries, while CO_2 would essentially never come back to its pre-

industrial level on time scales relevant for our society"[IPCC1]. Quoting further from the 2013 IPCC report,

> As a consequence of the large inertia in the climate and carbon cycle, the long-term global temperature is largely controlled by total CO_2 emissions that have accumulated over time, irrespective of the time when they were emitted. Limiting global warming below a given level (e.g., 2°C above pre-industrial) therefore implies a given budget of CO_2, that is, higher emissions earlier implies stronger reductions later.

The maximum amount of carbon that can be emitted into the atmosphere from carbon dioxide emissions so that the global temperature does not increase beyond 2°C has been estimated as one trillion (metric) tons [Hansen2]. In terms of CO_2 equivalent emissions the IPCC gives a 50% probability that global warming will stay below 2°C if cumulative emissions do not exceed 1.21 trillion tones of carbon. In other words, with 50-50 odds, the increase in global temperatures will stay below 2°C provided that the total amount of CO_2 emissions since pre-industrial times stays below 1210 billion tons. After accounting for non-CO_2 climate forcings, this limit on CO_2 emissions must be decreased to 820 billion tons of carbon [IPCC1].

How much carbon has humanity already emitted into the atmosphere so far? The cumulative carbon emissions from 1750 to 2011 is 555 billion tons according to the IPCC, of which 375 billion tons came from burning fossil fuels and 180 billion tons from deforestation [Hansen2], [IPCC1].

Using this IPCC estimate, we are more than half way to 2°C of warming, with less than 300 billion tons of CO_2 equivalent carbon emissions left to go, and there is much, much more carbon than that still underground.

In fact, there is much more *times* that underground in known reserves. The total recoverable fossil energy reserves and resources estimated by the Global Energy Assessment are approximately 15 trillion tons [Hansen2]. This is more than enough to cook the planet.

More detailed analyses have been undertaken. Using the results of climate researchers, Bill McKibben estimated in 2012 that for an 80% chance for global temperatures not to exceed 2°C above pre-industrial levels, emissions by midcentury must remain below 565 billion tons of carbon dioxide, which is 154 billion tons of carbon [McKibben2].

In 2013, James Hansen and collaborators calculated that if humanity could exercise its collective will to remove100 billion tons of carbon from the atmosphere through reforestation, then a cumulative industrial-era limit of 500 billion tons of carbon from fossil fuel emissions is the maximum we can allow in order to keep the climate close to the Holocene range. Most of that budget has been used up from the 370 billion tons already emitted from fossil fuels since the late 1800s [Hansen2].

All of that carbon is waiting to be extracted and burned for profit within the framework of the global capitalist system. This is being increasingly accomplished by drilling at increasing ocean depths, squeezing oil from tar sands and shale, hydro-fracking natural gas, mining coal via mountaintop removal, drilling in the Arctic, extracting ocean methane hydrates, and other means.

The world now stands at a precipice. Continuing in the same direction will lead to devastation on an unprecedented scale. Is another direction even possible? Does the technology exist to supply energy for human civilization? This question is answered by the following chapter.

7. A sustainable global civilization is achievable

The destruction of the biosphere is not an inevitable consequence of human nature. Humanity has the means to live within the natural boundaries of the planet, and to live well. But achieving harmony with nature requires a fundamentally different system of human cooperation that includes profound changes in energy production, land use, transportation, and industry. The good news is that the technology needed to carry out such a global transformation already exists.

Let's start with the sources of greenhouse gas emissions. Figure 4 from the 2014 IPCC Working Group III report, shows the distribution of global sources of greenhouse gas (GHG) in 2010 by economic sector. Taking into account the global warming potential of the major greenhouse gases (see Chapter 3), the equivalent of 49 billion metric tons of carbon dioxide was emitted into the atmosphere that year.

Energy production was the greatest source and accounted for nearly 35% of global emissions. This sector includes all energy extraction, conversion, storage, transmission, and distribution processes that deliver final energy to the end-use sectors: industry, transport, buildings, and agriculture and forestry. The combination of the energy and transportation sectors accounts for nearly half of all global greenhouse gas emissions.

Greenhouse Gas Emissions by Economic Sectors

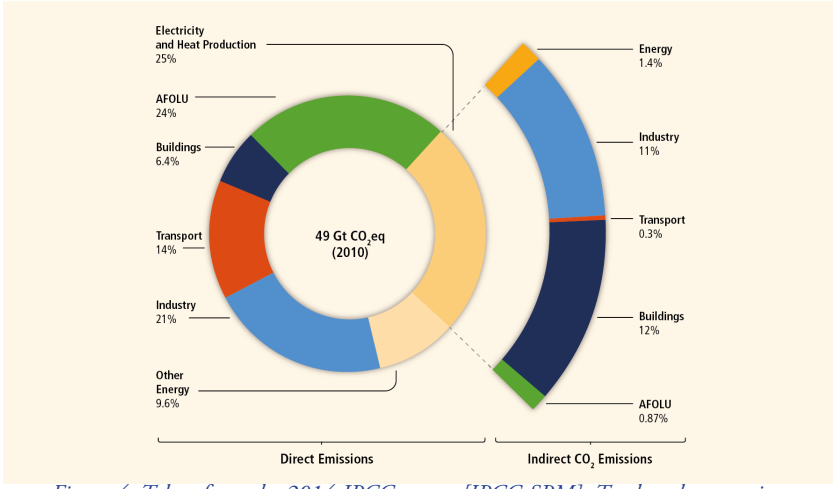


Figure 4. Taken from the 2014 IPCC report [IPCC-SPM]. Total anthropogenic greenhouse gas (GHG) emissions ($GtCO_2eq/yr$) by economic sectors. Inner circle shows direct GHG emission shares (in % of total anthropogenic GHG emissions) of five economic sectors in 2010. Pull-out shows how indirect CO_2 emission shares from electricity and heat production are attributed to sectors of final energy use. "Other Energy" refers to all GHG emission sources in the energy sector as defined in Annex II of the IPCC report, other than electricity and heat production [A.II.9.1]. The emissions data from Agriculture, Forestry and Other Land Use (AFOLU) includes land-based CO_2 emissions from forest fires, peat fires and peat decay.

Through the electrification of transportation, both of these sectors can be powered by renewable sources. Instead of fossil fuel burning cars, transportation could be provided by electric vehicles through first rate mass transportation systems powered by renewable energy. To appreciate the scale of wasted energy and carbon pollution stemming from transportation, consider for example that Americans collectively drove three trillion miles in 2010 [Foster].

In 2009, *Scientific American* published an article that explains how 100% of the world's energy needs, for all purposes, including transportation, could be supplied by wind, solar, geothermal, tidal and hydroelectric power systems (without nuclear power) by as early as 2030 [Jacobson1].

The authors, Mark Jacobson, a professor of civil and environmental engineering, at Stanford University, and Mark Delucchi a researcher at the Institute of Transportation Studies at the University of California, Davis, also published a detailed technical analysis to carry out their program in 2011 [Jacobson2]. Their plan calls for 3.8 million large wind turbines, 90,000 solar plants, and numerous geothermal, tidal and rooftop photovoltaic installations worldwide.

Since that time, Jacobson together with numerous co-authors published detailed plans for New York state, Washington state, and California to supply all their respective energy needs from renewable (non nuclear) power [Jacobson3], [Jacobson4], [Jacobson5]. Similar plans were under development for each state by the Solutions Project (thesolutionsproject.org) as of mid-2014.

A study along similar lines was carried out by researchers at the University of Delaware. A key technical problem is "intermittency." The problem is that power generation using renewable resources at one site produces only intermittent power. On a cloudy day solar panels produce little electricity, and when the wind stops, wind turbines do not supply energy. The study considered over 28 billion combinations of renewable electricity sources with storage using batteries and fuel cells at various locations, incorporated into a large grid system of 72 GigaWatts (i.e. 72 billion watts). Quoting from the abstract,

> We find that the least cost solutions yield seemingly-excessive generation capacity—at times, almost three times the electricity needed to meet electrical load. This is because diverse renewable generation and the excess capacity together meet electric load with less storage, lowering total system cost. At 2030 technology costs and with excess electricity displacing natural gas, we find that the electric system can be powered 90% – 99.9% of hours entirely on renewable electricity, at costs comparable to today's—but only if we optimize the mix of generation and storage technologies." [Budischak]

The University of Melbourne's Energy Institute in Australia and a nonprofit organization, Beyond Zero Emissions, published a blueprint for creating an electrical system drawing 60% of its power from solar energy and 40% from wind in just a ten year period. Related separate studies by the U.S. National Oceanic and Atmospheric Administration (NOAA) and the U.S. Department of Energy indicate that large majority of electric power for the U.S. can be harnessed from renewable resources in the near future [Klein, p 102].

What about pollution from renewable energy?

There can be no doubt that manufacturing renewable electricity technologies causes pollution and greenhouse gas emissions. An article from *The Guardian* describes the devastating pollution in Baotou, China that has resulted from the extraction of materials used in smartphones, GPS receivers, wind turbines, and electric cars. The disposal site has the appearance of a huge lake, but is instead,

> a murky expanse of water, in which no fish or algae can survive. The shore is coated with a black crust, so thick you can walk

> on it. Into this huge, 10 sq km tailings pond nearby factories discharge water loaded with chemicals used to process the 17 most sought after minerals in the world, collectively known as rare earths... The foul waters of the tailings pond contain all sorts of toxic chemicals, but also radioactive elements such as thorium which, if ingested, cause cancers of the pancreas and lungs, and leukaemia." [Guardian]

Within the framework of capitalism, maximizing profit goes hand in hand with maximizing environmental destruction, and renewable energy technologies are no exception.

Wind turbines and photovoltaic cells emit no greenhouse gases when they generate electricity, but it is still true that greenhouse gases and other pollutants are generated from the extraction of materials and the fossil fuel energy used to build them and ship them long distances, as well as when they are scrapped at the end of their productive lifetimes (without recycling). The quantity of greenhouse gas emissions and pollutants resulting from the construction of renewable energy technologies varies widely because of the range of products, production processes, and varying environmental regulations among nations.

In this context, the environmental damage caused by the manufacture of renewable energy technologies has often been exaggerated, and sometimes grossly so, by people and groups opposed to their expanded use, especially in the case of wind turbines and photovoltaic (PV) technologies. How much environmental damage does the current production of wind turbines and PVs cause? Very little compared to the use of fossil fuels. Quoting from the concluding section of a published study, "Emissions from Photovoltaic Life Cycles" [Fthenakis],

> Using data compiled from the original records of twelve PV manufacturers, we quantified the emissions from the life cycle of four major commercial photovoltaic technologies and showed that they are insignificant in comparison to the emissions that they replace when introduced in average European and U.S. grids. According to our analysis, replacing grid electricity with central PV systems presents significant environmental benefits, which for CdTe PV amounts to 89–98% reductions of GHG emissions, criteria pollutants, heavy metals, and radioactive species. For roof-top dispersed installations, such pollution reductions are expected to be even greater as the loads on the transmission and distribution networks are reduced, and part of the emissions related to the life cycle of these networks are avoided.

Relative to the power they generate, wind turbines have an even lower carbon footprint than solar panels. The cradle to grave emissions from these technologies is at least an order of magnitude smaller than that of electricity generated by the least destructive of fossil fuels. The IPCC evaluated life cycle greenhouse gas emissions of various forms of electricity generation, including manufacturing processes and albedo effects (Annex III in [IPCC3]) and some of the findings are delineated below in Table 1. The minimum, maximum, and median values of greenhouse gas emissions collected from the numerous surveyed studies are given in units of CO_2-equivalent grams per kilowatt-hour.

Technology	Min	Median	Max
Coal – pulverized	740	820	910
Gas – combined cycle	410	490	650
Biomass – dedicated	130	230	420
Solar PV – utility scale	18	48	180
Solar PV – rooftop	26	41	60
Geothermal	6.0	38	79
Concentrated solar power	8.8	27	63
Hydropower	1.0	24	2200
Wind offshore	8.0	12	35
Nuclear	3.7	12	110
Wind onshore	7.0	11	56

Table 1 Lifetime greenhouse gas emissions in units of grams of CO_2 equivalent emissions per kilowatt-hour for selected electricity supply technologies

The use of renewable energy to generate electricity (and for other purposes) is vastly less destructive to the climate in comparison to the use of fossil fuels, even within the framework of capitalist production methods. As in Mark Jacobson's and his co-worker's plans, bio-fuels and nuclear energy with all its dangers, are not necessary to provide energy we need for all purposes.

If the constraint to maximize private profits were removed (in a post-capitalist society), and the goals were instead to work for the common good of humanity and to preserve the biosphere, production methods

could no doubt be vastly improved so as to render environmental damage negligible. In particular, renewable energy could eventually replace fossil fuel energy in the production and transportation of renewable energy technologies.

Air travel

Within the transportation sector, aviation deserves special consideration. In the apocalyptic British film, *The Age of Stupid*, one of the characters remarks, "other than setting fire to a forest, flying is the single worst thing an ordinary individual can do to cause climate change."

Air travel indeed contributes disproportionately to global warming, not only because of greenhouse gas and soot emissions but also on account of the effects of contrails and other influences aircraft have on atmospheric chemistry and cirrus cloud formation. In 2005 aviation alone accounted for some 3.5% of the warming caused by human activities (in the sense of "radiative forcing") [Lee]. This despite the fact that only a tiny percentage of the world's population can even afford to fly. Among mitigations that have been proposed are improvements in fuels, better aerodynamic designs, and lower cruising altitudes so as to eliminate contrails [Williams].

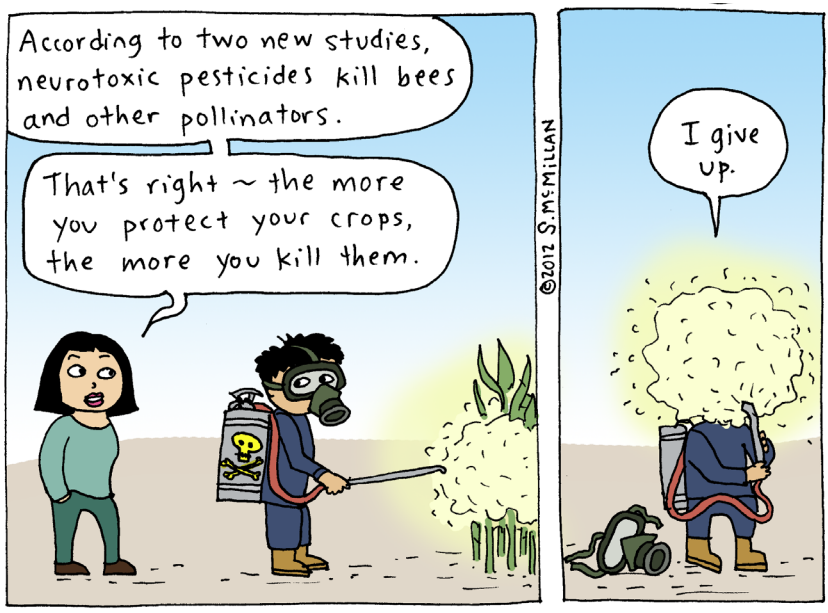
To solve the problem completely requires the development of carbon neutral fuel such as hydrogen, which can be produced via electrolysis using renewable energy sources, as described above [Lee]. This is within reach of existing technology, but cannot be accomplished without interfering with corporate profiteering.

Hydrogen fuelled aircraft have a reputation for being dangerous because of the Hindenburg disaster. The containment bag back then was vastly different from the highly insulated and structurally sound ergonomic

tanks for liquid hydrogen currently available. In-depth studies show hydrogen to be a safer alternative to kerosene and other fuels [Khandelwal].

Agriculture

Agriculture and land use are responsible for nearly a quarter of all global greenhouse emissions. Plants extract carbon dioxide from the atmosphere and nitrogen from the soil and redistribute them within the biosphere. The global capitalist economy subverts natural carbon and nitrogen cycles through the extensive use of synthetic and petroleum based fertilizers, pesticides, and herbicides, and massive deforestation. Fertilizer not only emits greenhouse gases, but because of runoff, fertilizers cause wholesale pollution of streams, rivers, ponds, lakes and coastal waters, often leaving "dead zones" depleted of oxygen.



Land use under capitalism is not sustainable. Absent are global programs for reforestation and sustainable agriculture, including the restoration of organic soils essential to limit global warming. Is a better system of land use possible? Yes, sustainable agriculture is nothing new. What we now call "organic farming" sustained humanity for thousands of years, and ecological practices continue in many parts of the world. Cuba provides an illuminating example.

With the collapse of the Soviet Union in the early 1990s, oil, fertilizer, and pesticide imports into Cuba all but vanished. To avoid starvation, Cuba initiated urban agricultural gardens and promoted organic farming methods. Large scale monocultural agriculture was largely abandoned in favor of small plots on which farmers practiced crop rotation, organic composting, crop interplanting, using bio pesticides and oxen instead of tractors. The results have been remarkable. Some 50,000 hectares of previously unused land produce more than 1.5 million tons of vegetables with yields up to a hundred tons per hectare—all of this with no use of synthetic chemicals. Urban farms provide more than 70% of all the fresh vegetables consumed in cities such as Havana and Villa Clara [Altieri].

Reforestation is critical because it draws down carbon from the atmosphere and has the potential to store 100 billion tons of

carbon [Hansen2]. Atmospheric carbon can also be sequestered in biochar. Biochar, much like charcoal, is created by heating residues from crops, forestry residues, and animal wastes in a low oxygen environment. It is rich in carbon and stable enough to hold carbon in soils for thousands of years. Biochar also helps soil retain nutrients and reduces soil emissions of greenhouse gases. As described in the IPCC report,

> Heating biomass with air excluded (pyrolysis) generates energy-containing volatiles and gases. Hydrogen and O[xygen] are preferentially eliminated, creating a stable (biologically recalcitrant) C-rich co-product (char). By adding char to soil as 'biochar' a system can be established that may have a higher carbon abatement than typical bioenergy alternatives" [IPCC3].

It has been estimated that biochar could provide a maximum possible drawdown of 1.8 billion tons of carbon dioxide (equivalent) per year, which was 12% of greenhouse gas emissions in 2010, without endangering food security, habitat or soil conservation. Biochar can be produced industrially, on individual farms, or even at the domestic level [Woolf].

Buildings

Reducing greenhouse gas emissions from buildings is addressed in Chapter 9 of Working Group III of the 2014 IPCC report as follows,

> Recent developments in technology and know-how enable construction and retrofit of very low- and zero-energy buildings, often at little marginal investment cost, typically paying back well within the building lifetime (*high agreement, robust evidence*). In existing buildings 50–90% energy savings have been achieved

> throughout the world through deep retrofits (*high agreement, medium evidence*).

The IPCC report goes on to say,

> Market forces alone are not likely to achieve the necessary transformation without external stimuli. Policy intervention addressing all levels of the building and appliance lifecycle and use, plus new business and financial models are essential.

Market forces are the cause of the problems and cannot provide solutions for sustainable buildings or for any other sector of the global economy.

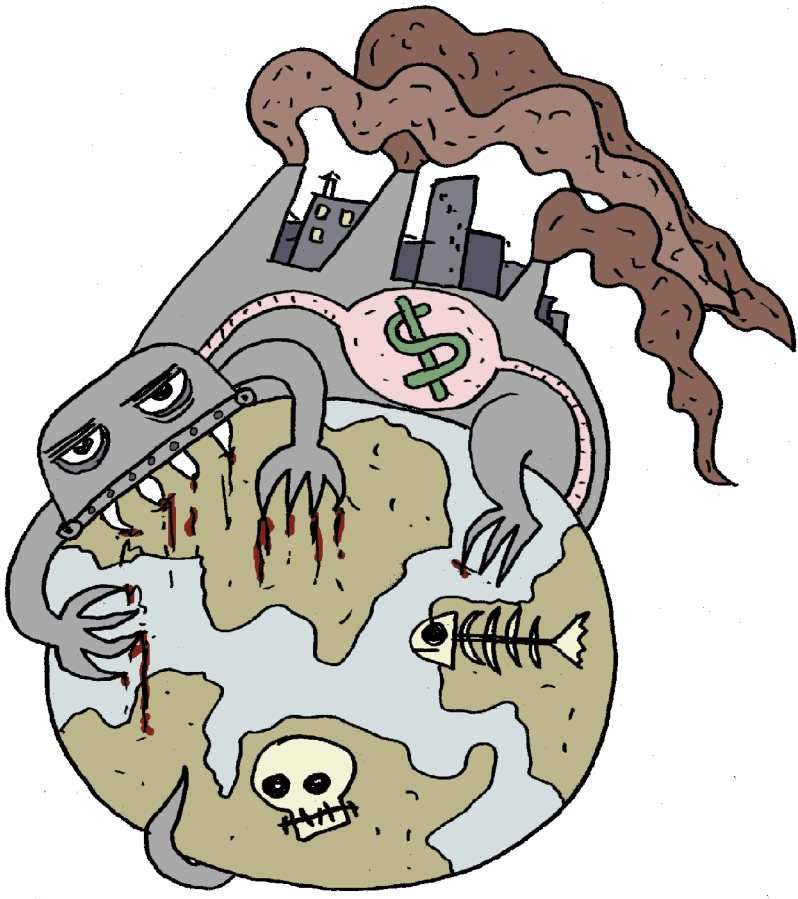
Industry

Industry, a critical sector of the economy, is a major source of greenhouse gases and the leading source of countless other poisons and pollutants that are destroying the planet. Industrial production brings us right to the heart of capitalism. Because of this, we postpone to Chapter 14 a description of the changes that are both possible and necessary for this sector.

Summary

Humanity has within its grasp all of the technical means to create a thriving and sustainable future in harmony with nature. What stops us from doing this? The barrier to our collective survival is the system of rules and relationships we are presently constrained to have with each other. That system is capitalism.

Part 2: Why Capitalism Cannot Solve the Climate Crisis



Introduction to Part 2

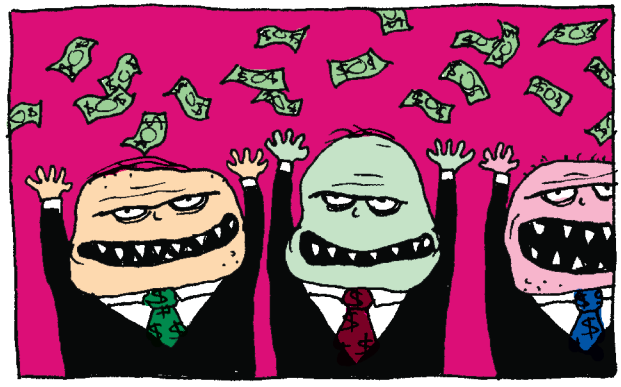
Capitalism is so revered in America's corporate-induced culture that it functions much like a state religion. Policies may be debated in congress, on news shows, and in public, but not the system that leads to those policies: capitalism. Even within the U.S. Left, criticisms of the past few decades were largely restricted to "crony capitalism," "corporate capitalism," "free market capitalism," or "casino capitalism," and especially the overused term "neoliberalism," but rarely capitalism itself. The rule of thumb was that capitalism should only be criticized with an adjective in front, as if the quintessence of capitalism itself was beyond reproach.

It was not always so. In earlier periods of U.S. history, criticisms of capitalism were far less muted. An instructive example is Albert Einstein's 1949 essay, *Why Socialism?*, well worth reading even today [Einstein].

Capitalism's immunity from mainstream public scrutiny, especially between the time of the collapse of the Soviet Union to the economic crisis of 2008, has had the debilitating effect of sidelining any serious analysis of its cause and effect relationship with the climate crisis. That timing is particularly unfortunate, as the burdgeoning threat of global warming became widely known during those years.

The aim of Part 2 of this book is to give a coherent description of the cause and effect relationship between capitalism and the global climate

crisis. We argue that solving the climate crisis in a satisfactory way, on the one hand, and capitalism, on the other, are mutually exclusive.



This "impossibility theorem" requires extensive explanation and clarification. To that end, we begin in Chapter 8 with a working definition of capitalism. Chapter 9 describes waste and pollution endemic to capitalism in theory and in practice. Chapter 10 explains why capitalism must expand without end and describes various forms of that expansion. The necessity for capitalism to expand is central to our argument. Examples of what might be called "green capitalism" are analyzed in Chapter 11 along with the ways in which they fail to address global warming. Chapter 12 illustrates the conflict and incompatibility between capital investment and sustainability. The remaining chapters discuss actions that can abolish capitalism.

8. What is capitalism?

Capitalism is a relative newcomer in human history. It first appeared only a few hundred years ago in Europe, during the Medieval and Renaissance periods, but now it engulfs the planet. It dominates the world economically, ideologically, and politically. It shapes what we think about, how we spend our time, the histories we learn, the TV shows we can watch, the music we listen to, which foods we prefer, clothing styles, even our moods, who we love, and how we die.

Most people are oblivious to it, like the air around us, but capitalism diminishes us in countless ways. On a subconscious level capitalism teaches us that greed, exploitation, and economic competition are not merely to be tolerated, but venerated as necessities for the common good.

What is it exactly? Karl Marx wrote three volumes to explain capitalism as a social relation. A recent and more concise development is given in *Capitalism Must Die!* [McMillan]. For our present purposes, we define it this way:

> *Capitalism is an economic and social system in which the means of production are privately owned. The owners, or capitalists, appropriate the surplus product created by the workers. This appropriation leads to the accumulation of more capital, the amassing of wealth, further investment, and thus the expansion of capitalism. Commodities are produced for the purpose of generating profit and promoting accumulation. Within the capitalist system,*

individuals pursue their self interests against competition and impersonal forces of the market.

A key concept for understanding accumulation within capitalism is *surplus value.* During a working day, workers produce more value than the amount of wages they receive. The labor power that produces that extra value is not paid for. It is surplus value. Surplus value is the result, the residue, of the exploitation of labor. It comprises a portion of the

commodity's exchange value, making it profitable to sell. Capitalists are compelled to maximize surplus value by whatever means they can. This is the fundamental conflict between the capitalist class and the working class [McMillan].

Surplus value is one form of profit, but not the only one. In addition to surplus value, profit can accrue, for example, from rent, interest on loans, currency speculation, and arbitrage, and many of Wall Street's other activities.

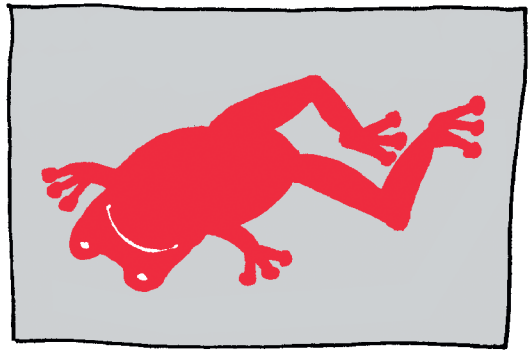
Investing money in order to make a profit is an essential feature of capitalism, but merchants have done this throughout recorded history. So why not describe the bulk of human history as capitalist instead of characterizing only the last few hundred years as capitalist? It is when the entire economy, including production, is dominated by and made dependent on the investment of capital, that the system is characterized as capitalist. In capitalist societies the purpose of the production of goods and services is to generate profit to be reinvested in further production. Karl Marx described this process with the schematic M-C-M^{+}, in which money (M) is invested to produce commodities (C), which are then sold for more money (M^{+}). The process repeats unendingly with the investment of (M^{+}) to produce even more money (M^{++}) in an upward spiral.

The driving force of capitalism is its quest for accumulation of ever-greater wealth, with most profits used to make more profits. Investments are made in order to generate more money, not to provide goods or services for social needs.


CAPITALISM
StephanieMcMillan.org
GLOBAL WARMING
WASTE
BANK
TAXES
CREDIT
IMPERIALISM
SURPLUS VALUE REINVESTED
SURPLUS VALUE REALIZED (PROFIT)
COMMODITY
PURCHASE
CONSUMPTION
LAND THEFT
EXTRACTION (PRIMARY ACCUMULATION)
PRODUCTION (EXPLOITATION OF LABOR)
WASTE (COSTS EXTERNALIZED)
WASTE

9. Planet Earth, capitalism's garbage dump and slaughter house

Polluting the environment is not a goal of capitalism. That ongoing catastrophe is just a byproduct of capitalism's routine operations. Maximizing profits is the objective, and the disposal of waste in the cheapest possible way is merely a requisite step toward that goal. Within the logic of capitalism, generating waste and polluting the environment is just economic efficiency. In fact, waste from overproduction is an inherent, unavoidable outcome of capitalism.



Capitalist crisis of overproduction

Capitalists sell commodities for more than they pay the workers who produce them. The difference is surplus value (see Chapter 8). A

consequence—and one of the major contradictions of capitalism—is that the monetary value of all commodities produced in the world necessarily exceeds the collective buying power of the world's workers. This wastefulness of capitalism is not something that can be adjusted or fine tuned away. It is an essential feature of capitalism.

The saturation of markets leads to what is called a *crisis of over-production.* There's just too much stuff, and the people cannot be paid enough to buy it all, at least not without eliminating the defining characteristic of capitalism—surplus value. One of the many irrational traits of capitalism is that economic crises are always crises of overproduction (in contrast to pre-capitalist economic crises which were the result of shortages). When a surplus of commodities finds no buyers, firms collapse, workers are fired, sales and orders for products and raw materials plummet, and people suffer.

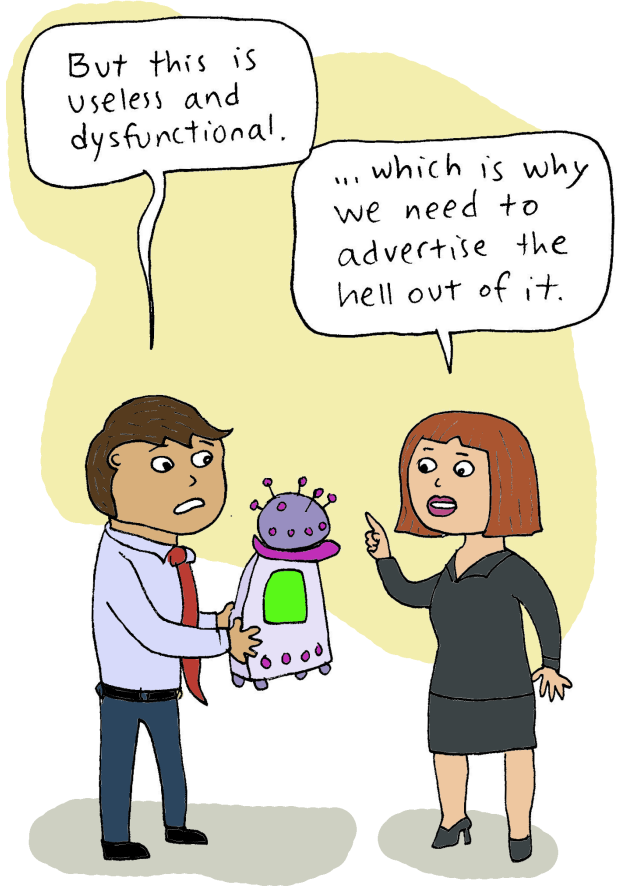
The housing crisis that began in 2009 simultaneously left in its wake homeless people and empty houses (repossessed by banks). A more rational system would fill the empty houses with the people who need shelter and provide them with jobs that contribute to society, for example construction of renewable energy sources or insulation of buildings. Instead, under capitalism, most jobs force us in one way or another to help destroy the planet that sustains us, and along that path of destruction, some people may suffer from malnutrition or even starve because, ironically, too much food is produced.

Trash

Under capitalist production, wasted food worldwide accounts for more greenhouse gas emissions than any single country except for China and the United States, according to a United Nations report. A third of all

food produced for humanity is wasted, giving it a carbon footprint of 3.3 billion CO_2 equivalent tonnes annually. Produced but uneaten food occupies about 30% of the world's agricultural land area [Food].

More than 150 billion single-use beverage containers are purchased each year in the United States and 320 million take-out cups are thrown away each day. Over 100 billion pieces of junk mail are delivered to mail boxes

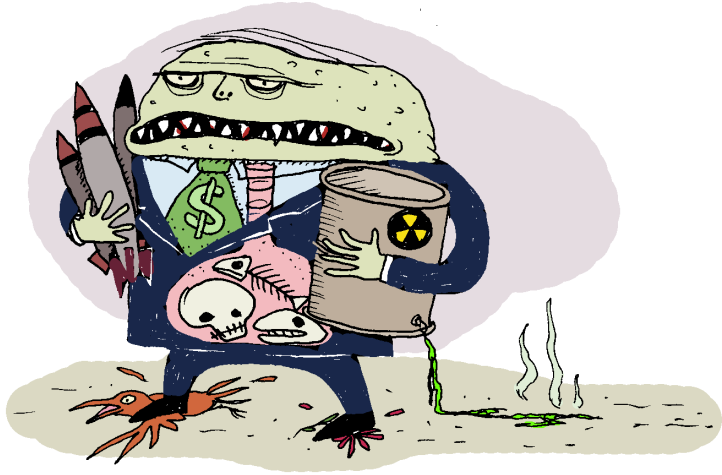


every year and that alone generates 51 million tons of greenhouse gases annually [Foster].

In the capitalist economy, products are intentionally designed to be unrepairable. Consumers are trained to discard them and buy newer versions. For example, cell phones in the U.S. typically last only a couple of years because of both technological and psychological obsolescence. According to the Environmental Protection Agency, 140 million cell phones reached their "end of life" in 2007 along with 250 million computers and peripherals [Foster].

The packaging industry is the third largest industry in the world after food and energy. Packaging is estimated to account for 10% to 40% of the collective cost of all non-food commodities [Foster]. As a form of marketing, containers are often larger than necessary than the contents within them require in order to give consumers a false sense of quantity. The waste is enormous (think of all the boxes, wrapping, and plastic you have to throw away).

Plastic was invented in the mid 1800s and has been mass produced since the end of World War II. Each year, approximately 300 million tons of plastic are produced and eventually discarded, more than enough to cover the entire United States in plastic food wrapping [Foster]. However, much of it ends up in the oceans. It has been estimated that more than 5 trillion pieces of plastic weighing over 250,000 tons have accumulated on the ocean surfaces and vastly greater amounts enter the food chain or disintegrate and fall to various depths in the ocean with unknown but potentially catastrophic consequences [Eriksen], [Cózar], [Parker]. The worldwide concentration of plastic illustrates perhaps better than any other single example the limited capacity of Earth to serve as the garbage dump for capitalism.



Toxins

In the United States there are more than 80,000 chemicals in commercial use. The compositions and dangers posed by some 20,000 of these chemicals are unknown because their compositions are legally withheld by corporations as "trade secrets." As of March 2010, the Environmental Protection Agency was able to require health and safety testing for only about 200. The center of world capitalism, the United States, has one of the worst records among industrialized countries for the protection of its citizens from toxic chemicals found in everyday products like cosmetics, dental products, and even food [Magdoff, pg 24].

Poisons from industrial waste, fracking, coal ash and other enterprises pollute the air, water, and land throughout the world, and especially poor communities and poor nations. Since the 1970s, capitalist enterprises have exported waste, including toxic industrial waste, to poor countries most especially in Africa. Larry Summers, a former president of Harvard

University and top economic advisor to President Obama, was also once the Chief Economist of the World Bank. In that capacity he wrote a 1991 memo that said, "underpopulated countries in Africa are vastly underpolluted" and lamented the paucity of exports of waste [Magdoff, pg 87].

Spills of oil from ship maintenance and waste from seafood processing contaminate the oceans along with fertilizer runoffs, industrial dumping, and ocean acidification (see Chapter 4). Massive satellite guided fishing trawlers, with nets the size of several football fields deplete ocean species, nearly to the point of extinction (if not beyond in some cases), an example

of how even "renewable resources" can be obliterated by capitalism. The short term interests of individual fishing industries is to capture and freeze as many fish as possible, but these actions collectively lead to planetary catastrophe. That is the logic of the free market.

Animals

The imposed suffering of animals for the sake of greater production efficiencies is a a violation of what ought to be sacred. Within the food industry, cut-throat competition and capitalism's drive for ever greater profits has resulted in a system of animal slaughter and sequestration through factory farms (e.g. for eggs and dairy products) of unprecedented efficiency, volume of production, and unspeakable cruelty.

Baby chickens and newly hatched turkeys are thrown into machines that grind them to a pulp. Sheep are beaten and bloodied with hammers and shears, punched, kicked, and thrown into walls before they are sheared for their wool by workers who are paid by volume, not time, so that even minimal acts of compassion would slow production and interfere with profits. Quoting a *Los Angeles Times* article about a dairy farm [Glionna],

> The activist says he captured images of workers using chains and metal wires to whip animals on their faces and bodies, using tractors to drag milk cows too weak to walk on their own, and electrically shocking the genitals of many animals to get them to move. Cows were also kicked, punched and stabbed with screwdrivers, the footage showed.

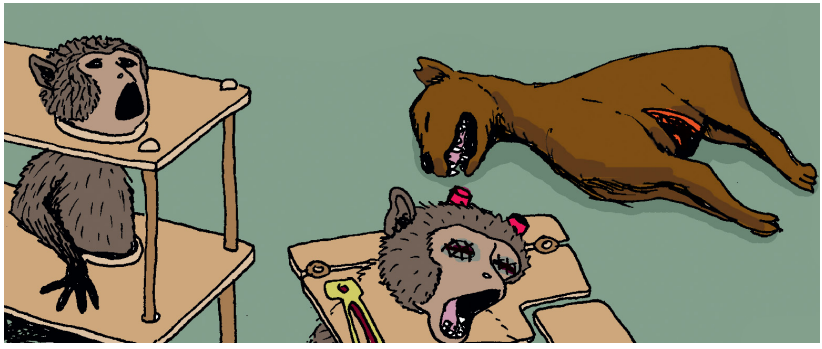
Compounding these crimes against nature, lobbyists for factory farms have made surreptitious filming of animal cruelty illegal in some parts of the world, including the U.S. states of Idaho, Utah, Iowa, Missouri, North

Dakota, Montana, and Kansas. Despite this, a handful of courageous journalists and animal rights activists continue to generate photographs and videos at considerable personal risk.

Cruelty to animals to facilitate increased productivity can also be understood in the context of the crisis of overproduction, described above. Economic competition leads to cruelty to animals in order to increase efficiency, which at the same time leads to overproduction and therefore shortages for human consumption. A rational economic system would treat animals with greater respect while at the same time meeting human needs.

Sheep, birds, pigs, cows, rabbits, and many other species are treated with such sadistic cruelty and on such massive scales that this issue alone constitutes more than sufficient grounds for the abolishment of capitalism. Even so, this facet of capitalism is dwarfed by the mass extinctions that this economic system threatens on a planetary scale. In its 2014 report, the World Wildlife Fund presented data indicating that vertebrate species populations worldwide declined 52% between 1970 and 2010 [WWF]. More generally, according to a study published in

Science in 2014, the modern extinction rate across species is 1000 times higher than the background rate without human intervention [Pimm].



10. Infinite expansion on a finite planet

Capitalism must expand or induce economic hardship. Its requirement to expand is, in the long run, incompatible with the finite limits of the planet. As Professor David Harvey observed, "Zero growth is a necessity and zero growth is incompatible with capitalism" [Harvey].

The current rate of capitalist expansion is staggering. In 1950, when the world population was 2.5 billion people, they consumed about 10 million tons per year of fabric for all uses. The 7 billion people as of this writing (mainly the wealthiest) consume more than 70 million tons of fabric annually, almost three times as much per person as in the 1950s. American houses today are more than twice the size of those built in the 1950s, even with shrinking families. Consumption of water for industry is exhausting the world's freshwater systems. Population rose fourfold in the last century, but water use has gone up by a factor of seven [Smith4].

Why does capitalism have to expand? Mainstream capitalist economists view economic expansion through increasing production of goods and services (and therefore increasing extraction of natural resources), as both good and necessary, and not at all controversial. Capitalism without growth is destructive, as during the 2008 worldwide recession, with its mass unemployment, increases in poverty and homelessness, and environmental issues pushed aside to spur growth. When profits cannot be made by growing the pie, it must be done by cutting what is left into

smaller slices, and that creates widespread misery. This issue is considered further in Chapter 11 where the focus is on Green Capitalism.

Expansion is part of the very definition of capitalism given in Chapter 8, but the actual dynamics of capitalist expansion deserve elaboration. The following economic forces cause capitalism to expand [Smith1] (see also [Blauwhof]):

1) Increasing division of labour and technological advances increase productivity and output, and that drives capitalists to find new markets.

2) Competition forces capitalists to increase market share in order to benefit from economies of scale and to re-invest in technological improvements.

3) Corporations must respond to the constant pressure from shareholders to expand in order to increase profits. Interest rates and inflation also drive expansion.

Capitalist economies are predominantly composed of corporations that operate in response to these forces, so the economy as a whole is also compelled to expand under normal circumstances.

The role of banks in giving credit and creating debt is another factor to consider in the expansion of capitalism. To increase market share, whether for existing firms seeking to launch a new line or new startups entering the market, capitalists must incur costs in advance of sales. The costs come from wages, salaries, and equipment. These investments add to the purchasing power of workers and the businesses that supply equipment before sales even begin. Where does the new money come from? It comes


You can't have infinite growth on a finite planet.
You're obviously not an economist.

from banks which create this credit essentially out of thin air by making loans well beyond the actual cash value they hold [Blackwater].

A key point is that without the anticipated increases in production, this credit would lead only to inflation or financial ruin. In order for the credit to increase wealth—the very reason that business is in business and the reason that banks offer credit to them—there must be an expansion in

the overall value of goods and services that can be exchanged for money. So when capitalist production begins with debt in this way, capitalists are forced into a game of catch-up; every loan is made with the expectation of additional sales income returning as a result. And when the entire economy is in net debt, it must grow in order to pay back what it owes to creditors with interest. Quoting economist Bill Blackwater,

> *From its very beginnings, the entirety of the capitalist system has been one enormous Ponzi scheme* ... The entire system is in debt, dependent on future growth, owed by future producers and consumers; the current income of capitalists and workers is drawn on a generational IOU; the entire system must keep growing or it will collapse. [Blackwater]

However, capitalist expansion is not steady and continuous, and it occurs chaotically even when large effective monopolies dominate particular markets, as the next section explains.

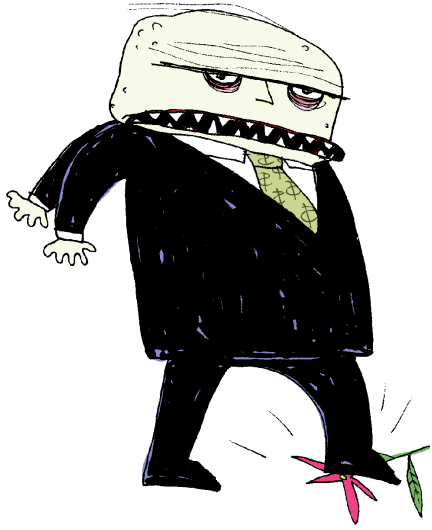
Creative destruction

Once the market is saturated by particular commodities, capitalists must find new forms of investment to maintain profits. Much of this is accomplished through *creative destruction*, a process of industrial mutation "that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one" [Schumpeter].

This phenomenon was first described by Marx and Engels in the *Communist Manifesto* (but was so named by Joseph Schumpeter). Schumpeter described capitalism's requirement to expand this way:

> [The] capitalist economy is not and cannot be stationary. Nor is it merely expanding in a steady manner. It is incessantly being revolutionized *from within* by new enterprise, i.e., by the intrusion of new commodities or new methods of production or new commercial opportunities into the industrial structure as it exists at any moment. Any existing structures and all the conditions of doing business are always in a process of change. Every situation is being upset before it has had time to work itself out. Economic progress, in capitalist society, means turmoil. [Schumpeter]

As an illustration, the cassette tape replaced the reel-to-reel tape, and the former was replaced by the compact disc, which was then largely supplanted by digital music. Corporations with near monopoly status in a particular technology which suddenly becomes obsolete can be wiped out by entrepreneurs with revolutionary new technologies. In order to



survive, capitalists must constantly search for innovations and increase market share of existing technologies.

Expansion, fossil fuels, and the Jevons paradox

Fossil fuels play a critical role in the expansion of capitalism. Indeed, industrial capitalism would not have been born without them. From the beginnings of the industrial revolution, coal has been the leading energy source. Its role in capitalism's expansion can hardly be overstated. In his book, *The Coal Question*, British economist William Stanley Jevons wrote in 1865,

> Coal in truth stands not beside but entirely above all other commodities. It is the material energy of the country—the universal aid—the factor in everything we do. [Jevons]

Jevons observed that increasing efficiencies of coal-powered steam engines led to increases in the overall consumption of coal, iron, and other resources, rather than to a lowering of consumption, as many assumed. As Jevons wrote in his book,

> It is wholly a confusion of ideas to suppose that the economical use of fuel is equivalent to a diminished consumption. The very contrary is the truth.

The mechanism was that greater efficiencies made coal more cost-effective and that resulted in an increase in the use of steam engines for mechanical work across a wider range of industries, resulting in a net expansion of capitalism.

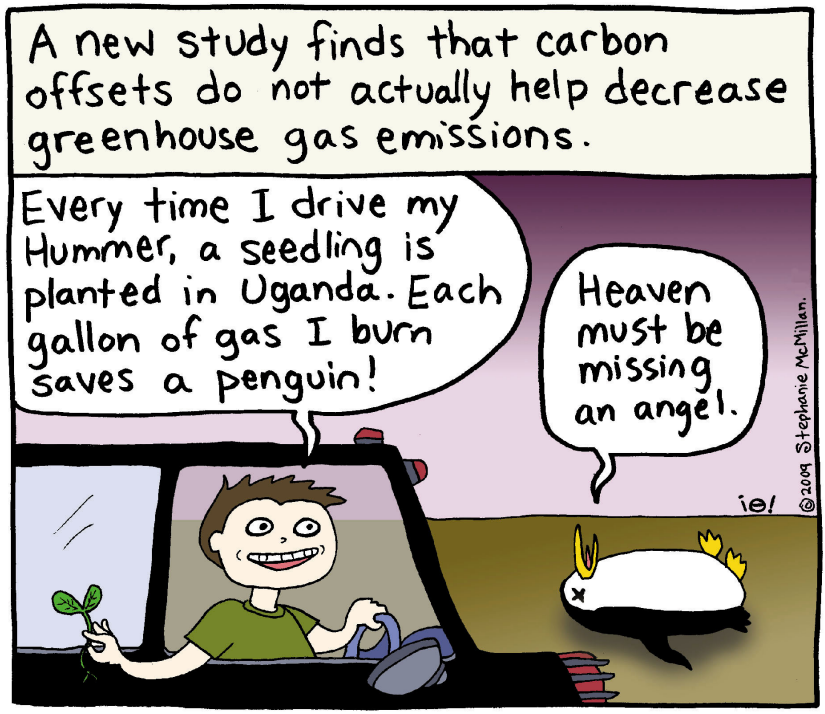
What Jevons described is the prototype example of a phenomenon now called the *Jevons paradox* or *Jevons principle*. The Jevons principle says that as technology advances, the increasingly efficient use of a resource tends to increase rather than decrease the rate of consumption of that resource. In short, capitalism's appetite for natural resources is insatiable and boundless.

The Jevons principle applies to the present day macroeconomic economy. Quoting economist Richard Smith [Smith2],

> Since 1975, the US has made substantial progress in improving energy efficiency. Energy expended per dollar of GDP has been cut in half. But rather than falling, energy demand has increased, by roughly 40 percent. Moreover, demand is rising fastest in those sectors that have had the biggest efficiency gains—transport and residential energy use. Refrigerator efficiency improved by 10 percent but the number of refrigerators in use rose 20 percent. In aviation, fuel consumption per mile fell by more than 40 percent, but total fuel use grew by 150 percent because passenger miles rose. Vehicles are a similar story. And with soaring demand, we've had soaring emissions. Carbon dioxide from these two sectors has risen 40 percent, twice the rate of the larger economy.

Elaborating on the example of air travel, the use of light weight materials in the construction of airplanes directly increased the efficiency of flight because less fuel is needed for lighter aircraft to travel a given distance. This greater efficiency did not lead to greater conservation of fuel. Rather, it led to a dramatic increase in air travel, expanded the tourist industry, and opened new lines of investment.

Crucially, the Jevons principle also applies to the use of all fossil fuels: coal, oil, and natural gas. Worldwide, energy consumption is increasing even as the use of renewable energy resources is also expanding. According to the U.S. Energy Information Administration, global electricity consumption nearly doubled from 1990 to 2011 along with all the technological advancements of those two decades. Electricity consumption increased steadily from 10.4 trillion kilowatthours in 1990 to 19.3 trillion kilowatthours in 2011. Similar increases in total energy consumption, and fossil fuel consumption occurred during the same period [EIA].



The increase of the global greenhouse gas emission rate over time is another measure of the expansion of capitalism. The IPCC reports that emissions grew at an average annual rate of 1.3% from 1970 to 2000, and then nearly doubled to an annual rate of 2.2% per year in the following decade 2000 to 2010, the last year for which complete data was available. Quoting the 2014 IPCC report,

> Total anthropogenic GHG emissions were the highest in human history from 2000 to 2010... Emission growth has occurred despite the presence of a wide array of multilateral institutions as well as national policies aimed at mitigating emissions. [IPCC3]

High emissions continued in 2011 and beyond. The Global Carbon Project reports that carbon dioxide emissions from fossil fuel burning and cement production went up by 2.1% in 2012 [GCP], and the World Meteorological Organization reported in 2014 that greenhouse gas concentrations in the atmosphere reached a record high in 2013. Carbon dioxide levels in the atmosphere increased more between 2012 and 2013 than in any previous year from the preceding three decades [WMO].

In 2012, President Obama claimed credit for capitalism's expanded use of fossil fuels when he said in a speech on March 22 in Cushing, Oklahoma,

> Under my administration, America is producing more oil today than at any time in the last eight years. That's important to know. Over the last three years, I've directed my administration to open up millions of acres for gas and oil exploration across 23 different states. We're opening up more than 75 percent of our potential oil resources offshore. We've quadrupled the number of operating rigs to a record high. We've added enough new oil and gas pipeline to encircle the Earth and then some. [Obama]

Democrats and Republicans both serve the capitalist class. That is their primary obligation, and that is why they prioritize corporate profits above all other concerns, including saving the planet for future generations [Jamail2].

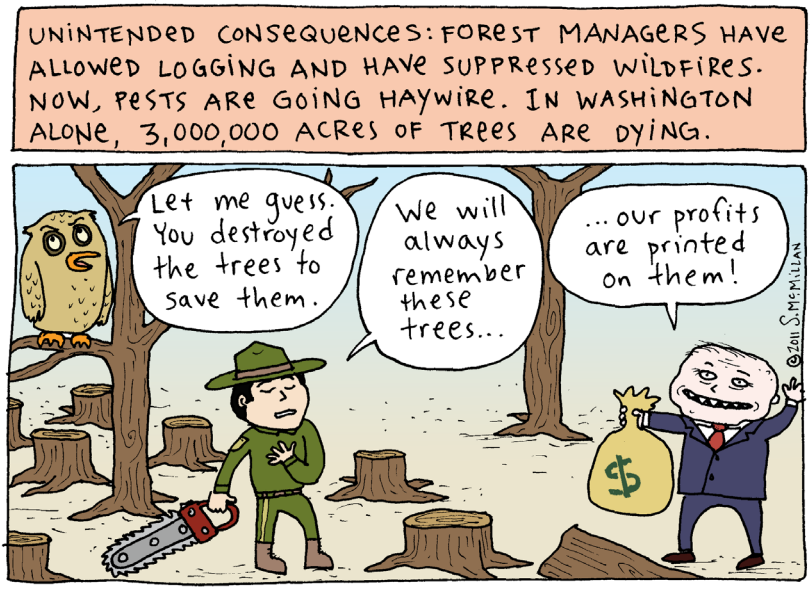
What expands?

Capitalist expansion includes limitless commodity production, depletion of resources, proliferation of waste, and animal cruelty as previously discussed, but unfortunately there is more. Capitalist expansion also leads to increased deforestation, population growth, and unending wars

for control of natural resources and markets. These are discussed below in turn.

Deforestation and capitalism

Primary forests, sometimes called old growth forests, are the largest above-ground carbon repositories in the world. It is therefore of the utmost urgency that they be protected. Capitalist expansion is doing the opposite: burning forests down for profit. The cause and effect relationship between deforestation and greenhouse gas emissions was described in Chapter 4. Here, capitalism's role in the acceleration of deforestation is addressed. The dwindling forests of Indonesia provide important and illustrative examples.



Indonesia has the third greatest land area of tropical forests among the nations of the world after Brazil and Congo. The country is, in addition, the third largest emitter of greenhouse gases, behind China and the US, with 85% of its emissions coming from deforestation. Primary forest losses in Indonesia totaled 6.02 million hectares (about 15 million acres) between 2000 and 2012, with a rate of increasing annual loss of 47,600 hectares. In 2012, Indonesia lost 840,000 hectares of forest, more than any other country and nearly double the massive loss of 460,000 hectares by Brazil the same year [Vidal].

Deforestation in Indonesia is carried out largely by the intentional burning of forests, but Indonesia is not alone. NASA satellites detected more than 3,000 separate fires across Indonesia, Thailand and Malaysia between mid-January and March 2014, exceeding the previous record set in June 2013. Satellite images have also revealed fires and haze across Burma, Thailand, Cambodia, Laos, the Philippines and Papua New Guinea.

The Asian "haze" has resulted in the closure of schools, airports, and roads. Visibility in some areas is at times only a few yards. In Sumatra alone more than 50,000 people were treated for asthma, bronchitis and other respiratory illnesses because of the smoke from the fires [Vidal]. The destruction of forests and peat lands is also having devastating effects on animal life and biodiversity in the region, as various pollutants (in addition to greenhouse gases) fill the atmosphere.

Why is this happening? Why are Indonesia and other countries burning their own forests? The short answer is profit. Indonesia is the world's largest producer of palm oil, which is used in cooking, cosmetics, a variety of foods, and fuel. Palm oil production is extremely profitable

and is a major part of the Indonesian economy. Forest land is cleared to make way for plantations for palm oil and pulp-paper production.

Most of the fires were started in Riau province in northern Sumatra, the center of the Indonesian palm oil and pulp-paper industries. There, 70% of the fires were lit by landowners in order to clear ground for more plantations. In this way and others, capitalism has made Asia the center of global air pollution which (along with obesity, another capitalist inflicted malady), is the world's fastest growing cause of death [Vidal].

Of course, deforestation cannot continue indefinitely. At some point the world will run out of forests for capitalists to burn, but in that situation, human survival would be doubtful. It is also true that capitalist enterprises are not the sole direct causes of deforestation. Increasing droughts from global warming also cause forest fires, for which capitalism is the indirect cause. In addition, population increases lead to deforestation simply because people need more land to live on and sustain themselves. But even population increase may be laid at the doorstep of capitalism, which, as the next section explains, benefits and stabilizes the global capitalist system in the short run.

Population growth

Some environmentalists point to overpopulation, rather than capitalism, as the fundamental cause of global warming and other environmental threats. This concern is not new. Warnings of the perils of unbridled population growth date back to Thomas Malthus who, in the late 1700s, considered consequences of exponential growth. Analyses and warnings about population growth have continued ever since.

A simple calculation illustrates the basis of these concerns. The average annual rate of population increase for humanity between 1700 and 2012 was about 0.8%. If that rate were to continue for the next three centuries, the world population would be about 70 billion in the year 2300, ten times the world population today. The planet could probably not sustain such numbers. Clearly, perpetual population growth on a finite planet is impossible.

The size of the human population and its possible affects on climate merit careful consideration. As a first step in that direction, it should be taken into account that different populations around the globe have widely varying impacts on the climate. As a thought experiment, imagine that some advanced alien civilization were to suddenly remove a large population of people from the planet. How would their choices of which humans to remove affect global warming?

Suppose first that the world's poorest three billion people were removed from the planet. That would cut the global population nearly in half, a substantial number, but since the poor of the world generate, through their activities, almost no greenhouse gases, there would be virtually

no change in total greenhouse emissions or the climate. If on the other hand, the aliens chose to remove the world's richest 500 million people (including much of the U.S.), then greenhouse gas emissions would be cut in half, and the planet would be well on its way to recovery [Magdoff, pg 32].

Population size matters, but fundamentally it is capitalism that both causes climate change and drives population growth. The highest population growth rates in human history coincide with the capitalist era as the following table based on data provided in the technical appendix to Thomas Piketty's book, "Capital in the Twenty-First Century" shows [Piketty].

Historical Interval	Global Population Growth Rate
0 - 1000	0.02%
1000-1500	0.10%
1500-1700	0.16%
1700-1820	0.46%
1820-1913	0.56%
1913-2012	1.39%

Table 2 Global Rates of Population Growth

The dramatic increases in growth rates appear starting in 1500, about the time that modern capitalism emerged. It should be noted that many factors affect population growth, not just economic systems. For example, as resources to sustain growth reach planetary limits, population growth

rates will likely decrease and may eventually become negative, even with capitalism.

It is hardly surprising that capitalism should spur population growth. Efficiencies and growth of food production naturally lead to population increases. Capitalism also tends to benefit from an increasing population because markets expand with population, and so does the labor pool. An expanding labor pool lowers the cost of labor thus increasing profits, and that engenders economic growth.

If the population stopped growing, there would, for example, be little demand for new housing, and with fewer new households, purchases of furniture and appliances would plummet. The construction industry would collapse and pull down numerous other industries with it. Unemployment would soar. Population growth and capitalism constitute a positive feedback loop, reinforcing each other.

Piketty's *Capital in the Twenty-First Century*, analyzes how the long term concentration of wealth in capitalist societies depends on population growth. The basic idea stems from a comparison of the rate r of the return on capital to the rate g of growth of the economy as a whole. If $r > g$ for an extended period of time in a capitalist society (the most important example being the entire world), then wealth can become so concentrated that the society becomes unstable and prone to revolution [Piketty, pg 263].

Mathematically, the rate g is a sum of two terms: the per capita output growth rate and the population growth rate. In any capitalist economy, as Piketty explains, economic "growth always includes a purely demographic component" [Piketty, pg 72]. Thus, r is likely to be much larger than g when there is zero or negative population growth, and capitalism becomes more unstable because of excessive concentration of wealth.

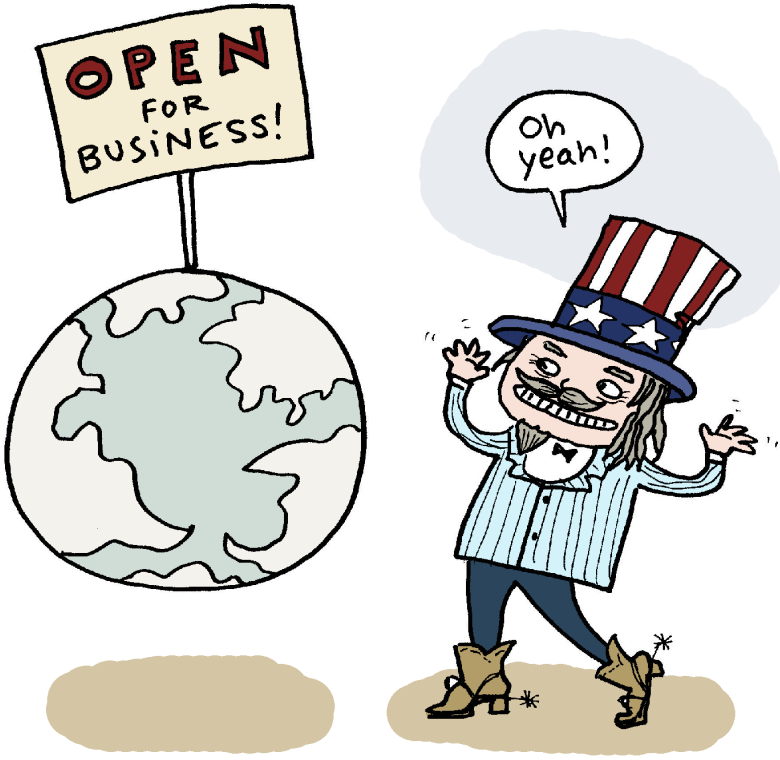
The history of population increases in the U.S. and Europe help to illustrate the basic principle. Primarily because of immigration, the U.S. went from a population of less than 3 million in 1780 to 300 million in 2010, more than a hundredfold increase in two centuries, compared to the relatively stable population of Europe. Partly as a consequence, the concentration of wealth remained lower in the U.S. than Europe for most of that period [Piketty].

However, the concentration of wealth under capitalism in the second decade of the 21st century is increasing rapidly, especially in the U.S. where the wealthiest one percent took 95% of all economic growth since the crash of 2009, while the bottom 90% became poorer. Globally, nearly half of the world's wealth is owned by one percent of the world's population, and that one percent owns 65 times as much wealth as the bottom half of the world's population. The 85 richest individuals alone own as much wealth as the 3.5 billion people who constitute the poorest half of the planet. [Oxfam].

According to United Nations projections, the global population growth rate is expected to fall to 0.4% by 2030 and decrease further to 0.1% in the 2070s. Under these circumstances, Piketty estimates a global growth rate g between 1% and 1.5% and a rate of return r on capital of 4% or 5%, so that r will be much larger than g. The conclusion is that without intervention against the mechanisms of the free market, wealth concentration will reach unprecedented levels and destabilize the global capitalist system. That is indeed an ominous scenario. If humanity permits capitalism to continue on its path, the destruction of the environment and the biosphere will accelerate. We discuss this further in chapters that follow.

Resource wars

Wars have existed throughout human history, long before capitalism, so it would be incorrect to say that capitalism is the sole cause of war. Nevertheless, capitalism's search for cheap labor, new markets, and increasingly for natural resources drives the people of the world into an unending cycle of wars. A complete description of these wars, their causes, and the broader framework of imperialism is beyond the scope of this book, but a few examples illustrate how this works. Examples from



the early 20th century are nicely summarized by a famous U.S. war hero, Smedley Butler.

Smedley Darlington Butler held the rank of Major-General in the U.S. Marine Corps, and retains legendary status among U.S. soldiers for his leadership and conspicuous acts of courage. He was awarded two Congressional Medals of Honor for separate acts of valor, among other recognitions for heroism and dedication. But in spite of his military background, once he retired from the Marines in 1931, he began to question the reasons for the wars he fought. He came to the realization that it was all for capitalist profits. In 1935, Butler published his book, *War is a Racket,* a powerful condemnation of the capitalist interests driving those wars [Butler]. In one of the dozens of speeches he gave against war, he summarized his experiences this way:

> I spent 33 years and 4 months in active service as a member of our country's most agile military force—the Marine Corps. I served in all commissioned ranks from Second Lieutenant to Major-General. And during that period I spent most of my time being a high-class muscle man for Big Business, for Wall Street and for the bankers. In short, I was a racketeer for capitalism.
>
> Thus I, helped make Mexico and especially Tampico safe for American oil interests in 1914. I helped make Haiti and Cuba a decent place for the National City Bank boys to collect revenues in. I helped in the raping of half a dozen Central American republics for the benefit of Wall Street. The record of racketeering is long. I helped purify Nicaragua for the international banking house of Brown Brothers 1909 – 1912... I brought light to the Dominican Republic for American sugar interests in 1916. In

> China in 1927 I helped see to it that Standard Oil went its way unmolested.
>
> During those years, I had, as the boys in the back room would say, a swell racket. I was rewarded with honors, medals, promotion. Looking back on it, I feel I might have given Al Capone a few hints. The best he could do was to operate his racket in three city districts. We Marines operated on three continents. [Zinn]

Butler recognized that the wars he fought were for capitalist expansion. That expansion, in turn, leads to more wars.

George Kennan, Director of Policy Planning of the U.S. State Department in 1948, clarified the goals of post WWII U.S. foreign policy in a top secret memo that was later declassified:

> ... we have about 50% of the world's wealth but only 6.3% of its population... In this situation we cannot fail to be the object of envy and resentment. Our real task in the coming period is to devise a pattern of relationships which will permit us to maintain this position of disparity without positive detriment to our national security. To do so we will have to dispense with all sentimentality and daydreaming, and our attention will have to be concentrated everywhere on our immediate national objectives. We need not deceive ourselves that we can afford the luxury of altruism and world benefaction...We should cease to talk about such vague and—for the Far East—unreal objectives as human rights, the raising of living standards and democratization. The day is not far off when we are going to have to deal in straight power concepts. The less we are then hampered by idealistic slogans, the better [Kennan].

The point was that U.S. capitalism demanded the removal of all barriers to global markets, labor, and natural resources. It is striking that Kennan was regarded as a liberal voice within the U.S. government at the time. He left his position not long after this memo was written because he was considered insufficiently tough-minded, and was replaced by a hard-liner, Paul Nitze, at the end of 1949.

The considerations leading up to the U.S. invasion of Vietnam (even before the defeat of the French) were similar. In Seattle, August 3, 1953, Dwight D. Eisenhower addressed a conference of state governors and told them,

> Let us assume we lose Indochina...The tin and tungsten that we so greatly value from that area would cease coming...So when the United States votes 400 million dollars to help that war, we are not voting a give-away program. We are voting for the cheapest way that we can prevent the occurrence of something that would be of a most terrible significance to the United States of America, our security, our power and ability to get certain things we need from the riches of the Indochinese territory and from Southeast Asia" [Gerassi].

The U.S. military invasions after 2000 were carried out primarily for the purpose of controlling the world's largest oil reserves so as to increase economic growth. Alan Greenspan, the world's most powerful banker, and former Federal Reserve Chairman at the time of the U.S. invasion of Iraq put it succinctly. In his memoires, Greenspan wrote: "I am saddened that it is politically inconvenient to acknowledge what everyone knows: the Iraq war is largely about oil" [Beaumont].

Iraq's oil reserves rank second in the world, only after Saudi Arabia. A prominent oil industry analyst summarized the outcome of the U.S. invasion in an interview with Al Jazerra this way,

> Prior to the 2003 invasion and occupation of Iraq, US and other western oil companies were all but completely shut out of Iraq's oil market, but thanks to the invasion and occupation, the companies are now back inside Iraq and producing oil there for the first time since being forced out of the country in 1973" [Jamail1].

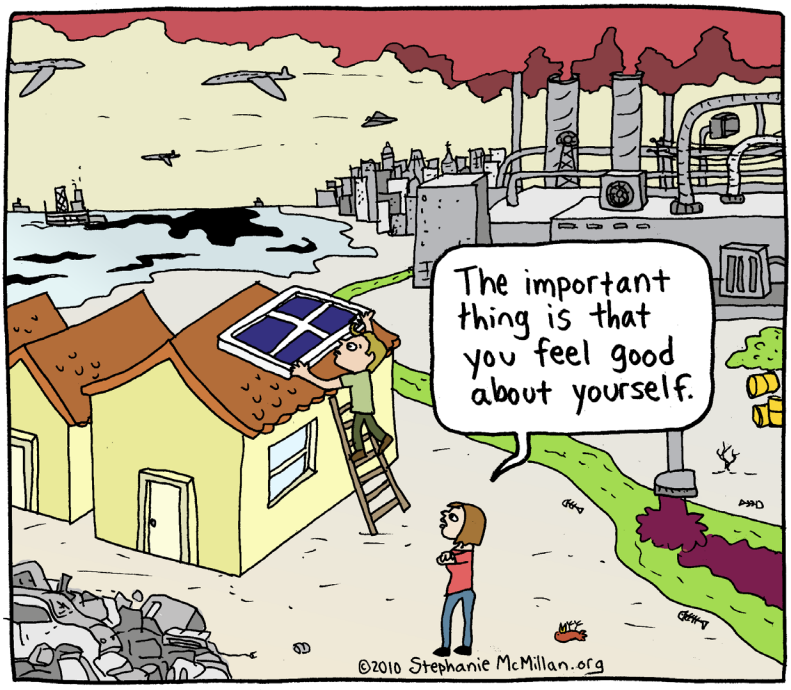
Domination of the world's resources requires enormous military capacity. One illustration (among many) of the immensity of this enterprise is the number of foreign military bases maintained by the U.S. Empire, the chief enforcer of global capitalism.

Chalmers Johnson was the first scholar to undertake a detailed investigation of U.S. foreign military bases, using the Pentagon's publicly available documents. In his 2004 book, *The Sorrows of Empire*, Johnson estimated that the U.S. maintains well over 700 foreign military bases in 135 countries. More recent estimates, necessarily approximate, are on the order of 1000 U.S. foreign military bases around the world [Turse].

The military industrial complex is a major component of capitalism with its own motivations for expansion. Recent wars are driven by capitalism's need for access to fossil fuels, the fundamental cause of the global climate crisis. The machines of war are largely powered by fossil fuels, so their use contributes further to the crisis, along with the explosions, fires, and massive destruction they cause, not to mention the immeasurable human costs.

11. Green capitalism

Despite the fundamental contradictions between capitalism and sustainability of the planet, mainstream environmentalists and environmental organizations promote capitalist solutions to the climate crisis and other environmental threats. These "solutions" have labels like green consumerism, the green economy, the green new deal, or green capitalism [Fitz].



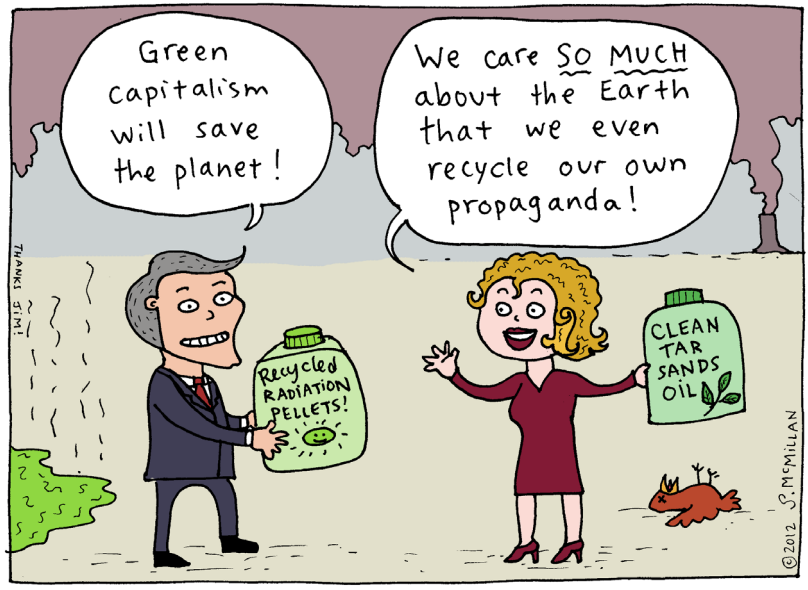
For simplicity these will be referred to generically as *green capitalism*. The basic idea of green capitalism is to make environmental destruction unprofitable within the framework of capitalism. However, in practice, protecting the "free market" is the highest priority of green capitalism —higher, unfortunately, than saving the planet. Proposals for versions of green capitalism date back to the 1980s and 1990s [Smith2], [Fitz].

The first thing to observe about green capitalism to date is that it has failed and dramatically so. This is immediately evident from the steady increases in global greenhouse gas emissions (see Chapter 10). Moreover, the idea that capitalism can save the planet from a problem continually and increasingly caused by capitalism is not only dubious on its face, but it has failed all real world tests. As we describe below, the best case scenarios to date for green capitalism have resulted in more generation of electrical power from renewable energy, but have largely left untouched non electrical sources of greenhouse gas emissions and those neglected sources constitute well over half of greenhouse gas emissions for the countries in question (and for the world).

The scale of change necessary to achieve zero global carbon emissions—called for by the IPCC (see the discussion of RCP 2.6 in Chapter 6) in order to stay below 2° C of warming—is vastly greater than what any version of green capitalism can accomplish. Meeting this challenge will require revolutionary changes to global political and economic systems. Nevertheless, dedication to market driven solutions dominate green NGOs (non governmental organizations or non-profit organizations) and the mainstream environmental movement, with virtually unflagging adherence.

A prime example is The Nature Conservancy, the largest environmental NGO in the world. Operating in 35 countries with more than a million

members, it has billions of dollars in assets. Its business council members are associated with BP America, Chevron, Shell, and include the CEO of Duke Energy, one the leading coal-burning utilities in the U.S. JP Morgan has given the Conservancy hundreds of thousands of dollars to produce voluntary guidelines for fracking, an unconventional extraction method that should be abolished, not "guided" (see Chapter 4). The Nature Conservancy even owns and operates oil and gas wells on one of its nature preserves [Klein, Chapter 6].



The Environmental Defense Fund (EDF), another leading Green NGO, collaborated with energy corporations to open the Center for Sustainable Shale Development, whose title features a strikingly Orwellian use of the word "sustainable." The Center, through its development of voluntary

guidelines for fracking, serves as a fig leaf for corporate assaults against nature.

In support of natural gas extraction, the EDF joined with other co-sponsors and funders from Chevron, Shell, ExxonMobil, the Walton Family Foundation, green billionaire Tom Steyer, and others, for a study published in the *Proceedings of the National Academy of Sciences* that effectively vindicated fracking and natural gas extraction. The 2013 paper entitled, "Measurements of methane emissions at natural gas production sites in the United States," reported methane gas leakage rates substantially below what previous studies found. But this finding was a result of design flaws in the research which allowed gas companies to choose the wells they wanted inspected and the times of inspection. Under the EDF banner, the study received considerable positive press coverage, but has been rebutted by serious scientific researchers [Howarth2], [Klein].

In an article published in *The Nation* in 2010, Johann Hari provided other examples, including this one [Hari]:

> ... in 2009 the EPA moved to regulate greenhouse gases under the Clean Air Act, which requires the agency to ensure that the levels of pollutants in the air are 'compatible with human safety'—a change the Sierra Club supported. But the Center for Biological Diversity petitioned the EPA to take this commitment seriously and do what the climate science says really is 'compatible with human safety': restore us to [an atmospheric carbon concentration of] 350 ppm. Suckling explains, 'I was amazed to discover the Sierra Club opposed us bitterly. They said it should not be done. In fact, they said that if we filed a lawsuit to make EPA do it, they would probably intervene on EPA's side. They threw climate science out the window.'

These are far from the only examples of Big Green groups collaborating with corporate foundations and fossil fuel companies. As Naomi Klein puts it, "The 'market-based' climate solutions favored by so many large foundations and adopted by many greens have provided an invaluable service to the fossil fuel sector as a whole" [Klein, p. 199].

Buying green

One strand of green capitalism is "green consumerism." The idea is that if consumers make the right choices then green businesses will thrive and polluters will be driven from the market. According to this line of thought, we can essentially buy our way out of global warming and deadly pollution.

The main fallacy of this agenda is that it ignores capitalism's fundamental requirement to expand. Capitalism relies on an endless cycle of increasing consumption to maintain profits, jobs, and tax revenues (see Chapter 9). "Green products" like organic groceries, energy-efficient light bulbs and appliances, and electric vehicles are merely a few of the pathways for capitalist expansion, among a myriad of others. A key point is that green products do not decrease the totality of commodities; they simply add to an expanding overabundance.

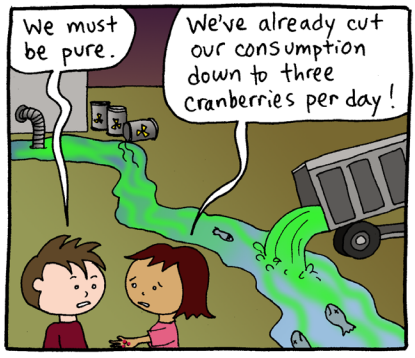
Consider the case of hybrid and electric cars. Cars produce 56% of all the pollution they will ever cause during the manufacturing process, before they are sold, and 4% after they become scrap [Smith2]. So while there can be a significant reduction of pollution during the time the vehicle is driven, continual expansion of the plug-in car market in China, India, and around the world, will in the end worsen the climate crisis, not improve it.

This could be mitigated by manufacturing cars that last longer, but the last thing auto makers want to do is build cars that can last for decades. Within the framework of capitalism, it is more profitable to increase the rate of consumption and entice customers to buy new cars every three or four years. What the world really needs is electrified mass transportation and an end to the proliferation of single occupant vehicles, but since that is far less profitable, capitalism cannot supply that.

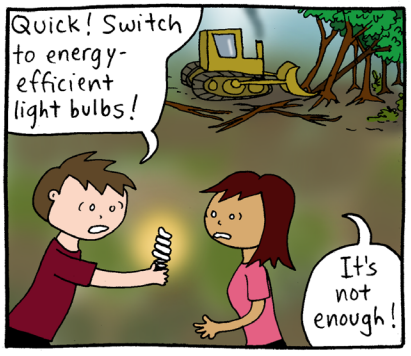
Buying less

An alternative liberal vision is to increase people's environmental awareness and to help them realize that consumerism does not lead to greater happiness. What if masses of people were able to disentangle their happiness from owning more things, and instead choose more frugal


We must be the change we wish to see.
That sounds so reasonable!


We must be pure.
We've already cut our consumption down to three cranberries per day!


I'm sorting all this trash, but it's not working!
Recycle harder, damn it!


Quick! Switch to energy-efficient light bulbs!
It's not enough!


We need to stop industrial capitalism from destroying the planet.
It's too dangerous to dissent!


It's time to fight back!
No!
We'll get in trouble!

life styles? Wouldn't that solve the problem? The realistic answer is no. No alternative to ever-increasing consumption is possible in a capitalist economy. The powerful advertising industry is fine-tuned to subvert any such challenge, and it is highly effective.

In the United States more than two-thirds of market sales, and consequently most jobs, depend on direct sales to consumers. Most of the rest of the economy, including enforced spending programs for the military and infrastructure, is dedicated to propping up overconsumption and the "American way of life."

Illustrations of the centrality of consumption to capitalism were President Bush's appeals to the American public to continue shopping and buying in the immediate aftermath of the 9-11 attack. As in the U.S., most jobs in industrialized countries depend critically on increasing consumption [Smith2]. We cannot buy our way out of the climate crisis, nor can we avoid it by appealing to the masses to buy less when they are constantly bombarded by the advertising industry to buy more. Even if they did buy less (which many are currently doing involuntarily due to rising unemployment and increased living costs), capitalists can overcome that with forced consumption, for example, through increased privatization of state services.

Carbon tax, offsets, and cap-and-trade

A leading market based policy is "cap-and-trade." The idea is for governments to set a cap on allowable CO_2 emissions for a specified group of polluting industries. Then, for every ton of CO_2 that a polluter reduces below the cap, it is awarded a permit to pollute. Permits can then be bought, sold, traded or saved for the future. A corporation that cuts its emissions below the mandated level can sell its pollution permits to more

heavily polluting industries, which can then keep on polluting. Over time, so the theory goes, governments would lower the cap, reducing the supply of carbon allowances. This would drive up the cost of the permits, and polluters would face rising costs to keep operating.

Europe introduced the first large-scale cap-and-trade system in January 2005, and the system was a complete failure. Corporations lobbied effectively for high caps and permits at low cost. Prices for electricity increased but so did greenhouse gas emissions, and the permits generated a new multi-billion dollar market that enriched financial investors. Quoting the *New York Times*,

> The European Union started with a high-minded ecological goal: encouraging companies to cut their greenhouse gases by making them pay for each ton of carbon dioxide they emitted into the atmosphere. But that plan unleashed a lobbying free-for-all that led politicians to dole out favors to various industries, undermining the environmental goals. Four years later, it is becoming clear that the system has so far produced little noticeable benefit to the climate—but generated a multibillion-dollar windfall for some of the Continent's biggest polluters. [Kanter]

In some carbon trading schemes, *carbon offsets* play a significant role. The idea is for corporations to be able to buy the right to pollute by purchasing and preserving forests and nature preserves. The reasoning given is that the carbon that these capitalists put into the atmosphere is offset by an equal amount of carbon absorbed by plants and soils so that there is no net discharge. But this ignores the fact that plants and soils were absorbing carbon anyway, before the capitalist bought them, and

that the only way out of the climate crisis is a full stop on the emission of greenhouse gases (see Chapter 6).

Carbon offset schemes have led to numerous instances of "green human rights violations." Through the commodification of nature, indigenous people continue to be pushed off lands purchased as offsets by corporations and facilitated by Big Green NGOs. Peasants and indigenous peoples are not allowed to continue traditional practices of hunting and fishing, and lose the freedom to sustain themselves in traditional ways. Ironically, those persecuted by this form of green capitalism have been living in the most sustainable and least carbon intensive ways on the planet [Klein].

One version of this general scheme is the United Nations program for "Reducing Emissions from Deforestation and forest Degradation" or REDD. REDD was launched in 2008 with the stated intention of protecting existing forests as carbon reserves and decreasing the rate of deforestation, especially in the tropics. It was later expanded and renamed "REDD+". The effects of this policy have been devastating. Tom Goldtooth, Executive Director of the Indigenous Environmental Network, described REDD as,

> ... a policy that grabs land, clear-cuts forests, destroys biodiversity, abuses Mother Earth, pimps Father Sky and threatens the cultural survival of Indigenous Peoples. This policy privatizes the air we breathe. Commodifies the clouds. Buy and sells the atmosphere. Corrupts the Sacred ... REDD really means Reaping profits from Evictions, land grabs, Deforestation and Destruction of biodiversity. REDD does nothing to reduce greenhouse gas emissions at source. And REDD may result in the biggest land grab of the last 500 years. [Morningstar]

Mainstream critics of cap-and-trade promote an alternative simpler market "solution," a flat carbon tax that would eliminate manipulation of markets and profiteering from the exchange of permits. The proposal is that a tax would be paid at the point where fuels are extracted from the earth and enter the stream of commerce, or where they are imported into the U.S. (or a country with this policy).

Energy corporations and fossil fuel importers would pass along the cost of the carbon tax to the market, which would in turn make renewable sources of energy relatively more competitive. The tax could be returned directly to consumers, or alternatively used for social projects. Finland was the first nation to introduce a carbon tax in 1990, and since then

Sweden, Germany, Britain, South Korea, and South Africa followed suit [Smith2], but carbon emissions continue to increase.

Among the supporters of a carbon tax versus cap-and-trade is Rex Tillerson, chairman and chief executive of Exxon Mobil Corp. According to Reuters, he "favors a carbon tax to curb greenhouse gas emissions—rather than a cap and trade system using pollution credits—because the tax is more effective, less costly and easier to administer." Similarly, Donald E. Felsinger, Chairman and CEO of Sempra Energy, was quoted by the *New York Times* as saying, "We are having debates within my own company about what is a better outcome, whether it be cap-and-trade or a tax. I think the most effective way to deal with carbon pollution is to have a carbon tax." [CTC]

Lewis Hay III, Chief Executive of FPL Group reportedly believes that a carbon tax "set at a reasonable level and gradually increased, would create market pressures encouraging emission cutbacks not just on utilities but across the economy—but it should be done in a way that is friendlier to industries, businesses and consumers than the 'cap and trade' scheme dominating discussions in Congress." According to Hay, cap and trade would result in a "giant food fight over these [carbon] allowances," invite fraud, as occurred in Europe, and volatility in carbon pricing. According to Hay, "We think the big winners in a trading scheme will all be the investment bankers" [CTC]. Leading capitalists are not afraid of a carbon tax because it can just be folded into the cost of doing business, and it will not stop corporations from burning fossil fuels.

Disputes between capitalists over the relative merits of cap-and-trade versus a carbon tax may be a reflection of evolving tensions between finance capital and industrial capital. Investment bankers and the financial sector stand to benefit from trading schemes offered by cap-and-trade, whereas a uniform carbon tax would be a predictable cost of doing business for the fossil fuel based industries (regardless of how income from the taxes is distributed). Neither of these green capitalist policies would stave off the impending climate catastrophe, but instituting one of them could shift wealth in one direction or the other within the capitalist class.

Whether a cap-and-trade policy with carbon offsets or a carbon tax is introduced by leaders of green capitalism, in the end, powerful corporations will not allow governments to curtail profits, even slightly. A clear example was provided by Australia, the world's leading coal exporting nation. Australia instituted a carbon tax on July 1, 2012 and then repealed it two years later, on July 17, 2014. Capitalism, whether green or some other color, by its nature places profits above all else, including the survival of the planet.

What about European social democracies?

Mainstream environmentalists sometimes point to countries such as Germany, Norway, Sweden, or Denmark as models of green capitalism that can lead the way to a survivable planet. Some policies embraced by these countries are indeed less damaging to the environment compared to the practices of the major capitalist powers, China, the U.S., and many other nations.

In a system as vast as the global capitalist system, variations are inevitable. Some centers will produce greater than average carbon emissions and others less, but the components of capitalism are so interconnected and interdependent that no single nation or region can be isolated in terms of its effect on climate.

For example, in Stockholm, Sweden's capital and Scandinavia's largest city, 74% of residents walk, bike, or use public transportation to go to work, a far more enlightened arrangement than what occurs elsewhere [Klein, p. 179]. And yet Sweden is the third largest weapons exporter per capita in the world, with arms shipments to regimes conducting massive human rights abuses such as Saudi Arabia, Thailand, Bahrain and Egypt. Sweden thus contributes significantly to imperialism by supplying military hardware to enforce the flow of oil and other resources into the capitalist centers [Goodman].

Because of its rivers and waterways, Norway gets 97% of its electricity from hydropower, and the nation is a relatively low emitter of greenhouse gases. But the U.S. Energy Information Administration estimated in 2013 that Norway was the 3rd largest exporter of natural gas in the world, and the 12th largest net exporter of oil in 2013. The majority state-owned company, Statoil, has had investments in the Alberta Tar

Sands project, and made plans to tap into Arctic oil. Norway, for all its renewable energy, is a major contributor to global warming.

Denmark and Germany have adopted partially decentralized renewable electrical power systems, largely in response to popular movements against nuclear power. Denmark holds the world record in wind-generated power per capita and generates more than 40% of its electricity from renewables. A large percentage of Danish wind turbines are community-owned by farmers and cooperatives [Klein, p. 131]. Likewise, under Germany's Energy Transition program, wind turbines and solar panels have proliferated. More than 25% percent of Germany's electrical power consistently comes from renewable sources, and the country plans to increase that percentage substantially.

In spite of these advances, Germany's total greenhouse gas emissions increased in both 2012 and 2013. For all its achievements in renewable energy production, Germany is Europe's largest consumer of coal, and much of the coal in Germany is lignite (also called brown coal), which is particularly high in emissions. Taking into account Germany's total energy use, including heating and transport (and electricity), energy classified as renewable accounts for just under 12% of the total. The remainder comes from fossil fuels and nuclear power.

Even some electrical generation designated as renewable is polluting. A majority of Germany's renewable energy comes from biofuels "many of them made from imported soya and palm oil that are being expanded at the expense of tropical forests and peatlands and that destroy the livelihoods of small farmers, indigenous and other forest dependent peoples worldwide" [Ernsting].

As in Germany, Denmark's bioenergy accounts for a greater percentage of renewable energy than wind. It includes biofuels for transport, which might be worse for the climate than equivalent amounts of oil, if all emissions from deforestation, destruction of peatland, and other land use changes are taken into account. Denmark is also the European Union's second biggest wood pellet importer after the United Kingdom. Denmark's wood pellets are imported from the Baltic states, Russia and from countries where clear-cutting of forests is rampant [Ernsting].

The point here is not to belittle the European social democracies for their important efforts and achievements to become more sustainable. These advances are the result of popular pressure on the governments of

these nations, and they help point the way toward further improvements. Rather, the point is that even the most environmentally benign capitalist social formations fall far short of what is needed to avoid climate catastrophe. Quoting Richard Smith [Smith4],

> Much is made, for example, of Germany's increasing use of renewable energy. But what difference does it make, really, if the Germans get 30 percent or even 100 percent of their electricity from renewable sources, if what they use that electricity for is to power huge factories producing an endless waste stream of oversized, over-accessorized, designed-to-be-obsolesced Mercedes Benz global warmers? What kind of 'sustainability' is that?

There are structural barriers to further progress in all capitalist nations. In Germany, for example, the coal lobby is extremely powerful. When the European cap-and-trade system fell apart, the price of coal fell sharply and there were no market mechanisms to prevent its increasing use [Klein, p138]. The profit motive (for coal in this case) trumps saving the planet.

According to the IPCC, electrical power and heat generation worldwide account for only 25% of global greenhouse gas emissions (Chapter 7), so to achieve zero emissions before the end of the century as required for global warming to stay under 2° C (Chapter 6) requires sweeping changes across the whole economy, far beyond implementing more renewable electricity, and far beyond what market incentives can accomplish.

12. Capitalism or survival

In 2011, the Carbon Tracker Initiative, a group of London financial analysts and environmentalists, published a report for investors about the financial risks that climate change poses to stock portfolios. The organization compiled data on the quantity of oil, gas and coal that the world's major energy companies hold in underground reserves.

Using climate science research and accounting only for proven reserves, the Carbon Tracker Initiative found that there is about five times as much carbon underground in those reserves as the world can afford to burn and still remain below a 2°C global warming limit (see Chapter 6). The stark conclusion is that in order to avoid a climate catastrophe, close to 80% of known reserves must remain unburned and preferably underground.

How much is all that carbon worth? The total market value of all proven reserves was estimated in 2012 to be $27 trillion [McKibben2]. Therefore, to leave 80% of these reserves underground and restrain global warming to no more than 2°C, investors would have to give up some $20 trillion.

The numbers here are approximate, and the Carbon Tracker Initiative updated some of its estimates in a 2013 report [Carbon], but the crucial fact is that the abundance of fossil fuels is so vast, that burning even a fraction of what remains would result in an unprecedented climate catastrophe.

Worse still, the proven reserves do not include unconventional fossil fuel sources like methane hydrates, tar sands, or shale gas (obtained through fracking) that are being excavated at a feverish pace, the burning of which James Hansen and colleagues have shown could essentially cook the planet (see Chapter 6). Other analyst have reached the same conclusion. In its 2014 report, the Deep Decarbonization Pathways Project [DDPP] reported,

> The amount of CO_2 contained in proven reserves is roughly 3-7 times larger than the CO_2-energy budget [for 2° C of warming]. Total reserves and resources exceed the CO_2-energy budget by some 35-60 times. The conclusion is stark: there are vastly more reserves and resources than the world can use safely.

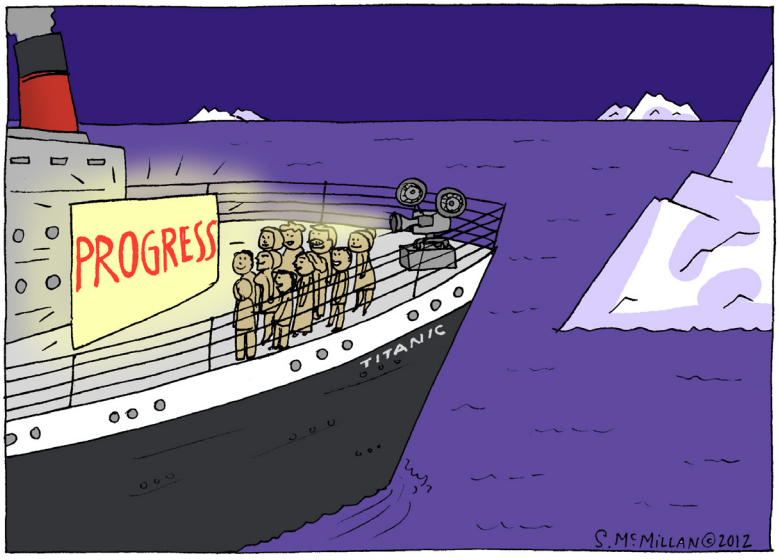
So why can't we just leave the carbon underground and use renewable energy? The problem is economics. Even though this carbon is still underground, the market value, $27 trillion, has already been integrated into the global capitalist system. Companies borrow money against it, nations are basing their budgets on it, and its value is figured into stock prices, under the assumption that it will eventually be burned. Within a capitalist framework, the economic consequences of *not* burning it are stark. Of the ten largest Fortune Global 500 companies, seven are oil companies and auto manufacturers. If they had to cut production even by half (let alone 90% or more), they would go bankrupt and there would be a global economic depression with mass unemployment [Smith1], [Smith3].

In its 2013 report, the Carbon Tracker Initiative found that the top 200 oil and gas and mining companies spent $674 billion in the preceding year for the purpose of finding and developing more fossil fuel reserves and new ways of extracting them [Carbon].

The entire global capitalist system critically depends on fossil fuels in virtually every sector: transportation, industry, construction, farming, and more. The enormous emission cuts required to preserve the biosphere, including ourselves, would require putting nearly everyone out of a job (a problem that does not have to exist in a sustainable post-capitalist society). And capitalism is not capable of providing alternative employment because it exists only to generate profits and serve private wealth, not the general welfare. State power is controlled by concentrations of private power, i.e., by capitalists. This is why governments have not responded to the climate crisis, and work in opposition to saving the biosphere.

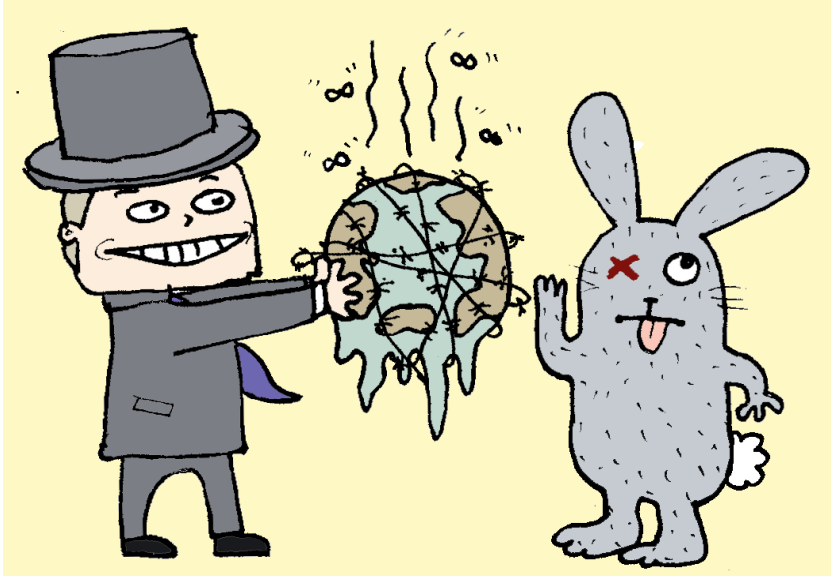
For example, according to the *New York Times,* "an examination of the American tax code indicates that oil production is among the most heavily subsidized businesses, with tax breaks available at virtually every stage of the exploration and extraction process." U.S. oil companies benefit from $4 billion annually in tax breaks [Kocieniewski]. According to the International Energy Agency, fossil-fuel subsidies worldwide in 2011 amounted to $523 billion, around six times the level of support to renewable energy [IEA]. Oil Change International and the Natural Resources Defense Council estimated global fossil fuel subsidies in 2012 to be $775 billion [Klein, p 1150].

Driven by capitalism's unyielding grow-or-die imperative, we have reached critical thresholds in carbon emissions, biodiversity loss, ocean acidification, freshwater depletion, and chemical pollution. The World Wildlife Fund reported in 2014 that "1.5 Earths would be required to



meet the demands humanity makes on nature each year. These demands include the renewable resources we consume for food, fuel and fibre, the land we build on, and the forests we need to absorb our carbon emissions. For more than 40 years, humanity's demand has exceeded the planet's biocapacity—the amount of biologically productive land and sea area that is available to regenerate these resources" [WWF].

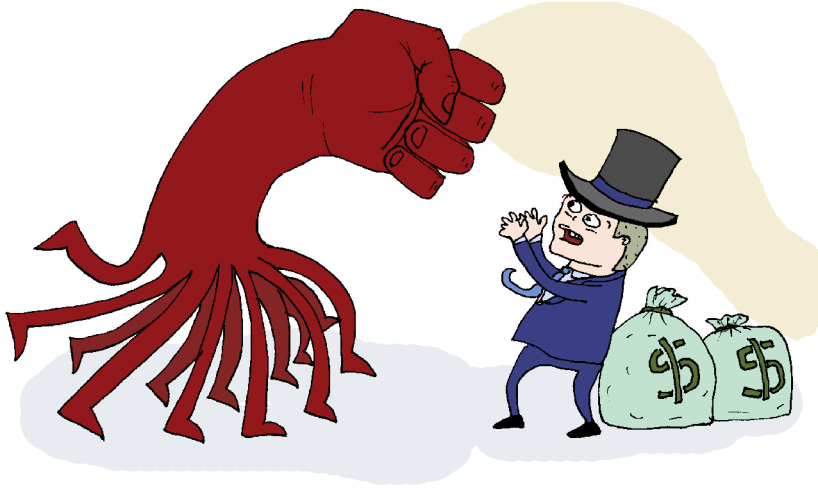
To save the planet, we must discard capitalism and develop a better alternative through democratic cooperation. Our survival depends on implementing a social system that meets our actual needs, is sustainable and respects nature.




If we make fuel out of this, it'll turn the entire world into dead goop within two weeks.
What's the projected profit margin?

13. How to Defeat Capitalism

Capitalism is destroying the very field on which it operates, the planet itself, by causing irreversible climate disruption, poisoning the environment, and depleting the world's natural resources. Left to its own internal logic, capitalism risks plunging the entire world into oblivion. Its natural course is to lock into place a chain of disasters leading to severe food and water shortages, mass extinctions in the natural world, hundreds of millions of climate refugees, and a massive (involuntary) depopulation of humanity. The world will be far better off if we can collectively interrupt this suicidal trajectory and abolish capitalism before it abolishes us.

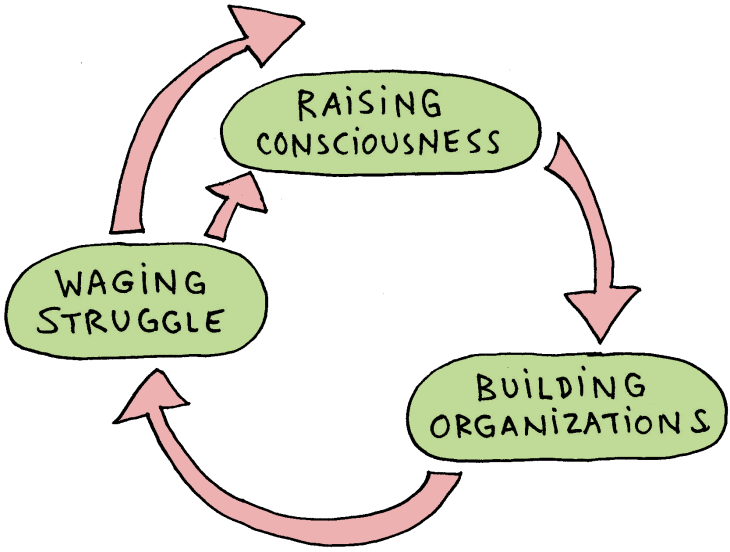


A first step for defeating capitalism is to understand it. At its core is surplus value, the difference between what a worker is paid and the value of her labor (see Chapter 8). Surplus value is the fount from which all other profits flow in capitalism. It may be thought of as capitalism's "on-off switch." Turn off surplus value, and capitalism cannot exist.

The working class is therefore uniquely situated to lead the struggle to abolish capitalism. This is because it is the working class that generates

the surplus value appropriated by capitalists, so only the working class can deprive capitalism of that surplus value. A unified working class is capable of organizing and carrying out national and international general strikes, as part of a revolutionary struggle to overturn capitalism and take over the means of production. Such actions, with the concomitant level of class unity, would be pivotal in the struggle to dismantle capitalism.

However, at the time of this writing, such a high degree of organized resistance does not yet exist. So, what can be done under current circumstances? A lot can be done! Grassroots anti-capitalist groups, even consisting of only a handful of people, can contribute to the struggle by meeting, discussing, taking action, and expanding. And thereafter repeating but escalating that sequence. Three steps for organizing may be helpful [McMillan]:



1. Affirmation. Raising consciousness.

This step, affirmation, is about finding allies and educating others. Even if you're alone, you can start. Methods include:

- Leafleting at events or in neighborhoods
- Online discussions
- Hosting open activities, such as lectures or film showings
- Attending events and talking to people

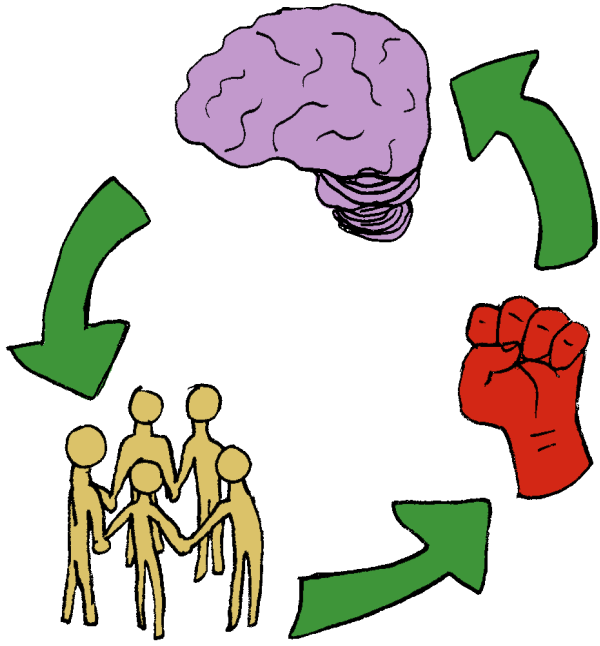
If you encounter someone who agrees with you or expresses similar perspectives, then you can ask that person for a one-on-one conversation to determine the extent of your unity and how you might be able to work together.

The follow-up is to see if that person is willing to start a group with you. The level of activity would be based on what you can agree on. It might take a few long meetings to define and determine what that is; this is to be expected. These interactions also provide an opportunity to teach each other about capitalism, its injustices, and why it is the fundamental barrier to survival. This process can then be iterated to draw in more members.

2. Building organizations.

We need to construct self-replicating, autonomous yet interconnected organizations. These ought to be structured with the capacity to deal with current conditions, and as much as possible function like the society we are aiming for. That includes fostering mutual respect and democratic behavior, and avoiding top-down bureaucratic dictums.

Changing society can only be done collectively, so building alliances is essential. Within these strategic alliances, we must be mutually supportive and set aside secondary conflicts and contradictions. We have to



maintain principled (non-opportunist) unity, and look past nonessential disagreements.

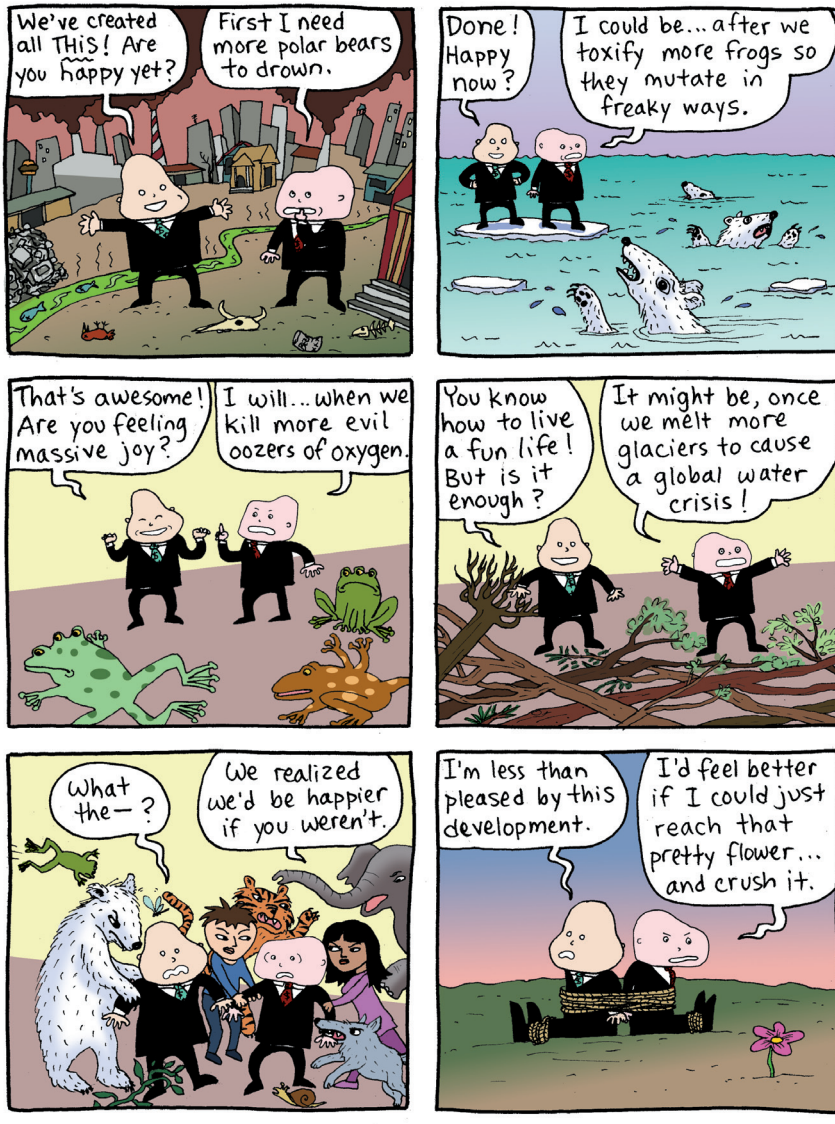
3. Waging struggle.

It is vital to build our collective capacity to act through struggle, starting small and initially taking on what we can potentially win. This helps to build stamina for the long road ahead before we reach a point where we can weaken and ultimately halt the production of capital.

Though each of these three steps flows into the next, they are not strictly sequential. They are best employed simultaneously, blending into and building upon one another in a mutually-reinforcing (dialectical) process.

It is important not to fall into the trap of reformism. The goal is not to reform capitalism in order to make it marginally more bearable, but rather to build opposition to it. A kinder, gentler form of capitalism is just the slow road to planetary suicide (as explained in all of the preceding chapters).

For example, a demonstration organized by a non profit organization to halt fossil fuel extraction at a particular site may take the form of appealing to corporations to be better "corporate citizens," or for elected representatives (whose campaigns are invariably funded by corporations) to increase regulations. That's reformism. But participating in such a demonstration while distributing flyers and holding placards that identify capitalism as the culprit advances the struggle in a non reformist way. In the context of struggling for reforms, we must make clear that these are not sufficient goals in themselves, but must be seen as steps in building a broad mass movement to struggle for qualitative change.


We've created all THIS! Are you happy yet?
First I need more polar bears to drown.
Done! Happy now?
I could be... after we toxify more frogs so they mutate in freaky ways.
That's awesome! Are you feeling massive joy?
I will... when we kill more evil oozers of oxygen.
You know how to live a fun life! But is it enough?
It might be, once we melt more glaciers to cause a global water crisis!
What the—?
We realized we'd be happier if you weren't.
I'm less than pleased by this development.
I'd feel better if I could just reach that pretty flower... and crush it.

Until a revolutionary situation ripens, we need to focus our energies on preparing for it. It is not enough simply to overthrow a regime. Think of the so-called "Egyptian Revolution" and the broader "Arab Spring" which resulted in replacing one set of generals protecting imperialism and capitalism with another set doing the same. In the aftermath of a social upheaval, it is vital that a progressive anti-capitalist agenda already be broadly promoted, and for the organized working class to be autonomously present, leading that struggle.

Then when uprisings fill the streets and events spiral out of control, people will know what side they are on and what must be done, and most crucially, we will have the ability to implement a just society that is consonant with nature. The consequences of not being prepared are dire. The people may rise up spontaneously, but if we are not prepared ideologically and organizationally, we will be defeated or co-opted, and nothing will substantially change.

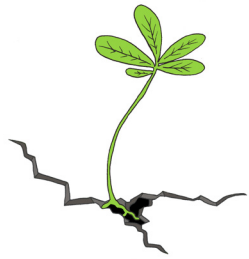
Much more can and should be said about the nature of capitalism, its class structure, and how to organize against it. A valuable resource for that purpose is *Capitalism Must Die!* [McMillan].

14. AFTER CAPITALISM, THEN WHAT?

The necessity to abolish capitalism raises the question: what should replace it?

Given the destructive and anti-democratic nature inherent in the class structure of capitalism, the elimination of class stands out as a natural democratic goal. Beyond that, if the planet is to avoid ecological collapse and restrain global warming to less than 2°C, then there must be general constraints on any future post-capitalist society. These broad constraints are discussed in the following section. But beyond these generalities, not much can be planned for the future, for two basic reasons.

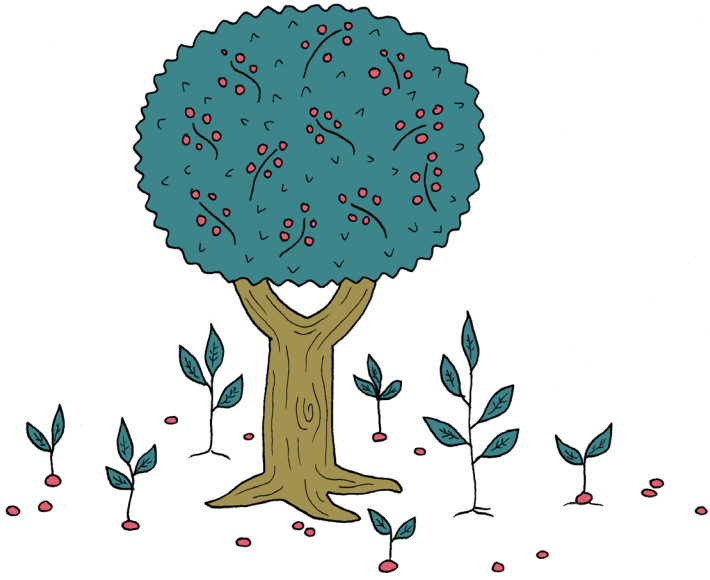
First, it would be anti-democratic. Those involved in the struggle against capitalism today are relatively few in number, and many more will join as opposition increases. If the roadmap to the future were already planned out before they arrived, then newcomers would be relegated to the status of followers and foot soldiers for a small revolutionary elite. So, if genuine democratic practices are to lie in our future, capitalism's successor must



be constructed collectively as events unfold, with full participation. That includes organizational planning, decision-making, and implementation.

The degree to which revolutionary movements incorporate democratic versus bureaucratic practices now will determine their future structures and values. It makes no sense for a handful of people to dictate plans to others today, and then hope for them to lead tomorrow. So if we're fighting for a collective society, a breakdown of classes, this must be reflected in our current practices.

Second, it is impossible to predict the future. We can extrapolate possible or even likely general trajectories, but the world is too complex to know what will happen in any detail.



It may be tempting to plan the perfect future society, where everyone lives happily and no one is allowed to suffer. Such blue prints appear throughout history, and they include actual experiments in small-scale communal living. Today, too, one can find elaborate schemes on paper: models of new economic and political structures, descriptions of improved administrative and legal apparatuses, plans contingent on the continued existence or future development of specific technologies. But in the end these utopian fantasies have little chance of reification.

Contemporary and past experiments in collective living are interesting, and there are lessons to be learned from them. We can also learn much from full-scale revolutions that have occurred, including the successes and failures of previous socialist and collective societies. But none of these can give us specific directions to follow; they were of their own time and place.

A new society is not an independent abstraction about the future; it will be the result of sequential transformations that unfold based on the way we organize ourselves and respond to the conditions we face.

General constraints on any future sustainable society

To understand the environmental constraints on any future post-capitalist society, consider our present circumstances and the drastic changes that are required to keep global warming below 2°C. As described in Chapter 6, the consequences of not achieving this are dire, and restraining global warming to this level, according to the IPCC, requires that greenhouse gas emissions decrease to zero before the end of the century.

There is no way to accomplish this in a capitalist economy. Even if we shut down every coal, oil and gas powered electricity generating plant

on the planet tomorrow, and replaced them with solar, wind and other renewably generated electricity, that would reduce global greenhouse emissions only by some 25% (see Table 4). In order to cut emissions by 90 to 100 percent, we will have to drastically suppress emissions across the entire global economy.

That means radically decreasing or closing down large numbers of power plants, mines, factories, mills, processing and other industries from the United States to China to Europe and everywhere. It means drastically cutting back or closing down not only fossil fuel companies, but the industries that depend on them, including automobile, aircraft, airline, shipping, petrochemical, manufacturing, construction, agribusiness, refrigeration and air conditioning industries [Smith4].

To block the ongoing depletion of the planet's remaining resources, we will also have to cut back or completely close down mines, lumber companies, pulp and paper and wood product companies, industrial fishing operations, factory farming, junk food production, private water companies, packaging, and disposable products of all sorts. And to put an end to the massive scale of toxic dumping and poisoning of fresh water, oceans, soil, and air we will have to shut down or drastically reduce production of the world's toxic chemicals, pesticides, herbicides, plastics, and completely change mineral extraction and farming methods [Smith4].

The loss of jobs from the de-industrialization required to save the environment would not be just a few coal mining and oil drilling jobs, but most jobs in the industrialized and industrializing world. Mainstream environmentalists argue that jobs versus the environment is a myth, but they are wrong. Within a capitalist framework that is exactly the choice. What we would need to do within the framework of capitalism in order to save the biosphere, including ourselves, means economic collapse

and mass unemployment. But the only way to save the planet is to stop commodifying it [Smith4]. This is an iron-clad constraint on any future society.

The scale of change needed to achieve a sustainable civilization is staggering. And unless we can collectively come up with an alternative economic system that will guarantee employment and meaningful lives for the workers in the industries around the world that will have to be shut down or scaled back, how could they ever be convinced to fight for the radical changes they and we all need to save ourselves?

People need something not only to fight against, but also a goal to fight for. This highlights another constraint. While we need to abolish all kinds of useless, wasteful, and polluting industries, we cannot contract the entire economy. We need to expand some industries, including renewable energy, public health care, public transit, long lasting energy efficient housing, durable mass transportation vehicles, long lasting appliances and electronics, repair shops, public schools, public services of all kinds, environmental remediation, reforestation, and organic farming.

The only way to rationally reorganize the economy in a sustainable way is to collectively and democratically plan most of the world's industrial economies. To do this, we will have to socialize virtually all large-scale industry. However, this does not mean we must nationalize small-scale owner-operated businesses, local crafts, mom-and-pop restaurants, worker cooperatives, or small garden farms, though regulations might be necessary. Such questions can only be resolved through democratic processes of a post-revolutionary future.

Regional differences

The people living in the most impoverished regions of the world are far from over consuming the planet, and the greenhouse gas emissions they generate are primarily for the production of commodities distributed in the capitalist centers, especially the U.S. Those regions, including much of Africa and Latin America, often lack electrical service, transportation, schools, health care, housing, and the most basic social services. This is the legacy of colonialism, imperialism and more fundamentally, capitalism. These regions of the world are in need of development, but not capitalist development. As in the case of China, that would only wreck the planet

faster. Global sustainability and basic principles of justice call for selective de-industrialization, especially in the dominant capitalist centers, combined with sustainable industrialization focused most intensively in the parts of the world that have born the brunt of imperialism.

As challenging as these revolutionary changes will be, they are not impossible. As Richard Smith observed [Smith4],

> Most of the worst environmentally destructive industries in the United States are businesses that have been built or massively expanded since World War II. Most of China's resource-wasting and polluting industries and coal-fired power plants have all been built in the last 20 to 30 years. Why can't these be dismantled or repurposed, if we need to do so to save the humans?

CONCLUSION AND CALL TO ACTION

The content of this book may be summarized with two theses:

> 1) The climate crisis is the greatest threat humanity has ever faced. It has the potential to cause the destruction of civilization, mass extinctions, and in the worst case scenarios, the end of our species.
>
> 2) Capitalism, by its very nature, must expand and it has reached the finite limits of the planet. It is not only incapable of responding adequately to this crisis, capitalism is the very cause of the crisis and can only make matters worse.

Recognition that capitalism is the fundamental cause of the climate crisis is gaining increasing acceptance worldwide. A head of state acknowledged it during the United Nations Climate Summit held in Lima, Peru in December 2014. In an interview with Amy Goodman for *Democracy Now!*, President Evo Morales said (in translation) [Morales],

> Sometimes in this type of event, official event, where governments are represented, the deep causes of global warming are not dealt with. We only remain at the effects of global warming. And we are convinced, as the plurinational state of Bolivia that represents the different social movements of Bolivia, that **the origin of global warming lies in capitalism. If we could end capitalism—and this is something we should do at the global**

> **level—we would have a solution.** This is why it's so important to integrate our peoples. [bold added]

If you, the reader, agree, then *now* is the time to militate against capitalism, and struggle for a sustainable and just future for our planet!

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About the author

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About the illustrator

Stephanie McMillan has been a political cartoonist since 1992. Her cartoons have earned several major awards, including the RFK Journalism Award, and the Sigma Delta Chi Award from the Society for Professional Journalists.

She has seven books, including most recently *The Minimum Security Chronicles: Resistance to Ecocide* (graphic novel, 2013, Seven Stories Press), *The Beginning of the American Fall* (comics journalism, 2012, Seven Stories Press). Stephanie has been involved in the struggle against capitalism since 1982.

Photograph by Sarah Cruz.

"Exciting, clear, and informative"

–Evan Randles, Cornell University Ph.D. candidate

"This book can be of great use as an introduction and in schools"

– Harry Hellenbrand, Provost, California State University, Northridge

The climate crisis is the greatest threat humanity has ever faced. Climate change threatens not only global civilization, but the very survival of our species and many others. The first part of this book gives a lucid explanation of the science of global warming and climate change. Drawing on a wide range of scientific findings, with specific references, Professor Klein presents stark scenarios for the future. Part 1 ends by explaining that technological solutions already exist, and the only barriers to implementation are political.

The second part of the book clarifies and illuminates the role of capitalism in creating and perpetuating the climate crisis and related dangers. Clear evidence and compelling arguments are presented to demonstrate the impossibility of adequately addressing the climate crisis within the framework of capitalism.

The exposition is interspersed throughout with the artwork of political cartoonist, Stephanie McMillan. Her cartoons clarify and condense the main ideas, and they add counterbalance and humor to the surrounding text. The book ends with a call to action together with guidelines to begin organizing for the overthrow of capitalism.