Getting the Fear

By Todd Neff

As I type these words, electrical pulses in a notebook computer somehow translate the mechanical thrusts of my fingertips into New Times Roman on a flat-screen monitor. The laser printer hums to my right, the dishwasher and washing machine rumble from different corners of the house. There are lamps, phone chargers, a garage refrigerator/freezer keeping unhealthy foods and bags of elderberries in a state of suspended animation. The furnace just kicked on, turning Rocky Mountain methane—four hydrogens mobbing a carbon, derived from photosynthesizers that haven't bagged a photon in fifty million years—into blue flames and parched, sustained gusts from grated holes in the floor.

Fifty gallons of water imprisoned in a cylindrical cauldron endure a scorching with every attempt to equilibrate with the cool sixty-four degrees of the basement utility room, such that, at a few moments notice, oatmeal might be rinsed posthaste from a pink plastic bowl.

When I accompany my daughters to their Montessori school, I bring along 5,600 pounds of fossil-fired Chrysler Town & County. When I return, I employ a device that uses a tiny propeller to atomize beans grown thousands of miles south of Denver, and another to heat water somewhere below the boiling point to strip vital stimulant from the carnage. And I think nothing of it, generally, any more than I spend time thinking about all those liters of blood flowing through my body, or about what my pancreas is up to at the moment, or that I'm breathing.

Energy is so fundamental, so abundant, so pervasive, it has no real meaning to us. Noticeable only when it disappears, it is classic infrastructure. But unlike a road, we have no sense of energy as a thing in itself—only its products: light, heat, work, motion.

I am breathing. And after a few years of having covered climate change for the Boulder *Daily Camera*, the effects of our collective energy, if rarely energy itself, does occasionally enter my mind. I know that when I inhale, my lungs take in 20 percent more carbon dioxide than when I took my first breath in 1968.[1] That's 20 percent more of the atmosphere's dominant greenhouse gas today than half a life span ago.

Without carbon dioxide, our planet would average a chilly three degrees rather than our current balmy fifty-nine degrees.[2] With much more of the carbon dioxide than we have today—38 percent higher than preindustrial levels and climbing—Earth changes its constitution in ways we can't completely know but which, it's widely agreed, will be unfortunate for civilization. Skeptics point out that the planet has been through a roller-coaster of carbon-dioxide fluctuations—and hence temperature ranges—in its ancient past. They're right. But the changes happened over millennia, giving biological systems time to adapt. We're thickening our greenhouse blanket by roughly half a percent a year, a rocket shot in geological terms. Our sustaining systems, particularly industrial agriculture, are finely tuned to our current global thermostat setting. We fiddle with it at our peril.

Perhaps because my feet are a mile up, but I worry less about sea-level rise than glacier disappearance in the Himalayas and the Andes, which could draw the Yangtze and Brahmaputra and the Rímac down to summer trickles, parching the world's most populous places and motivating desperate acts with global consequences. But water supply is just one of an overwhelming litany of climate-chance threats (heat waves, droughts, desertification, ocean acidification, more-intense storm systems, sea-level rise, extinctions….) upon which experts in the climate-science mecca of Boulder and elsewhere continue to elaborate. Staying abreast of the climate issue is an exercise in being alternatively sobered and terrified. We are almost certainly in worse shape than we think we are, and global carbon emissions are rising faster than the worst-case estimates of even just a few years ago.[3]

We have to do something about it. This is now a consensus among reasonable people. Doing something about it has mostly to do with energy. The Rocky Mountain West is central to any discussion of energy in America: We're home to Powder River basin and other mines supplying 54 percent of the nation's coal, wells producing about a quarter of our natural gas, some of the best solar and wind resources in the country, and the National Renewable Energy Laboratory (NREL) in Golden, the world's foremost green-energy research center.[4] We are a big part of the problem, and will be a big part of solutions to our fossil-fuel fix.

Despite a lot of impressive studies and good intentions (the Priuses, the hemp grocery sacks, the compact-fluorescent lightbulbs), we as Westerners remain as ignorant as America at large to the monumental scale of the challenges we face in transitioning, in any meaningful way, to a true New Energy Economy, as Colorado governor Bill Ritter calls it. By *meaningful*, I mean cutting carbon emissions at a ratio equivalent to those necessary to stop dangerous climate change.

Given a system as complex as the Earth's, nobody can be sure what that threshold is. Climate scientists such as National Aeronautics and Space Administration's (NASA) James Hansen have chosen a two-degree Celsius (3.6 F) average global warming. Scientist figure atmospheric carbon-dioxide concentrations of more than about four hundred fifty parts per million risks such heating. That's just 17 percent above where they are today.

Earth's carbon cycle does ultimately flush airborne carbon dioxide and sequester it through geologic processes, but carbon dioxide tends to hang in the air for centuries. Keeping the number below 450 parts per million means cutting carbon-dioxide emissions 60 percent to 80 percent by midcentury.

What would reducing 80 percent of my carbon output mean? I think about scarcely-roughed-up coffee beans producing lukewarm swill, two-hour workdays, a January thermostat set to forty-two degrees. About driving my preschoolers 25 percent of the way to school—to the convenience store at Eleventh Avenue and Yosemite, roughly, from which they'd walk, through rain, snow, and sleet, like little postal workers.

Consider the Energy Information Administration's (EIA) US forecasts through 2030, which, although conservative, reasonably represent the continuation of American life as we know it without the societal upheaval (which thin, lukewarm coffee would certainly precipitate) or some unanticipated technological or political development (a $30 per-ton carbon tax, say).

Carbon emissions will climb, the EIA predicts, a total of 7 percent by 2030, a modest amount considering anticipated gross domestic product growth of 76 percent by 2030.[5] Renewable energy looks promising, the EIA says, possibly providing 13 percent of our energy by 2030, more than a doubling of today's sum. The agency predicts solar exploding from a roughly 1 gigawatt total capacity in 2007 (the capacity, when the sun shines brightly, of a single nuclear plant) to 13 gigawatts in 2030, and wind from about 16 gigawatts to 44 gigawatts. Assuming these intermittent sources generate electricity 30 percent of the time, that's a savings of the equivalent of perhaps fifteen coal plants the size of Xcel's under-construction Comanche 3 plant outside of Pueblo.[6] Alas, the EIA expects the equivalent of another fifty-three Comanche 3–sized coal plants to be built in this country by 2030.[7]

The EIA is telling us, then, that anything remotely resembling status quo of energy use and delivery stands a good chance of triggering dangerous climate change, unless the rest of the world completely shuts off the lights. So let's look elsewhere—to the Alliance for Climate Protection's "Repower America" program. This is Al Gore's movement to generate 100 percent of America's electricity through renewable sources in ten years. Wind would provide 27 percent of all electrons (1.3 percent today), solar about 16 percent (0.1 percent today; the bulk of the envisioned additions would be in concentrating solar, which uses mirrors to boil liquids to generate steam to turn turbines), geothermal 3 percent (0.2 percent today)…and "negawatts"—energy efficiency—28 percent. There's more, but we can stop.

“It’s not feasible in any possible way I can see,” said Paul Komor, faculty director of the University of Colorado Energy Initiative and as sharp an energy expert as I’ve come across.

Wind is ready for prime time, Komor says, roughly cost-competitive with new coal or natural-gas plants. But the very places wind developers covet—those with driving, sustained winds—tend to be sparsely populated because they have driving, sustained winds. So you need transmission lines—perhaps twelve thousand miles of them—which cost about $1.5 million per mile.[8] That adds 15 percent to wind’s cost, Komor says. Transmission lines require land, and land decisions tend to be made locally—town boards, county commissions, city councils. So wind’s challenges are also political and bureaucratic. Still, Komor and NREL experts view the idea of 20 percent or more of US electricity coming from wind as entirely feasible—but probably in twenty years rather than ten.[9]

As for solar, solar-photovoltaic power from silicon panels costs about $0.25 per kilowatt hour, or roughly three times as much as wind. Solar only makes strict economic sense when massively subsidized, at least without carbon taxes, which beautify renewables by throwing (perhaps deserved) mud at fossil energy. Concentrating solar power is less expensive, costing just twice as much as wind, roughly, Komor says, but also requires transmission from large solar farms in brutally sunny places. Storing superhot liquids to stoke power generation after the sun goes down reduces variability of solar-power output, but it adds further to cost.

But let’s assume we get to 27 percent wind and 16 percent solar, and stretch the deadline to 2030. Forty-three percent of our electricity would come from the sun and the wind. Why not? In 1988, who could have imagined a technology as magically distracting as the iPhone? But even if every renewable kilowatt hour supplanted a pound of coal (and it won’t—the first to go will be natural-gas plants, which are marginally more expensive and emit 40 percent less carbon per unit energy), we’d only wipe out about a third of US carbon emissions. We’d be less than halfway home.

I could go on. Many, many groups have done studies discussing the potential of various forms of renewable energy.[10] I'm familiar with just one that took a serious shot at putting it all together. Chuck Kutcher, a group manager in NREL's Center for Buildings and Thermal Systems, was chairing the American Solar Energy Society's Solar Conference in 2006 in Denver. As part of the program, he asked colleagues from various realms of energy research to come up with their best estimates of how far their various technologies might reduce carbon emissions by 2030—concentrating solar power, photovoltaics, wind power, biomass, biofuels, geothermal energy, plus building efficiency and plug-in hybrid vehicles. It ended up in a book, printed with soy-based ink on recycled paper, called *Tackling Climate Change in the US*.[11] In the foreword, NASA scientist Hansen wrote: "If we are to keep global temperatures from exceeding the warmest periods in the past million years—so we can avoid creating 'a different planet'—we will need to keep atmospheric CO_2 to a level of about 450 parts per million."

Striking in this paper is the role of energy efficiency—fully 57 percent of carbon reductions would come from squeezing more light, heat, and work from less energy. The report discusses improving the efficiency of heating, cooling, lighting, and appliances; using passive solar heat and natural daylight; making more-efficient building shells, lighter vehicles and aircraft; and employing more-efficient industrial motors, heat recovery, and cogeneration in industrial settings.[12]

Sure, but 57 percent? I look around my house and see squiggly lightbulbs everywhere already. I could unplug the garage fridge, air-dry clothes, set the thermostat to "uncomfortable," install a condensing furnace and a tankless hot-water heater. The real problem is the building envelope—the house is thin-walled—two-by-fours rather than the four-by-sixes better builders use (and Denver code now mandates). I can't send my house over to the gym to bulk up, and stapling Styrofoam to the exterior would get me in trouble with the homeowner's association. Lowering my personal carbon footprint 80 percent would mean serious sacrifice. Every keystroke contributes to the problem. Yet I type on.

When Franklin D. Roosevelt issued the "the only thing we have to fear…" sound bite in his first inaugural address in March 1933, hunger ran rampant amid 25 percent unemployment rates. Adolph Hitler had just celebrated his appointment as German chancellor by incinerating the Reichstag. The postwar global order was collapsing. A paralyzing fear shrouded the country.

Now, we have no fear. Not because we are courageous, but because we are complacent. Rather than fear, we worry, a form of fear too faint to motivate, as counterproductive as catatonic terror.

I wrote a book about a space mission. A young aerospace engineer mentioned to me that, at some point late in the mission, everybody just *got the fear*. The fear that if they didn't work insane hours and sacrifice their personal lives, their spacecraft would stumble and a $300 million effort would implode in their hands. Manhattan Project scientists and engineers had the fear too—that Germany would develop The Bomb first. Apollo's creators, beyond the fear of technical failure haunting all engineers, feared the Soviets would beat them to the moon. The legendary Iowa wrestler Dan Gable trained harder than anyone else because he had the fear his opponents were working even harder. Show me greatness, and I'll show you fear.

What does this have to do with climate and energy? We as Westerners, as Americans, must achieve greatness in the coming years, leading a mass transition to energy systems based on lower rather than higher-density inputs (civilization has always climbed the energy-density ladder, from wood to coal to oil and gas to nuclear), a feat unprecedented in human history. We will have to adjust in many ways, from practicing conservation to the point it feels like rationing to paying far higher prices for everything involving energy, which is everything. A new energy infrastructure will cost trillions of dollars.[13] Adding to our burden is generational injustice: We must atone not only for our own energy irresponsibility, but for the unwitting combustive transgressions of centuries of forebears burning lumps of coal, lighting kerosene lamps, driving big, stupid cars with tailfins. We have every reason to fear the consequences of our profligacy, of our continued disregard for the planet's carrying capacity.

Yet there is no mustached villain to galvanize our collective will to act—just a colorless, odorless gas and a lot of dour trends and dire predictions. A nation distracted by professional sports and popular culture when not working (or, increasingly, job hunting) has little chance of getting the fear. Absent fear, there will be no mobilization and no meaningful action to stem the risk of dangerous climate change.

"If we're really going to reduce carbon emissions by 80 percent, we're going to have to get new technologies online, because it's going to be a lot easier than getting so many people to change their behavior," Lisa Dilling, a professor at the University of Colorado's Center for Science and Technology Research, told me. "People aren't going to voluntarily decide to use less energy and change their lifestyles. It's going to be more a kicking and screaming type of thing."

Without deep carbon cuts by the masses—directly or through taxes or fees to bankroll decarbonization—we are betting civilization on the emergence of magical new renewable-energy technologies.

Perhaps it's a good wager. Ray Kurzweil, the inventor and futurist (among other innovations, Kurzweil invented with the synthesizer, thereby enabling futuristic music), believes technology is advancing according to a Law of Accelerating Returns, sort of a Moore's Law for Everything.[14] In the late 1980s, Kurzweil foretold the explosive growth of the Internet in the 1990s and that, by 1998, a computer would defeat the human chess champion. IBM's Deep Blue defeated Garry Kasparov in 1997.[15]

In 2008, Kurzweil predicted that, within five years, breakthroughs in nanotechnology would render electricity from solar panels as cheap as fossil energy, and that in twenty years all our energy will be carbon neutral. I still have the fear, but I now harbor just a hint of blind hope.

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Notes

1. ftp://ftp.cmdl.noaa.gov/ccg/co2/trends/co2_annmean_mlo.txt.

2. Jeffrey Bennett, Megan Donahue, Nicholas Schneider, and Mark Voit, *The Cosmic Perspective, Fourth Edition* (San Francisco: Addison-Wesley, 2007), 295.

3. Michael R. Raupach, Gregg Marland, Philippe Ciais, Corinne Le Quéré, Josep G. Canadell, Gernot Klepper, and Christopher B. Field, "Global and regional drivers of accelerating CO2 emissions," *Proceedings of the National Academy of Sciences* 104 (24): 10288-93, www.pnas.org/content/104/24/10288.full.pdf+html. The current baseline for such information, spanning some 2,700 pages, is the Intergovernmental Panel on Climate Change's 2007 Fourth Assessment Report, available at www.ipcc.ch. The Daily Climate (www.dailyclimate.org) provides an excellent daily e-mail summary of the world's top climate-related stories. The Pew Center on Global Climate Change (www.pewclimate.org) and the Union of Concerned Scientists (www.ucsusa.org/global_warming/) are also good references. The National Oceanic and Atmospheric Administration's Global Monitoring Division has the latest on global carbon-dioxide levels (http://www.esrl.noaa.gov/gmd/ccgg/).

4. www.eia.doe.gov/oiaf/aeo/pdf/appa.pdf, p. 30 (coal); http://tonto.eia.doe.gov/dnav/ng/ng_prod_sum_dcu_NUS_m.htm (natural gas, including New Mexico, Colorado, Wyoming, and Utah).

5. www.eia.doe.gov/oiaf/aeo/pdf/appa.pdf, pp. 36, 39.

6. Ibid, p. 33; Comanche 3 will be 750 megawatts.

7. Ibid, p. 20.

8. www1.eere.energy.gov/windandhydro/pdfs/41869.pdf, p. 114.

9. www1.eere.energy.gov/windandhydro/pdfs/41869.pdf. Note that "just" 20 percent wind would amount to an additional 305 gigawatts both onshore and offshore. It would involve adding 16 gigawatts of new capacity (10,700 standard 1.5 megawatt turbines, roughly equal to the total installed US wind capacity today) *each year* after 2018. Wind farms would cover 19,300 land acres, more than five times the area of Yellowstone National Park.

10. The American Council on Renewable Energy's "The Outlook on Renewable Energy" (January 2007) discuses many such efforts, www.acore.org/files/RECAP/docs/OutlookonRenewableEnergy2007.pdf.

11. Available online at http://ases.org/images/stories/file/ASES/climate_change.pdf.

12. http://ases.org/images/stories/file/ASES/climate_change.pdf, p. 47.

13. Britain's Stern Report estimated the costs of dealing with the disasters of unmitigated climate change to be from 5 percent to 20 percent of global annual gross domestic product each year; the Intergovernmental Panel on Climate Change's 2007 Fourth Annual Report estimated the cost at 5 percent annually by 2050. The Stern Report estimated the cost of maintaining carbon-dioxide levels below 450 parts per million to be 1 percent of gross domestic product

to 2100, or about $500 billion a year in today's dollars—roughly the size of the US defense budget. See Roger A. Pielke Jr., "An idealized assessment of the economics of air capture of carbon dioxide in mitigation policy," Environmental Science Policy 12 (2009): 216-225, p. 222 (available at http://sciencepolicy.colorado.edu/admin/publication_files/resource-2716-2009.03.pdf).

14. Moore's Law: the theory that semiconductor density (and thus processing power) doubles every eighteen months, which Intel cofounder Gordon Moore proposed in 1965 and which has held true.

15. www.nytimes.com/2008/06/03/science/03tier.html?n=Top/Reference/Times%20Topics/People/T/Tierney,%20John