

If flying-saucer creatures or angels or whatever were to come here in a hundred years, say, and find us gone like the dinosaurs, what might be a good message for humanity to leave for them...?
WE PROBABLY COULD HAVE SAVED OURSELVES, BUT
WERE TOO DAMNED LAZY TO TRY VERY HARD . . .

—author Kurt Vonnegut

As the effects of global warming become more and more apparent, will we react by finally fashioning a global response? Or will we retreat into ever narrower and more destructive forms of self-interest? It may seem impossible to imagine that a technologically advanced society could choose, in essence, to destroy itself, but that is what we are now in the process of doing.

—science writer Elizabeth Kolbert

The only certainty is that we have to act. How could I look my grandchildren in the eye and say I knew about this and I did nothing?

—naturalist David Attenborough

The biggest challenge is how to get people to wake up and realize this is a one-shot deal. If we fail, we are witting participants in the biggest experiment that humans have ever done: moving CO₂ levels to more than twice their value in the past 670,000 years and hoping it turns out okay for generations to come.

—chemistry professor Nathan S. Lewis

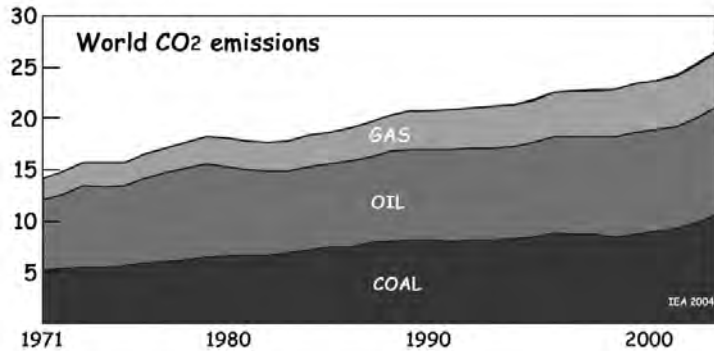
21

Get It Right on the First Try

As Samuel Johnson said in 1777, “When a man knows he is to be hanged in a fortnight, it concentrates his mind wonderfully.” So let me reframe our turnaround-by-2020 emergency by rearranging some of the prior points.

Our global fever has been spiking for the last thirty years, thanks to an accumulating blanket of CO₂ around the earth. Treatment proposals range from a low-carbon diet to elaborate umbrellas in space. Most will fail to do the job in time: too little, too late, or too local.

That’s because there is a big difference between a fever that peaks at about 2°C [3.6°F] above the 1990 global average and one that peaks at 3°C [5.4°F]. That additional fever has been recently recognized by climate researchers as the difference between an outcome that is bad and one that is terrible.



Holding it below 2°C requires, before 2020, stopping the annual escalation of emissions, recently at 3 percent each year (it was 1.1 percent in the 1990s but developing countries such as China and India have begun to burn a lot of coal and oil). If this annual increase in the burn rate doesn't go to zero and turn around until 2040, we get the 3°C fever.

That isn't *agree* to do something by 2020, it's *accomplish* it before 2020. This time frame rules out waiting for some equitable international agreement to be negotiated or relying on slow half-measures such as cap-and-trade to encourage the free market to reorganize the energy sector.

Unlike the downwind fallout of coal ash and acid rain, our CO₂ mixes with everyone else's within a year, then hangs around for centuries like a shroud. The less organized countries, by modernizing like we did, can easily cancel out our greenhouse efforts. And so we must provide them with inexpensive solutions, ones that keep them from burning their local coal (the worst and cheapest of the

fossil fuels) for electricity or cutting down their remaining forests to grow biofuels.

The time for gradual solutions and new inventions is largely past, thanks to our party-now-pay-later attitudes since scientists began warning us of the growing problem in 1956. As a consequence of our Faustian bargain, that 2°C fever will kill off not just the coral reefs and polar bears but (in my opinion) half of all plant and animal species. That's how bad our stewardship of the Earth has become.

Fortunately, we already have the technology in hand to head off the far more terrible consequences of a 3°C fever, a world full of refugees and genocides, Darfur writ large. No single treatment is both quick and global but there is one combination of existing technologies that might head things off at difficult before they advance to terrible. They're my suggestion for a "Turning Around by 2020" agenda.

First, we need to convert most vehicles to C-free energy. Plug-in hybrids will shift the transportation sector's energy needs from oil to whatever produces the local electricity. This need not mean batteries on board as the electrical power can be used to create some other intermediary fuel, hydrogen for fuel cells or compressed air for an air car.

This will get rid of much of the CO₂ from gasoline. Even if the electricity comes from coal, there's a gain because of size efficiencies and avoiding the waste of idling gasoline engines in traffic jams.

There is much talk of expanding solar, wind and biofuel energy sources for the long term. But we cannot count on such developments succeeding in the short run of 2020. While five times as many nuclear plants could replace most coal use in the U.S., solar and wind would need to increase more than a thousand times to do the job. For geothermal, the increase needed would be a hundred times—but it might be quicker than nuclear.

I cannot believe that the other renewables, or retrofiting thousands of coal plants to capture and store the CO₂, are capable of being ramped up fast enough for the 2020 time frame. The only well-developed clean power sources are geothermal, hydro, and nuclear—and high-rise hydro is pretty well maxed out.

Second, for the short run we need to build a great many Hot Rock geothermal power plants or clone a smaller number of nuclear plants. We're just getting started with Hot Rock Energy production and, even though all the parts and pieces are familiar, we cannot rely on the new combination yet in quite the same manner as we can for expanding nuclear. So let me discuss the traditional objections to nuclear in the light of twentieth-century experience.

Despite the levels of public concern, nuclear power has the best safety record, by a large margin, of any means of generating electricity—even hydro, as dams fail regularly somewhere in the world. Compare less than one fatality per year for nuclear to the monthly headlines of yet

another mining disaster. In China alone, 6,000 coal miners die each year. Longer-term risks from nuclear are also tiny compared to the cancer and asthma risk of living downwind of coal-fired plants—as does everyone in the eastern half of the U.S.

It takes about five years to actually construct a new nuclear plant, once permits are lined up. No new nuclear plants have been started in the U.S. since 1978 (nor have we reprocessed any of their spent fuel as France, Russia, and Japan do).

France has switched to nuclear for 78 percent of its electricity. Hydro gives it another 13 percent. So France is 91 percent clean, 9 percent dirty—and Texas is the exact opposite. Texans now get 91 percent of their electricity from fossil fuels, almost twice the national average.

If France switched its vehicles over to electrical power, it would serve as an even better C-free energy model for the world. Much as I admire Denmark's style of distributed cogeneration and the move to renewable wind and solar energy, there simply isn't time to scale that up around the world before 2020, given how many coal trains and oil tankers need to be retired quickly.

Too much of the present discussion is either pie-in-the-sky or envisages a slow evolution of urban architecture, commuting, energy, and civic virtue. We once had time for such planning. We can still explore on many fronts at once but for 2020 we need to be quickly building something foolproof. For the heavy lifting, that looks like Hot Rock geothermal or third-generation nuclear.

For speed, we now have to go with what we've got. We can still ramp up the others for the long run. Each time they add up to 1,000 megawatts, we can cancel an order for a nuclear plant.

Does substituting electricity for gasoline and ramping up nuclear and geothermal solve the world's 2020 problem? Alas, you can't simply give a nuclear power plant to a developing country where plant security and the rule of law are fragile things.

So the third thing we must do is quickly build networks of the low-loss DC transmission lines, where it takes 2,100 km to get a 10 percent line loss (a mere nothing compared to the 67 percent energy loss for generating the electricity from fossil fuels). They will allow continent-wide distances between power plant and consumer. Thus, DC will allow the developed countries on each continent to house the nuclear reactors and provide for both the electricity and transportation needs of the developing countries. The price would need to be subsidized to keep them from burning their coal or importing oil. If Hot Rock geothermal suits, we can start drilling deep wells for them.

Note that most of the candidate technologies are more than fifty years old. You can't say that we don't have the technology to solve the 2020 problem.

That's my three-part suggestion for how to achieve "Turning around by 2020." Clearly we'll also need C-fees to encourage replacing vehicles, forming car pools, and

remodeling buildings. We'll need some cap-and-trade to encourage innovation more broadly, though it has all the potential problems and delays of inventing a new international currency and auditing credits for performance. We dare not rely too much on a low-carbon diet or individual initiative. That's because diets often fail within several years of an initial "success."

To go further and actually lower the greenhouse fever, we will need to take much more CO₂ out of the air than we put in. That's necessary because CO₂ serves to acidify the surface layer of the ocean—which in turn will reduce photosynthesis, crash the food chain, and kill the carbon pump which makes limestone out of CO₂.

"Inevitable" is a much overused word. The only thing inevitable is that nearly all extinct species will remain gone forever. Success in lowering global fever won't reverse all of climate change but extreme weather and desertification ought to turn around with the temperature drop. And while we speak of the first degree of fever as the inevitable delayed consequences of past emissions, much of this could also be headed off if we were able to remove CO₂ from the air with a large scale enhancement of C sinks.

Even though China now emits more CO₂ annually, the U.S. has contributed more, over the years, to the insulating blanket around the Earth than any other country (30 percent). Yet the U.S. still resists even baby steps toward energy reform. The rest of the world sees the U.S. as the 500-pound gorilla. (The other gorillas won't go very far down a path until the big guy finally gets up and comes

along.) A colleague of mine came back from an international meeting of climate scientists having overheard someone say that, since he didn't live in the U.S., he felt impotent to deflect the world from the road to catastrophe.

I've emphasized a quick technofix because the window of opportunity is closing on us and we've only got one planet to lose. Time is short. And because of starting late, we must get this right on the first try or we may be trapped in a runaway.

That's where we lose existing sinks for CO₂ via closing the leaf pores, drought, fire, baking the soil, and ocean acidification. Some carbon sink regions turn into net sources, as when wood decay emits more CO₂ than the remaining trees can recapture. We already see that in the tropical rain forests during an El Niño. That pushes up the fever and further accelerates the decay in topsoils, which add more CO₂. This accelerates the temperature spike. Like the squeal of a public address system when the speakers are heard by the microphone, it just keeps building up, bringing most activities to a shrieking halt.

That's why planting more forests is not a very reliable way to sink CO₂.

I will leave the downside scenario to the producers of disaster movies. But should we find ourselves in the midst of a runaway climate change, there will still be much meaningful work to do, such as the organized kindness of

relief work. There will also be things to do for a future civilization.

Our civilization presumes that each generation has a responsibility to make the future better for the next. There is a possibility that our civilization will fail. Catastrophically. And so we would want to make sure that the downsized remnant of our society has a good Recovery Manual to guide the eventual restoration of civilization.

There's no point in them having to make the same mistakes as we did. Historians will outline how to make a transition from autocratic rule to democracy, how to keep peace between minority groups, how to keep a free flow of information and opinion, and how to recognize disinformation and fear campaigns.

The health care professionals will need to write do-it-yourself medicine books for a world with minimal medical supplies, as well as crafting recipes for bottom-up production of the major medicines and dental tools. Technologists will need to describe how to bootstrap energy production and manufacturing.

Since we cannot assume working technology to read CDs and the like, the operations manuals will need to be in durable book form. Cartoons on monuments will direct finders to mountain tops where they will find caches of books on decay-resistant media and directions to large libraries buried in dry caverns.

But we'll need insurance against book burners. Since salvaging scrap metal will be a major endeavor for survivors, perhaps we will photoengrave small-print chapters

of the Recovery Manual on every commonplace metal surface—airplanes, cars and trucks, the inside of beverage cans, and the skins of light rail cars. Someone will start reading the cans. Piecing together the jigsaw puzzle to get a full document will become a community effort.

If the recovery books turn out not to be needed because the technofix succeeds, the books will nonetheless prove useful for self-empowerment in developing countries. And, in my experience, the effort to boil down the material to fit a smaller space often results in making new discoveries about how things hang together. We might discover a few things from making this effort.

There is something to be said for starting such projects immediately. They should be done cheerfully, as in the claim that carrying an umbrella keeps it from raining. The recovery manuals would provide meaningful work for those who cannot participate more directly in climate restoration. Most importantly, the effort might bring home the seriousness of our situation to voters confused by the real choices.

We need to remember the lessons of behavioral economics as, alas, they all work against taking action on climate. It's possible to work around them, but only if you know they are there.

People “endow” their possessions and paychecks with inordinately high value, simply because they possess them. People feel the pain of a loss more acutely than the

joy of a gain—one reason why future gains are hard to balance with the loss of present-day spending money.

Status quo bias, the tendency to keep doing what you've always done, is often stronger than the rational arguments for changing course.

When dealing with an unfamiliar situation where it is difficult to discern the true costs, there is a tendency to seize upon any big number as a meaningful starting point. This provides an “anchor” for the discussion. To frame the discussion, be careful which anchor you choose.

People have a tendency, when faced with too many choices, to decide *not to decide*. Disinformation campaigns about climate science have been designed to promote decision paralysis and I hate to think of what new disinformation campaigns will be deployed by the highly profitable coal and oil interests when they contemplate their sales dropping by half.

Hopefully they will realize that they can maintain profits by doubling the price instead of sowing confusion. Still, we'll have to prevent them from again lowering prices for long enough to bankrupt the alternative fuels entrepreneurs. We can do that by establishing a base price where taxes kick in to make up for a lower price.

Now in conclusion, a few words addressed to the comfortably middle aged.

This isn't a problem that you can leave for the next generation to solve.

Your age and experience puts you, for better or worse, in the driver's seat for another decade or two. Unless you slow down this runaway coal train, it is going to smash us.

And, if you carry civilization through this difficult time, your generation will be known as the can-do generation of all time.

Finally, some perspective for the up-and-coming generation of students and young professionals. Remember that the leadership of the civil rights movement was young. They accomplished a great deal within fifteen years. Martin Luther King, Jr., was, at age 35, the youngest person to ever win the Nobel Peace Prize. Trashing the planet is a great moral issue and it needs great leadership.

Your generation gets to do the real makeover of our civilization. Many people will soon concede that real changes must be made, that we cannot stay trapped in business as usual.

Avoid being distracted by the doom-and-gloom types who see each hurricane as a sign that the apocalypse has come. You will also be competing with the gut-feeling, do-nothing happy talk that slides right past the problems—and the opportunities to intervene.

Others will hinder you more directly. There will be those who will want to increase the burn rate for resources on the grounds that *The End is Near* (James Watt, the U.S. Secretary of the Interior under President Ronald Reagan, had exactly such an attitude).

Even worse are the fans of Armageddon, some of whom will be a real danger (Aum Shinrikyo, in their 1995 sarin attacks in the Tokyo subways, was trying to promote a world war that would destroy everyone—except, of course, the faithful).

But no previous generation has ever had such an opportunity as you now have. As you tackle the longer-term issues of redesigning our civilization for resilience, you may be able to reconfigure education, governance, and the social contract. You will be laying the reinforced foundation for the next thousand years of our civilization.

Our present civilization is like a magnificent cathedral, back before flying buttresses were retrofitted to stabilize the walls. Civilization now needs such a retrofit. It will be a large undertaking, not unlike those that once went into building pyramids and cathedrals. I'm optimistic that the younger generation can create a better civilization during our major makeover—provided that those currently in the leadership can stop this runaway coal train, real fast.

Climate change is a challenge to the scientists but I suspect that the political leadership has the harder task, given how difficult it is to make people aware of what must be done and get them moving in time. It's going to be like herding stray cats, and the political leaders who can do it will be remembered as the same kind of geniuses who pulled off the American Revolution.

The public interest requires doing today those things that men of intelligence and goodwill would wish, five or ten years hence, had been done.

—Edmund Burke (Anglo-Irish statesman, 1729-1797)

We are now faced with the fact that tomorrow is today. We are confronted with the fierce urgency of *now*. In this unfolding conundrum of life and history there is such a thing as being too late. Procrastination is still the thief of time. Life often leaves us standing bare, naked and dejected with a lost opportunity.

The 'tide in the affairs of men' does not remain at the flood; it ebbs. We may cry out desperately for time to pause in her passage, but time is deaf to every plea and rushes on. Over the bleached bones and jumbled residue of numerous civilizations are written the pathetic words: 'Too late....'

—Martin Luther King, Jr., 1967

Eyes from the past. The big statues of Easter Island originally looked like this one. The eyes were often looted by raiding tribes. Archaeologists found this pair hidden nearby and restored the toppled top hat as well.

Most societies that collapsed in the past did not realize that they were slowly destroying their environment. As Jared Diamond describes in his book *Collapse*, a few pulled themselves back from the brink — but not the one on Easter Island.



GLOBAL How to Treat Climate Change FEVER

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Contents

1.	The Big Picture	3
2.	We're Not in Kansas Anymore	13
3.	Will This Overheated Frog Move?	21
4.	"Pop!" Goes the Climate	33
5.	Drought's Slippery Slope	41
6.	Why Deserts Expand	59
7.	From Creeps to Leaps	71
8.	What Makes a Cycle Vicious?	87
9.	That Pale Blue Sky	101
10.	Slip Locally, Crash Globally	111
11.	Come Hell and High Water	127
12.	Methane Is the Double Threat	151
13.	Sudden Shifts in Climate	163
14.	A Sea of CO ₂	173
15.	The Extended Forecast	189
16.	Doing Things Differently	205
17.	Cleaning Up Our Act	219
18.	The Climate Optimist	227
19.	Turning Around by 2020	239
20.	Arming for a Great War	273
21.	Get It Right on the First Try	279
	Read Widely	295
	List of Illustrations	301
	Notes	307
	Index	333