MuseLetter

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Dear subscriber,
This month has seen the start of a historic and tragic invasion. In this month's Museletter I've examined some of the Ukraine war's likely implications for energy, economy, and geopolitics. Meanwhile, in a second piece Museletter maintains its gaze on an even bigger picture--what we humans are doing to the planet and how we might best shift our policies even at this late date to preserve a livable climate. Best wishes to you, and peace to us all.
Richard

After the Ukraine Invasion: Sobering New Global Energy-Economic-Political Terrain

Russia's invasion of Ukraine, and the West's response, are ushering the world into a new energy, economic, and political era. In broad outline, this new era will have less-globally-integrated energy markets, and less-secure supplies of fossil fuels. Since energy is the irreducible basis of all economic activity, this translates to a precarious global economy and a likely reordering of national alliances. We are, in short, living through a moment that may be as politically and economically transformative as the World Wars of the 20th century, though with little likelihood of an outcome anywhere near as desirable as the boom decades of the 1920s or 1950s.

Energy
We begin with energy, since all else flows from it. The following would seem to be a small news item in comparison with other events and risks detailed further below, but it's emblematic of the new era we're entering.

Major oil companies, including ExxonMobil, Shell, and BP, have announced that they will cease collaborating with the Russian petroleum industry, which includes state-owned energy giants Lukoil and Gazprom. This will likely have implications more far-reaching and long-lasting than President Biden's ban on imports of Russian oil and gas to the US. Russian oil and gas resources and production are enormous (the country supplies over a tenth of the world's oil and 7 percent of the world's gas), but many of the country's oil and gas fields were initially developed decades ago and are no longer able to maintain former rates of flow. In 2021, the Russian Energy Ministry forecast that the nation was at peak petroleum production levels and would probably never exceed pre-Covid rates of output. For many years, Russian producers have depended on the expertise of giant foreign companies like

ExxonMobil to help manage depleting fields and keep production up for as long as possible. Production cooperation agreements required years of negotiation, along with the transfer of key personnel and billions of dollars' worth of infrastructure. With those agreements now in tatters, it is unlikely that Western oil companies will revive them, even if a relatively quick resolution to the Ukraine war ensues. Whether export embargoes continue or not, Russian oil production will begin to decline, and, unless the Russian oil industry quickly obtains investment and expertise from China and India, the declines may happen faster than almost anyone would have predicted.

This comes at a time when global oil production has remained below November 2018 levels for the past 27 months. Demand has been whipsawed by the pandemic, leaving companies wary to start new projects. At the same time, the industry is running out of places to drill. Oil discoveries have been declining for decades; discovery levels for 2021 were the lowest in 75 years.

Earlier this month oil prices spiked to $130 per barrel, with some commentators forecasting prices of $150 or even $200 by midsummer if the war drags on. But now prices are back down below $100 and inflation-wary economists are breathing a sigh of relief. I'm not so sure celebration is warranted. As Rystad Energy's senior oil market analyst Louise Dickson points out, the market has probably not fully factored in the potential impact of reduced Russian production and exports.

If oil prices resume their upward hike, the results could be severe. In the last 75 years, a recession resulted each time oil prices roughly doubled (as happened in 1972, 1979, 1990, 1999, and 2008). While the world uses oil more efficiently now than it did decades ago, it is still overwhelmingly dependent on petroleum for transportation and agriculture. The switch to electric cars is happening far too slowly to make much of a difference over the next couple of years. So, what are the options to maintain affordable oil prices and avert economic mayhem?

In the US, there have been calls to open the taps on domestic oil and gas production in order to ease prices. The assumption that US producers can simply open their spigots is understandable, given the industry's last few years of astounding success at coaxing millions of barrels per day from rock formations that geologists had long ago given up on. And it's true that tight (shale) oil wells can be brought online much more quickly than conventional wells. World conventional oil production had been on a plateau since 2005, a year that saw the height of "peak oil" awareness as measured by Google searches. Since then, salvation has come from unconventional oil, a category that includes Canada's oil sands and US tight oil (sometimes called "shale oil") produced by horizontal drilling and hydrofracturing. Between 2006 and 2019, the United States went from pumping about 5 million barrels of oil per day to over 12 million barrels—a rate of growth never before seen anywhere in the world. But now, after more than a dozen years, shale's shine is fading. Fracking producers have cut back on drilling because they got hammered by lower prices during the pandemic while having no discipline about curtailing production. Now investors are much more circumspect and demand returns on their investments, which they are now seeing due to high prices. But that isn't the full story. Most production and profit have come from small sweet spots within the larger geological formations that drillers have targeted. And those sweet spots have been drilled so full of vertical holes and lateral

extensions that there's hardly room for more. As Earth scientist David Hughes has documented in a series of detailed studies, only the Permian Basin in Texas still has growth potential. The Bakken region in North Dakota, an enormous source of petro-optimism just years ago, is already in terminal decline, as are most other tight oil plays. US production may increase slowly and only somewhat from its current levels, but only for a couple of years or so until the effects of depletion elsewhere overcome rising production in the Permian.

The US Strategic Petroleum Reserve holds only about a week's worth of world oil supply. Of course, there is zero likelihood that it would be emptied in such a short timeframe. This reserve is meant to help the nation and the world get through just a few weeks of supply difficulties. If drawn down by a couple of million barrels per day, it would be exhausted in a year.

There is talk of the US helping Venezuela increase its oil production as a way of offsetting any global loss of Russian crude. Venezuela boasts enormous reserves of extra-heavy oil. However, terrible relations with the US during the Chavez-Maduro years and poor management of the state-owned oil company PDVSA led to sharply declining production. Last week Washington sent a high-level delegation to Caracas, and President Maduro freed two American prisoners (one of them an oil executive). But Venezuela's oil, however plentiful, will be slow and expensive to access. Further, as with Canada's oil sands, there will be an enormous environmental price to pay. Adding to the complexity is the fact that Venezuela and Russia have been cozying up in recent years. Venezuela's oil ministry now says that the country might be able to hike production by 400,000 barrels per day, without offering a timeframe, if granted the licensed exemption from US sanctions. Or is this just an empty promise designed to help end the sanctions?

What about OPEC? Reportedly, the Saudis wouldn't even answer the phone when President Biden called to ask their country to supply more oil to world markets. Most of the Middle East's oilfields are half-depleted, so raising production by much now would damage reservoirs, reducing future capacity.

The world is feeling a hint of oil shortage where it hurts most: global diesel fuel supplies are at the lowest level since 2008. Diesel is essential to trucks, which move raw materials and finished products of all kinds. Without diesel, the machinery of civilization would seize up within days. Some US truck stops are already rationing fuel to customers.

Many environmentalists are promoting the notion that electric vehicles and solar panels can rescue the world from dependence on Russian oil and gas. But a renewables build-out would be glacial in pace, requiring massive new infrastructure. After the past 20 years of dramatic expansion in wind and solar, these two sources together currently supply the world with just 3.3 percent of its energy. And there are doubts about the sufficiency of raw materials for building panels, turbines, and batteries at a vast scale. As I have written elsewhere, the real energy transition will almost certainly not be a complete and seamless migration from fossil fuels to solar and wind, but rather a shift from using a lot of energy to using a lot less.

The build-out of nuclear power shares one challenge with renewables—i.e., the need for massive electrification of industry and transportation. But to this

it adds higher construction costs, the problem of uranium depletion, and added environmental and political risks (as we are seeing now with the Russian takeover of Ukrainian nuclear power stations).

Coal is not immune to contagion from the rising prices of oil and gas. Last week, spot coal prices in China reached nearly double the government-set price cap. While there were domestic reasons for the price spike, there is also an international dimension: with natural gas potentially in short supply because of the Ukraine war, prices for shipments of coal are wafting skyward. At the same time, many of China's coalmines are getting more expensive to operate due to depletion.

In short, the world is now grasping at straws in its efforts to maintain affordable energy flows. We are probably near the inflection point that analysts who track resource depletion have long warned about. Regardless of the strategy chosen, total energy usage will likely be unable to grow much, and may start to decline from here on. Rising energy prices will periodically destroy demand by shrinking the economy, thus lowering demand (and prices) temporarily until economies can partially recover; then prices will be bid upward once more. The cycle may continue to repeat itself, each time at a lower level of economic activity and energy usage—though there is an outside chance that we will see a huge blowout of the financial system that lowers demand dramatically, once-and-for-all. The only sensible way forward would be to cooperatively manage production and consumption through rationing in order to reduce shocks and adapt to new and continuously shifting economic conditions.

Economy

There is a lot to discuss in this section, so please forgive a bit of rambling.

Rising energy prices are inherently inflationary, since energy is needed for all economic activity. Inflation in the US is running at nearly 8 percent—the highest in 40 years—which has perilous political ramifications for the party in power. But, at the same time, the world has engineered an enormous debt bubble, which carries the potential for large-scale *deflation*. In an ideal world, inflationary and deflationary trends would balance each other out. But our real world is far from ideal. Ahead we face both turbulence and contraction.

Economic contraction is, of course, the one outcome that world leaders wish to avoid at all cost (though, at long last, the IPCC is starting to discuss degrowth in a possible climate scenario). In the absence of a shared recognition that the end of growth is inevitable, nations and alliances of nations will probably try to expand their own economies at the expense of other nations and groups. This means more geopolitical tension and instability.

Capitalism is, by its very nature, a form of low-level economic warfare: competition is the norm within and between capitalist societies—tempered by high degrees of cooperation *within* corporations and nations. Geopolitical alliances are nearly always based on shared economic interests, and armed conflicts are often preceded by trade disputes.

With the Ukraine invasion and the Western response, the world has shifted to a kind of high-intensity economic warfare not seen since World War II:

- Sanctions have cut off Russian banks from global financial institutions, making it harder for Russian families and businesses to take out loans and use credit cards.
- Russian oligarchs have been individually targeted, and in some cases their assets have been seized.
- Many Western companies have moved out of Russia, with the list including McDonald's, Starbucks, Apple, Goldman Sachs, and JPMorgan Chase.
- Some companies have stopped exporting components to Russia, making it harder for Russian companies to manufacture cellphones, cars, and other high-tech items.
- Trading on Moscow's stock market was halted two weeks ago; when it resumes, stock prices will almost certainly plunge catastrophically.
- Russia's currency, the ruble, has lost nearly half its value since the invasion, thus raising the price of anything imported. The poor in Russia are feeling the pain first and foremost.
- As a result of the above, Russia could default on debts within days. Since the government has borrowed little, a default is unlikely to tip over the world's financial dominoes immediately; however, this would be a disaster for Russia, and would further destabilize the global system.

Historically, sanctions have been at least partly successful about one-third of the time they have been used, according to Nicholas Mulder in an interview with *The Atlantic's* Annie Lowrey. Rarely have they been deployed as sweepingly; but, even in the most extreme cases, as with North Korea, the consequences can sometimes be endured by the sanctioned country for years or even decades. Mulder makes the point that clarity in the purposes and goals of sanctions is essential to success. The only articulated goal in the current instance is for Russia to withdraw from Ukraine, but that outcome seems extremely unlikely in the short term.

Nevertheless, there are already signs the sanctions are having an impact on popular feeling in Russia, and on the opinions that matter the most—those of the oligarchs who keep Vladimir Putin in power. Erica Frantz, an expert on dictators at Michigan State University, recently told journalist Max Fisher, "The indicators of elite discontent that we have seen thus far are unusual in Putin's Russia and should therefore be taken seriously." So far, the invasion is not going well from Moscow's perspective. Russian forces are bogged down and making little headway against stiff Ukrainian resistance. A long war would certainly not be to Putin's domestic political advantage, nor would it aid his country's international standing or economic prospects. But retreat would, just as certainly, lead to Putin's downfall.

The UN Food and Agriculture Organization (FAO) food price index rose last month to its highest level ever. Wheat prices are up partly because both Ukraine and Russia are major wheat exporters. A global supply gap "could push up international food and feed prices by 8% to 22% above their already elevated levels," according to an FAO representative. Ukraine and Russia together export more than a third of the world's grain products, and Russia is also a key exporter of fertilizers (made from natural gas), with much of Europe and Central Asia depending on the latter.

High grain prices have long been associated with political instability. The

Ukraine war could thereby help destabilize parts of the Middle East and Central Asia. Over the longer term, Europe, South Asia, and Africa might be vulnerable.

Western nations will feel various forms of blowback from their economic warfare, likely including delays along the global supply chain. Such problems will be far worse if China comes to Russia's aid (see below). The world has spent decades building complex supply chains. I doubt if these will be quickly replaced or restructured; and, relying as they do on localized sources of minerals, expertise, and cheap labor, some may not be repairable.

The one sure winner in the Ukraine invasion, as in all wars, is the armaments industry. It's too bad we can't eat tanks and shells, the manufacture of which will be soaking up more and more of the world's wealth.

Politics, Geopolitics, and Governance

After the Ukraine crisis, the world will likely be more polarized. As the US continues its decline as a global hegemon, it may more aggressively seek to maintain zones of influence—even as it continues to digest the fact that recent wars in Vietnam, Afghanistan, and Iraq proved disastrous.

The current crisis may harm China, because it derives most of its economic power from liberalization of trade. So far, the Chinese are avoiding criticizing Russia, but are also withholding military aid. Unsurprisingly, Chinese leaders are looking out for their own interests.

Russia and China have for years been trying to end US economic dominance by forging trade partnerships in a way that circumvents the global supremacy of the US dollar. Washington has perceived this as a serious long-term threat (which it is!). Now, with the West's open economic hostility against Russia, China could lose an important ally. A great deal depends on its response. If China were to come to Russia's aid militarily, the prospect for global war would increase significantly. So far, Chinese President Xi does not appear willing to risk everything because of Putin's folly. More likely, China will "help" Russia by replacing Western oil and gas giants in managing Russian energy industries, and doing roughly the same with Russian mineral producers (global nickel prices spiked after the invasion).

Without Chinese aid, it's unclear how long Russia's economy can teeter without severe domestic political consequences. Tens of thousands of Russians, many of them intellectuals and journalists, have fled to Istanbul. This exodus somewhat eases the domestic political pressure on Putin. And, as independent media are shut down, Russians become more detached from global information flows. But totalitarian perception management has a way of backfiring eventually. There is talk of a palace coup in Moscow, but it's unclear if this talk is just Western disinformation. If Putin were indeed toppled, a leadership vacuum might result, which could lead to even more geopolitical risk and uncertainty.

Sadly and ironically, all of this geopolitical destabilization is happening as democracy in the US is faltering, and as the nation faces a possible right-wing takeover. The Trump years showed just how fragile US political institutions can be when confronted by authoritarian populism. While Trump himself is unlikely to be elected to another term, his party is busy cementing minority

rule in place in half the nation's states, and perhaps in Washington as well.

Europe is experiencing a pivot just as drastic, though complicated by national borders. Germany, the continent's economic powerhouse, is rethinking its long-planned energy transition after halting Nord Stream 2, the new gas pipeline from Russia that would have provided Europe with fifty-five billion cubic meters of gas per year. Berlin is quickly rethinking its plans to ditch coal, even though that means reneging on climate goals. There are also hasty plans to build LNG import terminals to replace the gas Germany has been guying from Russia—as a source both of electricity and fertilizer. The terminals will take two years to build, and the LNG, much of it coming from the US, will cost much more than piped Russian gas. Berlin is also reversing its policy of maintaining only a vestigial military force. If the country follows through on plans just announced, it could become the world's third largest military spender, after the US and China.

The political shifts following from the Ukraine invasion come at a time when skillfully produced disinformation has become a serious challenge to democracies worldwide. In particular, Russian propaganda has increasingly infected both far right and anti-imperialist left news outlets in North America and Europe. But Russia is far from being the only source of fake news, and tools of disinformation are quickly becoming cheaper and more effective. Indeed, the manipulation of perception and opinion is reaching the point where it will soon become extremely difficult if not impossible to tell who did what when, and therefore who's right and who's wrong in any given instance. Whoever controls artificial intelligence (AI) will effectively control perceived reality.

At a social gathering in Berkeley, California, a few days ago I chanced to meet an AI researcher who demonstrated on his computer things I thought would not be possible for another decade or two, if ever. With a minute's worth of keystrokes he was able to produce entirely new text and images, made to order. The result could be a piece of visual artwork, an essay, a news story, or a faked photograph. This technology could put millions of information workers and visual artists out of work. And if this is what's possible in a living room in Berkeley with a laptop, imagine what can be done in Langley or Moscow with a supercomputer. It's safe to assume that reality is already being simulated in ways to which most of us currently give little thought. When it is no longer possible to tell truth from simulation, democracy becomes nearly untenable.

Climate and Environment

It seems perverse to treat the subject of climate change as a tag-on item in this overview of recent events, unmentioned in the essay's title. But, after all, that's reflective of the priority that climate is getting from policy makers and journalists these days.

Any loss of global trust and cooperation hobbles progress toward peacefully reducing human overshoot on planet Earth. We appear to be nearing a historical moment of "let's choose sides and fight" as opposed to "let's sit down together and figure out what to do." As I've written elsewhere, our best hope to avert climate catastrophe is a cooperative agreement to cap and ration fossil fuel production and consumption. Absent that, our future is most likely a mad scramble for what's left.

If I'm right in saying that the Ukraine invasion likely signals the end of global energy growth, then any decline in fossil fuel production would be accompanied by a corresponding decline in carbon emissions (disregarding, for a moment, possible tipping points associated with melting permafrost or methane hydrates). Perhaps that's a good thing. Meanwhile the people of Ukraine suffer; and world leaders, transfixed by geopolitics, seem even further away from collective recognition of what will be required to avert societal collapse.

The Best Climate Policy You've Probably Never Heard Of

Current strategies to combat climate change aren't working. Carbon emissions are still increasing. But there is a way forward that would actually reduce carbon emissions—a way that's simple and transparent and that would enable long-term planning for policy makers, as well as greater security for the general public. Spoiler alert: there's a hitch.

Before exploring this alternative pathway, let's take a brief look at three current strategies to halt global warming that, despite good intentions, are *not* working.

Solutions involving energy substitution aren't working. While the world is increasing the levels of solar and wind power in its overall energy mix, annual growth in total energy usage still exceeds these renewable additions except in years of severe economic recession. Solar and wind are just supplementing, not displacing fossil fuels. So, despite significant spending and policy effort, we're pumping more CO_2 into the atmosphere now than we were just a few years ago (probably just *not quite as much* more as we would if no substitution efforts had been undertaken).

Divestment isn't working. The idea is ingenious: if activists can starve the fossil fuel industry of capital by persuading institutional investors to stop buying shares in companies like ExxonMobil, and by talking banks into loaning no more money for extraction projects, then production rates for oil, coal, and natural gas should eventually fall. It's a worthy effort, but in spite of heartening successes at getting pension funds and university endowments to back away from investments in the oil, coal, and gas industries, those industries are finding plenty of money to fund projects.

Finally, taxing carbon isn't working. Nearly 50 countries have some form of price on carbon, either through carbon taxes or emissions trading schemes. Economists generally agree that carbon taxes should eventually work; but, so far, the taxes haven't been high enough, or enacted in enough places, to actually turn the tide. Also, a tax gives no guarantee of actual reduction in fossil fuel usage, since money can simply be created by government borrowing and spending to subsidize the higher cost to fuel purchasers.

Many would argue that these are the best available means for turning the tide against climate change, and that we just need to try harder. Perhaps incremental progress could be made by doubling down on building solar panels, waging divestment campaigns, and lobbying for stiffer carbon taxes. But why not consider a policy that could achieve something beyond incremental success?

Here's an altogether different approach, one that has received little attention from climate scientists, activists, or policymakers. The essence of the plan is simplicity itself: just directly reduce fossil fuel production and consumption. I mentioned at the outset that there's a hitch, and I'll get to that in a moment. But first, let's explore the idea in a little more detail.

Directly reducing global production of oil, coal, and natural gas might best be accomplished through a process with three concurrent elements.

First element: through international treaty, legally cap the total amount of coal, oil, and natural gas that can be produced globally each year. Then allocate (i.e., ration) production volumes to companies and countries proportionally, based on historic production rates using the last ten years' averaged production statistics. Each company or country would have the right to trade or sell any part of its annual production quota to any other company or country; thus, the fuel industry as a whole could adjust its investments to take advantage of higher-grade resources or more efficient production techniques. Production caps would decline annually, with the rate of decline set by a global Committee on Climate Change, whose deliberations would be based on scientific consensus, independent of government. Coal would be phased out fastest, then oil, then natural gas (in view of the relative carbon intensity of these fuels).

Second element: tax windfall profits of the fossil fuel industry globally. With production caps in place, prices for coal, oil, and gas would likely rise, with increasing profits (per unit of output) going to fuel industries. Tax those profits at a high rate, and distribute the revenue as rebates to people with low incomes who have no current alternative to fuel usage, and to crucial commercial energy users such as farmers, to help with higher energy bills; also use the revenue to fund energy-efficient and low-carbon alternative energy infrastructure, supplying it preferentially to countries, communities, and households with low incomes. Also use the money to help localities transition to lower-energy and more resilient ways of meeting people's basic needs for food, housing, and transportation.

Third element: don't just ration production; ration consumption as well—at the national level. This gets more complicated. Rather than diving into the weeds here, I'll briefly describe (at the end of this article) an already well-thought-out energy rationing system. Why ration consumption? Because doing so will make it much easier for individuals, businesses, and governments to adapt fairly to changing energy availability. Rationing has a long and mostly successful history in helping societies adapt in times of scarcity, and as a tool in alleviating poverty.

The details remain to be ironed out, and the general proposal I've just outlined could be modified in various ways. For example, production permits could be sold rather than allocated, with revenue distributed the same way as windfall profit taxes. What's important is the basic mechanism: cap and ration fossil fuel production, while also rationing consumption.

Why is cap-and-ration better than just calling for more funding of green infrastructure? Substitution strategies are based on the underlying assumption that reducing fossil fuel consumption will threaten economic growth, while

installing more low-carbon energy sources will support economic growth. But will we in fact be able to maintain economic growth by building more solar panels and wind turbines while cutting fossil fuels usage? That's controversial: many people (including some environmentalists) think renewables aren't up to the job. Others say renewables can power us to a new age of energy abundance. The approach described here does not take sides in that debate. The fact is, burning fossil fuels releases greenhouse gases that are triggering catastrophic climate change. Therefore, the important thing is to reduce fossil fuel extraction and combustion. If we can enjoy solar-and-wind-powered economic expansion at the same time, that would certainly make a lot of people happy. But if we can't, then we should remember that fossil fuels are finite and depleting anyway. We will have to make do with shrinking amounts of them at some point. Why not deliberately engineer the decline now, in time to avert climate catastrophe, and in a way that's controllable, fair, and predictable? Then, if economic pain actually does ensue from living with less oil, coal, and gas, we can cooperatively limit and manage that pain.

By now you probably see the hitch. Getting the world's governments to agree on anything at all is challenging, and negotiating a global agreement typically takes years of hard effort. Getting every country to sign up to produce and use less of the very fuels that have driven economic growth over the past century or two would be extraordinarily difficult. In contrast, current global climate agreements have been easier to forge, because they just focus on *pledges* to lower emissions—and those pledges are hedged on all sides by carbon trading schemes, carbon offsets, and poorly funded aspirational plans for building renewable-energy or carbon-capture infrastructure. The result: actual emissions keep rising.

The challenges in reaching a global cap-and-ration agreement include, for example, convincing fuel exporting nations like Saudi Arabia to give up significant sources of national revenue, or talking coal-dependent nations like China into agreeing to phase out coal more quickly than other fossil fuels. But those are difficulties that will have to be faced one way or another anyway, if real progress (by whatever means) is to be made in lowering global emissions.

Further, a global cap-and-ration agreement would be harder to achieve than a global carbon tax. Yet, it would be arguably far better than a carbon tax, as there could be no gaming of the system by subsidizing fossil fuels on one hand while taxing them on the other. Emissions would decline because fossil fuel production and usage would decline. Simple and foolproof.

After contemplating the likely roadblocks in gaining universal buy-in to a global cap-and-ration scheme, it's easy to adopt a cynical attitude that says, in effect: "That's what we'd do *if* we were a rational species able to think ahead and give up immediate gratification in favor of long-term survival. But we're not, so we're headed for climate doom." As I document in my recent book *Power*, the capacity for self-limitation exists everywhere in nature; further, human societies through the ages have found innumerable ways to restrict population growth and consumption of natural resources in order to stay within environmental limits. Sometimes those efforts have been insufficient and societies collapsed as a result, but self-limitation is always a real option nevertheless. So, if we are capable of restraining aspects of our own behavior

that are ultimately self-destructive, why aren't we doing that now with regard to carbon emissions? There are likely many explanations. But one reason may simply be that the single strategy that would actually work to avert catastrophe—cap-and-ration—is not part of the public discussion.

If cap-and-ration is a good idea, then it should occur independently to many people. It already has; in fact, it's difficult to say who came up with it first. Aspects of cap-and-ration can be found in proposals and publications going back decades, including my 2006 book *The Oil Depletion Protocol*, which suggested a global cap-and-ration scheme as a way to avert economic disruption not just from climate change, but from oil depletion as well (the book was based on a proposal by geologist Colin Campbell). Years earlier, British economist David Fleming came up with an energy rationing system called Tradable Energy Quotas (TEQs), which I'll describe below. However, it really matters little who deserves the credit; what's important is whether the plan is workable.

Current proponents of cap-and-ration (in some form or other) include:

- Stan Cox, US author of *The Green New Deal and Beyond*, and a book on the history of rationing, *Any Way You Slice It*.
- Kevin Anderson, British climate scientist, who told the BBC in 2009: "When you have something essential like energy that you can't ration just on price—you have to ration it in a more equitable way."
- Jason Hickel, British economic anthropologist and author of *Less Is More: How Degrowth Will Save the World*.
- Peter Kalmus, US climate scientist and author of *Being the Change*.
- The UK's Fleming Policy Centre, headed by Shaun Chamberlain.
- Larry Edwards, engineer and co-author with Stan Cox of a key article in *Solutions Journal* titled "Cap and Adapt: Failsafe Policy for the Climate Emergency."
- Seth Klein, Canadian author, public policy researcher, and team lead with the Climate Emergency Unit.
- The Irish environmental economics organization FEASTA, which advocates "Cap Global Carbon" and "Cap & Share."

Discussions about cap-and-ration at the governmental level have included officials from Britain and Ireland; but, so far, those talks have been only exploratory, with no commitments for action or even further study.

The purpose of this article is to raise general awareness about cap-and-ration as an option. If there is to be any chance of its implementation, the plan will require the initial buy-in of environmental organizations, then the general public, and finally policy makers.

If cap-and-ration proves to be politically unattainable, then we should be honest with ourselves about the consequences. Without cap-and-ration, the world's policy makers will most likely continue to dither with proposals that appear to reduce emissions without actually doing so. Horrific consequences from those emissions will ensue. And young people around the world, whose lives will be tragically impacted, will give up on policy solutions and look for other strategies. Some may turn to industrial sabotage as a way to save the last vestiges of a livable climate.

A final, timely note: there are currently calls to embargo Russian oil and gas exports in the wake of the Ukraine invasion. Russia produces roughly a tenth of world oil, so such an embargo would have significant economic and geopolitical implications. From a climate standpoint, choking off Russia's exports might accomplish approximately what a global production cap would—though not in a context of cooperation and planning, but rather in one of competition and conflict. And there would likely be no effort toward energy equity via consumption rationing, and no mechanism for further production cuts. In short, it's about as bad a means to cut global oil production as could be imagined, delivering the same pain as a production cap but few of the side benefits and lots of extra risks.

Above, I promised a longer discussion of what might be involved in a national energy consumption rationing program, and that's probably a good way to end this article. Here is a short description of David Fleming's Tradable Energy Quotas (with most of the wording borrowed from the TEQs website).

Tradable Energy Quotas (TEQs): What They Are and How They Would Work

Rationing of fossil fuel consumption at the national level could be done by way of tradable energy quotas, or TEQs, a system initially suggested by the late British economist David Fleming over two decades ago. TEQs have been discussed and researched by the British government. The system would work as follows.

Each adult would be given an equal free entitlement of TEQs units each week. Other energy users (Government, industry, etc.) would bid for units at auction. When buying fuel or electricity, units corresponding to the amount of energy purchased would be deducted from the buyer's TEQs account; they would still need to pay for the energy. All fuels and electricity supplies would carry a "carbon rating" in units, with one unit representing one kilogram of carbon dioxide—or the equivalent in other greenhouse gases—released in the fuel's production and use. This would determine how many units are needed to make an energy purchase (thus giving a competitive advantage to low-carbon energy). If a person used less than their entitlement of units, they could sell the surplus. If they needed more, they could buy them. All buying/selling would take place at a single national price, which would rise and fall in line with demand. The total number of units available would be set out in the annual TEQs Budget, which would be integrated with fossil fuel production caps. Government would itself be bound by the TEQs system; its role would be to support the country in thriving on the available energy. Since the national TEQs price would be determined by national demand, it would be transparently in everyone's interest to reduce their energy demand, and to work together, encouraging a national sense of common purpose.