MuseLetter

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This month's Museletter is a pair of rebuttals to economist-columnist Paul Krugman. Krugman recently hit out at Post Carbon Institute in his New York Times column over our stance on the end of growth. In these posts I hit back.

Paul Krugman's Errors and Omissions

In a New York Times op-ed published September 18 titled "Errors and Emissions," economist-columnist Paul Krugman took a swipe at my organization, Post Carbon Institute, lumping us together with the Koch brothers as purveyors of "climate despair." No, the Koch brothers are not in despair about the climate; apparently our shared error is that we say fighting climate change and growing the economy are incompatible. And, according to Krugman, a new report from the New Climate Economy Project (NCEP) and a working paper from the International Monetary Fund (IMF) show that the falling cost of renewable energy means this is happily not the case.

But in our view Krugman himself is guilty of five critical errors, and three equally serious omissions. First the errors:

1. He mistakes post-growth realism for anti-growth activism. While Krugman linked to my book *The End of Growth*, it seems he may not have actually read it. If he had he would understand that we are not advocating the deliberate termination of growth that could otherwise be easily sustained; rather, we see clear evidence that growth is ending of its own accord because our economy is hitting biophysical limits at a speed and scale that are outpacing humanity's ability to adapt. The most critical limit to economic growth is the availability of affordable fossil fuels, those extraordinary resources around which we've organized the entire global economy (and its hundreds of trillions of dollars' worth of infrastructure) over the last century. Economists do generally recognize this limit, but summarily dismiss it as a problem seamlessly fixable by the market.

2. He misrepresents his sources. According to our reading, the IMF working paper suggests that the *majority* of emissions cuts (above 10.8 percent reduction) will be at a net economic cost, even considering co-benefits. The NCEP report—commissioned by former heads of state, the CEOs of major banks and the head of the International Energy Agency—itself admitted that "On their own, these measures would not be sufficient to achieve the full range of emissions reductions likely to be needed by 2030 to prevent

dangerous climate change." In fact, the report's authors made clear "The question the project has sought to explore is not 'how can greenhouse gas emissions be reduced?'...but 'how can economic decision-makers achieve their principal goals while also reducing their impact on the climate?'"

3. He assumes that wind and solar can substitute for all uses of fossil fuels. Oil fuels transportation, which is at the core of the trade-dependent global economy. It is far and away the world's largest single source of energy—and there just aren't any alternatives ready to replace oil in all the ways we use it, at the scale required, and in the time available. Electric cars are making inroads, but we're not about to see battery-powered airliners, bulldozers, container ships, tractors, or long-haul trucks. Compressed natural gas is no help from a climate perspective, and methane is another depleting fossil fuel. America's experiment with biofuels has been an expensive failure. How do we get more growth with less trade?

4. He claims it is easy to slash carbon emissions. The rapid build-out of renewables constitutes an enormous infrastructure project that will itself consume significant amounts of fossil-fuel energy. New solar panels won't immediately pay for themselves in energy terms; indeed, research at Stanford University recently showed that all solar PV technology installed until about 2010 was a net energy sink. It will fully "pay back the electrical energy required for its early growth by about 2020," but if we hasten the transition, energy break-even gets delayed: it is only once solar build-out rates level off that the system as a whole will start to turn a significant energy profit. That leads to the deep irony that we'll be powering the energy transition largely with fossil fuels. The faster we push the transition, the more fossil fuels we'll use for that purpose, and this could lead to the extraction of more tar sands, fracked tight oil and shale gas, deepwater oil, and Arctic oil (we've already used up the cheap, conventional oil; what's left will be expensive and dirty—and expensive oil is itself a drag on economic growth).

5. He assumes that a meaningful price on carbon would only impact direct energy prices. The entire economy is energy-dependent. One example: as minerals deplete, we have to use more energy (per unit of output) in mining and refining ever-lower grades of ores. When energy prices rise, that impacts all we do. Does Krugman believe that the global economy can continue to grow despite higher prices across the board?

Now Paul Krugman's omissions:

1. He omits mentioning what rate of greenhouse gas emissions reduction he thinks is necessary. Kevin Anderson of the Tyndall Centre for Climate Research, who has taken the important step of producing a carbon budget that puts society on a safe trajectory to the internationally agreed-upon limit of 2 degrees Celsius warming, calculates that industrialized nations need to reduce carbon dioxide emissions by over 10 percent per year starting now. In Anderson's opinion, this is "incompatible with economic growth." The only hope of maintaining economic growth while cutting emissions at such a pace is to rapidly decouple GDP from CO2; PriceWaterhouseCoopers says the decoupling would have to proceed

at 6 percent per year, which is entirely unprecedented. Is that rate achievable, in view of errors 3, 4, and 5 above?

2. He omits mention of constraints to fossil fuel supplies. Oil has become far more expensive in the past decade; production costs are rising at over 10 percent per year. The major petroleum companies are investing much more in exploration today, but their production rates are declining. For oil, the low-hanging fruit is gone. Does Krugman believe there is still excess production capacity for oil to use in building out renewable infrastructure, while still meeting the needs of the rest of the economy? If not, how will society maintain economic growth during the energy transition? If so, what part of the economy would need to contract in order to shift oil consumption to the renewables build-out, so as not to lead to increased overall use of climate-altering fossil fuels during the transition?

3. He omits mention of energy returned on energy invested, or EROEI. It takes energy to get energy, but historically fossil fuels delivered an immense profit on the meager investments of energy required to drill or mine for them. The EROEI figures for renewables are generally lower than current ones for fossil fuels. And energy returns for fossil fuels are declining as companies are forced to dig deeper and deploy more sophisticated (read: expensive) technology to get at lower-grade resources. The overall EROEI of society is falling, and the transition to renewables will not halt that process (though it will lead to an eventual leveling-off). If you think long and hard about what declining EROEI actually means for our civilization, it's difficult to imagine an outcome that could be characterized as economic growth—at least, growth as we've known it for the past century.

To be clear, we at Post Carbon Institute advocate massively deploying renewable energy and putting a price on carbon. If humanity has any hope for the future, there is simply no other option. But we just don't see how this can be achieved without: 1) raising the cost of energy and 2) leading to an increase in greenhouse gas emissions during the renewables build-out, unless other parts of the economy are allowed to contract. When it comes to energy, there is no free lunch.

Ultimately, climate change is not the only reason perpetual economic growth is incompatible with a finite planet. The world faces a suite of ecological problems related to water, soil, and biodiversity, all stemming from past growth, and all seemingly requiring reduction in human consumption levels for their solution.

We believe that humanity can enjoy an improved quality of life and build a more sustainable future even as we reduce overall resource throughput. There is ample waste to be cut in the excessively consumption-oriented western way of life, and there's still plenty of opportunity for less-wealthy countries to develop their economic and social systems in ways that are truly equitable and sustainable (and not fossil fuel-reliant). But that means changing priorities. Like fossil fuels, the growth fetish is something we must leave behind if we are going to have any chance of living sustainably on this planet.

Paul Krugman and the limits of hubris

Economist Paul Krugman evidently feels irked and irritated by the notion that there might be limits to economic expansion: he has followed up his New York Times op-ed of September 18 ("Errors and Emissions," to which I replied here) with a new piece titled "Slow Steaming and the Supposed Limits to Growth. It's interesting to examine his latest assertions and arguments one by one, as they reveal a great deal about how economists think, and why they tend to disregard physical science when it comes to questions about finite resources and the possibility of infinite economic growth on a small planet.

Mr. Krugman begins by noting: "We seem to be having a moment in which three groups with very different agendas—anti-environmentalist conservatives, anti-capitalist people on the left, and hard scientists who think they are smarter than economists—have formed an unholy alliance on behalf of the proposition that reducing greenhouse gas emissions is incompatible with growing real GDP." He omits mentioning a fourth group—ecological economists like Herman Daly, who take the position that, in the real world, the laws of physics and ecological limits trump economic theory. For Krugman, only mainstream economists are to be trusted; everybody else is prone to misconceptions. He seems perplexed why so many people are coming to the same mistaken conclusion from different directions. Could it be that they are all recognizing an unavoidable physical reality?

Next Mr. Krugman fires a volley at physicist Mark Buchanan's recent essay, Economists are blind to the limits of growth. Back in the 1970s, Krugman's mentor, Bill Nordhaus, led mainstream economists in denouncing the classic book Limits to Growth. Unfortunately for Krugman, Nordhaus's attack looks in retrospect like mere hand-waving: analysis of relevant data from the last 40 years shows that the most pessimistic scenario from the 1972 Limits to Growth study is tracking reality quite closely.

Mr. Buchanan's pithy piece zeros in on energy as the most important limit to endless economic expansion. But even though he carefully explains that we are getting more efficient at using energy (and balances that recognition with evidence that, despite this, economic growth implies using more energy overall), Mr. Krugman pretends that physicists have never heard of energy efficiency. He spends most of his op-ed explaining one instance (ocean-going freighters reducing their speed to use less fuel) as if this were proof of a new and pivotal principle that no hard scientist had previously noticed. Are there instances where we can use less energy while achieving the same effect? Of course! A better, though more shop-worn, example would be lighting: as a result of the introduction of compact fluorescent and LED lights, we've seen dramatic reductions in the amount of energy used to banish darkness from cities and homes.

But Mr. Krugman doesn't follow through on his argument. If he is implying that there are no limits to growth because energy use can be made more efficient, then logically he must also argue that energy efficiency can be improved endlessly—at least to the point at which no energy at all is needed in order to run the economy (I say "at

least," because presumably even then further growth would be needed in order to prove the non-existence of limits). But of course that's pure fantasy, as every physicist knows. **Energy is defined as the ability to do work, and the ability to do work is what generates GDP.** Energy efficiency can often be improved, but such improvements are subject to the law of diminishing returns: the first five percent of improvement is cheap, the next five percent costs more, and so on. Perfect efficiency in any process is either impossible to achieve, or infinitely expensive (depending on how you prefer to look at it).

My guess is that if and when Mr. Krugman honestly confronts the logical impossibility of infinite growth within a finite system, and the similar impossibility of infinite improvements in energy efficiency, he will retreat to saying something along the lines of, "Yes, but even if there are theoretical limits to growth, we're very far from reaching them, so they're practically irrelevant for the time being." However, once one acknowledges that there are indeed theoretical limits to expansion, one must then ask, "What would be the likely signs that we are approaching those limits?"

I'll suggest some: overall rising energy costs (indeed, energy production consumes a larger proportion of global GDP today than it did a decade ago); falling yields of minerals per unit of energy applied to mining and smelting (this is now true almost across the board, from antimony to zinc); rising environmental costs and risks from industrial processes (see "climate change").

Mr. Krugman writes: "So where does the notion that energy is somehow special come from? Mainly, I'd say, from not thinking about concrete examples . . . because if you think about actual economic activities even briefly, it becomes obvious that there are tradeoffs that could let you produce more while using less energy." Again, that's a statement no one would argue with. But Krugman's own example of energy efficiency highlights the fact that there are often hidden costs to efficiency efforts. He writes that "After 2008, when oil prices rose sharply, shipping companies . . . responded by reducing the speed of their ships. It turns out that steaming more slowly reduces fuel consumption more than proportionately to the reduction in speed." But moving ships slower meant deploying more ships to in order move the same amount of freight—thus substituting capital and labor for energy. This strategy didn't require the development of new technology; the shippers were "just using the same ships differently."

In the comments to Mr. Krugman's op-ed on the *New York Times* website, Ken White (one of my colleagues at Post Carbon Institute) points out that all those extra ships represent plenty of embodied energy, which was expended in extracting and refining ores and in other aspects of ship construction. When we look at many (not all) efficiency gains this way—that is, from a systems perspective—much of the advantage tends to disappear. Does the added cost of embodied energy in this case equal the energy of the fuel saved? I don't have the data and haven't done the calculations, but even if there are some net savings they are probably much smaller than Krugman assumes. You can substitute capital and labor for energy in some instances and up to a point, but there is literally nothing that anyone can do without some expenditure of energy. Substitution

itself is subject to limits.

Mr. Krugman clearly implies that it is only mainstream economists who think about concrete examples like the one just discussed; in contrast, hard scientists deal just in airy abstractions. For physical scientists, this must be surprising news, as most of them deal with concrete examples on a daily basis.

Here are some concrete examples:

- Nearly half of Earth's wild animals have disappeared in the last 40 years as a result of the expansion of human activities.
- The costs of oil extraction are rising at over 10 percent per year due to the depletion of conventional oilfields that yielded economy-boosting cheap energy throughout the 20th century.
- The world loses over 25 billion tons of topsoil each year as a result of industrial agriculture, and at this rate many countries will effectively face topsoil exhaustion before the end of the century.

Why is Mr. Krugman leading a crusade against the idea of environmental limits to economic growth? I believe there's a political agenda at work here, and that it's driven by laudable sentiments. I normally hesitate to guess at other people's motives, but in this instance they are rather plainly implied in Krugman's two opinion pieces cited above. He evidently is deeply concerned about climate change and wants to see humanity avert the worst likely impacts, but he believes that policy makers can never be persuaded to adopt climate protection policies if that requires reining in economic growth. He writes: "[T]here's a lot of room to reduce emissions without killing economic growth." Yes, there's room. According to a study Krugman himself cited in his previous op-ed, the first 10 percent of emissions cuts can be achieved without much pain. But beyond that, they're all at a net cost to the economy.

Like Paul Krugman, we at Post Carbon Institute are deeply concerned about climate change and want officials to adopt policies to avert it. It's true: if informed opinion leaders pretend that full climate protection can be achieved without any real cost, politicians are more likely to sign on to available no-cost policies. But they'll only be agreeing to weak pledges that will fail to achieve the levels of emissions cuts that are actually required. By misleading policy makers and the general public this way, we merely waste time and opportunity.

By acknowledging that climate change is a serious threat to humanity's future, Mr. Krugman is in effect acknowledging the existence of environmental limits to economic expansion. He would probably object that climate change is merely a limit to a fossil-fueled economy, and that a renewably-energized economy could happily expand forever. But once we open the limits box and peer inside, a long series of other critical boundaries quickly comes to light.

Let's get real. The Earth is a bounded sphere, and the human economy is an engine that extracts raw materials and produces waste. If we keep that engine's operation within the bounds of what our planet can absorb or replenish through its normal ecosystem

functions, all is well. But if the economy continues to grow year after year, at some point the planet's systems will be overwhelmed—even if we're using renewable energy to extract and transform raw materials. Our uses of energy and materials can be made somewhat more efficient, but only up to a point. If the Earth itself were expanding at an ever-increasing rate, perpetual economic growth would pose no problem. Yet last time I checked, the planet hadn't gotten any bigger—while our demands upon it continue to increase.

In his latest op-ed, Mr. Krugman derides "hard scientists who think they are smarter than economists." I can think of several snide responses to that characterization, but actually I don't think one is required. The phrase speaks volumes about economists' own hubris.