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Interview: Ramez Naam, futurist, author, and investor

My favorite futurist tells me how to beat Putin, solve climate change, and build the future

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Apr 23

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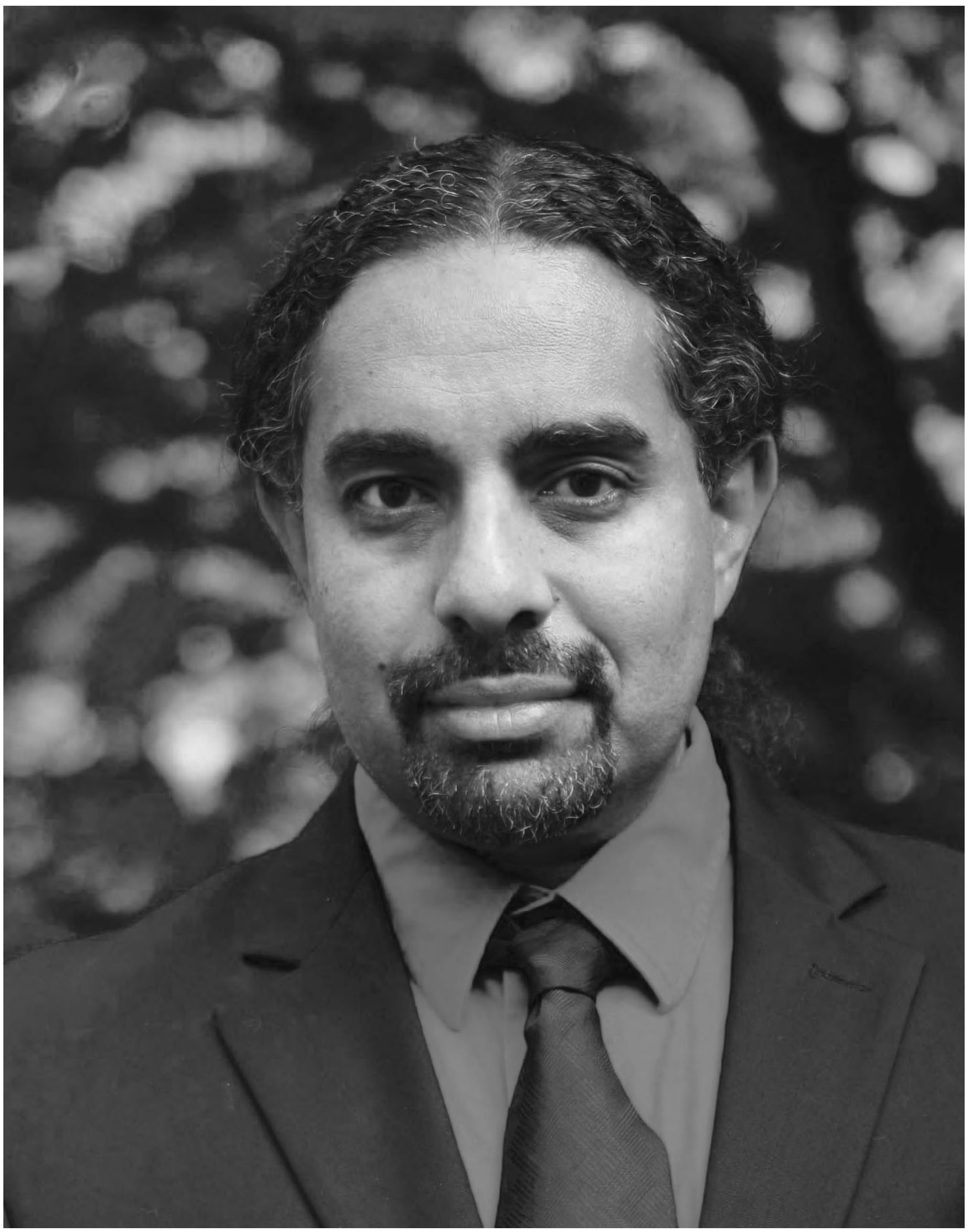


When I want to know what the future is going to be like, I go ask Ramez Naam. Over the years, his spyglass has seemed to peer just a little farther into the future than other people's.

My favorite example: In 2011 he wrote a guest post for Scientific American entitled "Smaller, cheaper, faster: Does Moore's law apply to solar cells?" that alerted the world to the startling, consistent, and seemingly unstoppable cost declines for solar energy. This came at a time when almost everyone in public discourse still thought of solar as an unworkably expensive pipe dream. But Ramez (or "Mez", to his friends) was right. Over the next decade, his prediction became conventional wisdom, not just for solar but for batteries as well. The resulting explosion in solar installation and electric vehicles has utterly changed scientists' outlook for climate change — catastrophe may still strike, but the most apocalyptic scenarios now look distinctly unlikely. This isn't Mez' doing, of course, but he saw it before others did.

Why is Mez so good at predicting the future of technology? Part of it is his personal experience — as a Microsoft engineer, he led the teams working on a number of core software products. But he's a dreamer as well as a doer — his science fiction series, the Nexus trilogy, deserves to be among the classics of the cyberpunk genre. He has also written two nonfiction futurist books, *More Than Human: Embracing the Promise of Biological Enhancement* and *The Infinite Resource: The Power of Ideas on a Finite Planet*. Readers of my blog will notice that biological enhancement and sustainable/renewable technology are two of the things I'm most excited about. Well, it's because I read Ramez Naam.

In this email interview, Mez and I discuss a lot of things related to the future of technology — how to get off oil and gas and weaken Vladimir Putin's regime, how to decarbonize the U.S. rapidly, what technologies to be optimistic about, and how to get involved building the techno-optimist future. As always, I learned a lot.

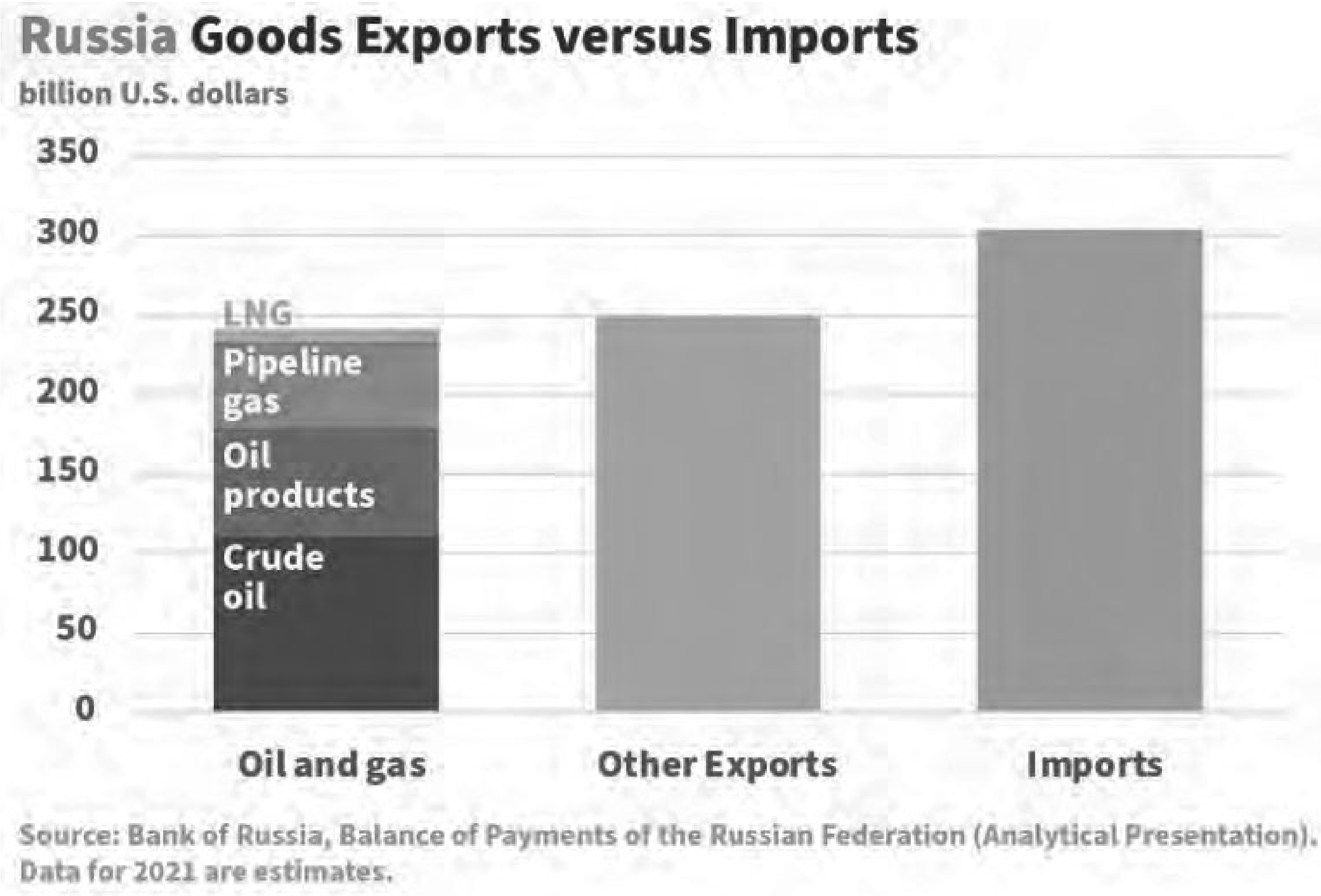
N.S.: Lots of people, including yourself, have talked about the need to get off oil and gas quickly in order to starve Russia of income, as part of the Ukraine war assistance effort and the new cold war with Russia. How exactly do we do that? What are the important steps?

R.N.: Noah, great to be here. My view is that Putin's invasion of Ukraine is going to substantially accelerate the clean energy transition. I say this as someone who invests in clean energy and climate tech startups, and keenly watches the pace of innovation in these technologies.

In particular, the war in Europe is going to accelerate the development, deployment, and price decline of the technologies needed to replace natural gas. Natural gas is the cleanest of the three major fossil fuels. Burning it causes half the carbon emissions of burning coal, and two thirds of the carbon emissions of burning oil. (Though leaks are a problem, since un-burnt methane released into the atmosphere is an incredibly potent greenhouse gas.)

Natural gas – really methane – is interesting to me in this situation for a few reasons.

First, while natural gas is a relatively small portion of Putin's *revenue* from selling fossil fuels, it's an enormous amount of his *leverage* over Europe. If you look at this chart of Russia's exports, from Nikos Tsafos, you see that oil and gas together are roughly half of all of Russia's exports. But within that oil and gas segment (the stacked blue bars on the left) oil is much bigger.



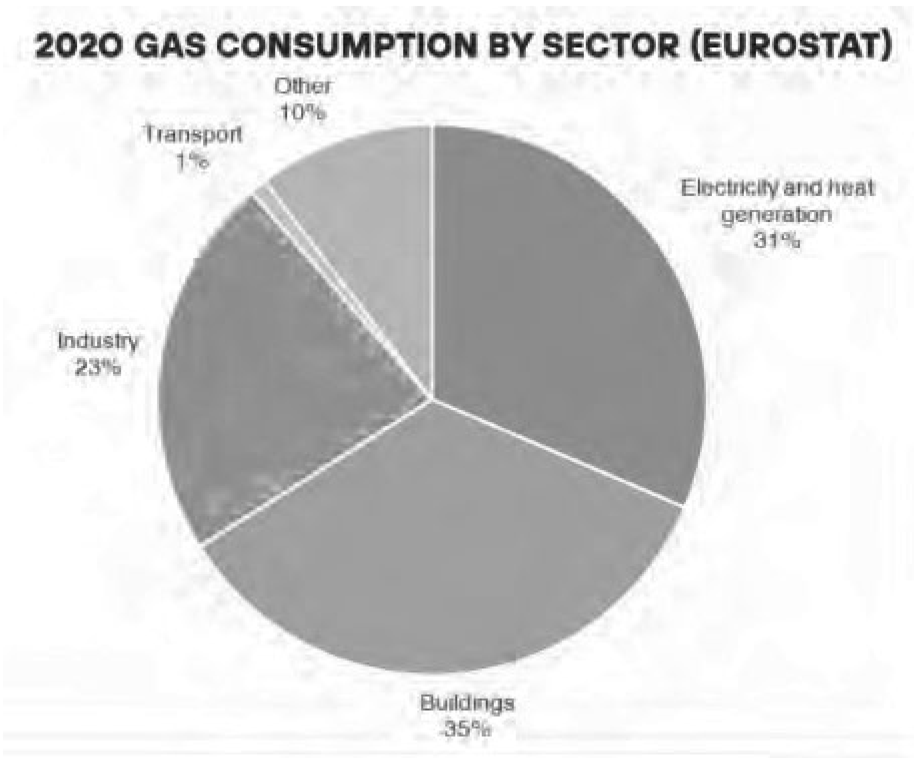
So oil is where Putin makes his money. Russia makes about three times as much money from sales of oi and oil products as it does from the sale of natural gas. Why is natural gas interesting?

Because natural gas (methane) keeps the lights on. And because it's a regionally traded commodity. You see, oil is a *global* commodity. Oil is moved extensively in tanker ships around the world. Europe could stop buying Russian oil and buy oil (or refined oil products, like gasoline or diesel) from somebody else. There's differences, but in general it's a pretty fungible market.

Natural gas is different. The world has relatively little shipping capacity. To move gas over oceans you have to chill it to -160 degrees C, and turn it into a liquid. That's doable. But it's relatively expensive. And so most gas is moved by pipeline. That means that if the gas link between Europe and Russia were shut down for any reason – political, economic, or physical – that you have a much harder time replacing that supply.

Now, this natural gas doesn't really make all that much money for Putin. I mean, it's on the order of $80B / year (before this crisis), which is a third of the amount Putin makes from oil. Yet gas is actually more important in terms of his leverage over Europe. That's because of the problems shipping gas around that I mention above, and also because gas is used to keep the lights on and houses warm.

If you look at where Europe uses methane gas, one third of it goes to buildings. That means building heat. Literally keeping your home or office warm. Another third is "heat and power" – that's electricity. That's keeping the lights on. Another third is "industry". And that's a mix of using natural gas to make ammonia, a key ingredient in fertilizer, which massively affects crop yields and thus food prices, and other industrial uses such as refineries, making plastics, and so on. You can see this breakdown in this chart from Eurostat:



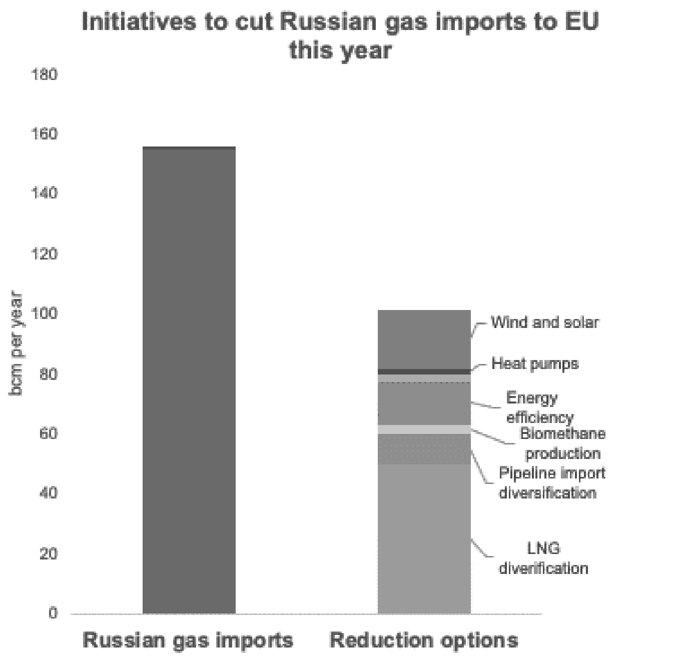
The combination of natural gas's greater difficulty of transportation vs oil, along with its mission critical role in keeping buildings warm, the lights on, and making fertilizer to apply to fields, means that, even though it earns Putin less money than oil, it's incredible leverage that he has over Europe.

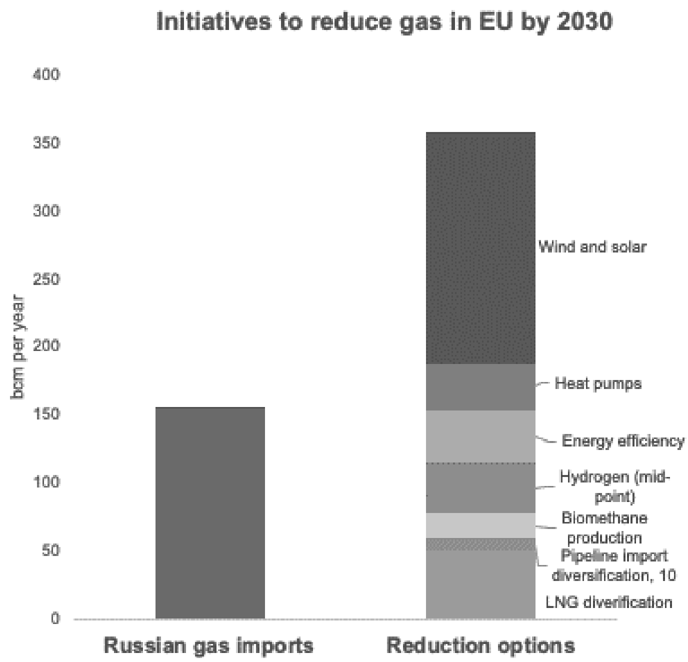
Gas is where he has Europe over a barrel. Or where he thinks he does. And reducing or eliminating the need for Russian natural gas is going to be and incredible driver of innovation.

N.S.: OK, so how can Europe get off of Russian gas? What are the policy steps for doing this as quickly as possible, with as little harm to the economy as possible?

R.N.: There will be short term steps, and long term steps. The EU published a plan in March on how to get Europe off of Russian fossil gas, and it clearly distinguishes between the two. In the short term, it's going to require something that environmentalists and climate activists don't want to hear. Europe is going to need to bring in natural gas from elsewhere. Some of it can come via pipeline, but most of it will come as LNG – liquified natural gas moved by ship. While the short term plan has many other aspects – more solar and wind;

keeping existing nuclear reactors running longer, turning down thermostats and otherwise being more energy efficient – the biggest single chunk, and the majority of the replacement of Russian natural gas, comes purely by importing natural gas from somewhere else. That will mean Qatar. And it will mean natural gas exports from the US as LNG. This doesn't make me happy. But, speaking as a vocal long-time clean energy advocate, there is no other realistic way to eliminate Europe's dependence on Russia's natural gas this year. And I believe strongly that we must do so, to eliminate his leverage over Europe, and thus to embolden Europe to take the actions necessary to save Ukrainian lives, stop this war of aggression, and arm Ukraine sufficiently to fully and completely defeat Putin's army.





What's most exciting about the chart above, though, is the long term, running out to 2030. That long-term chart is on a different vertical axis than the short term, 2022 chart. It goes more than twice as high. And what it shows is that accelerated build-out of solar and wind, alone, can more than make up for all imported Russian natural gas. And on top of that, it plans for increase deployment of electric heat pumps – which heat buildings though almost-magically-efficient use of electricity, rather than burning natural gas – along with increased energy efficiency, and deployment of new technologies like green hydrogen, made by using solar and wind electricity to electrolyze water.

What's really exciting about this is that, as I've written about for years, deploying *more* clean energy makes future clean energy *cheaper*. Clean energy is a technology, not a raw material. Its long term price isn't so much dictated by the law of supply and demand as it is driven by the virtuous cycle of increased demand leading to reduction of cost via Wright's Law / the learning curve, and those lower prices leading to increased demand. And that's a global phenomenon. Deploying more clean energy technology in Europe makes clean energy cheaper in the US, in China, in India, in Africa, and everywhere. I've written about this extensively in the past. In How to Decarbonize America, and the World, I argued that the most effective climate policy of all time was Germany's early subsidies of solar power, when that was a tiny, ludicrously expensive industry, because that scaling of industry made solar cheaper for everyone on the planet. In Solar's Future is Insanely Cheap I documented how every major data set of solar cost shows that increased scaling leads to exponential price decline, in a way that can be measured and forecasted using Wright's Law / learning rates.

Okay. Why does that matter now? Because natural gas was going to be the last fossil fuel we got rid of. Coal would go first. Then oil. Then finally gas. But because Europe has to reduce its dependence on Russian gas, it's going to scale the technologies to do so, making them cheaper for everyone, and accelerating the pace at which the whole world can get off of Russian gas.

Specifically, hidden inside those bar charts of the 2030 plan are some details that Europe has to figure out, that aren't made clear:

1. **Energy storage, especially long-duration energy storage**. Natural gas is useful in a wind and solar dominated grid because it's flexible. It can ramp up and down quickly, unlike coal, and economically, unlike nuclear. To do with less natural gas, Europe is going to have to deploy a lot more energy storage, to handle those times when the sun isn't shining and the wind isn't blowing. Including more super-long-duration storage, that can store multiple days of energy, for the long periods in winter when you don't have sun and you may have a wind lull for days at a time. Those technologies are nascent. Scaling them is going to have a massive impact on driving down their cost, with global ripple effects.
2. **Electricity transmission and the grid.** The very cheapest way to get more renewables onto the grid is to build a bigger, smarter grid. That's been held up as much by politics and NIMBY as anything else. Well, Europe now has a reason to push past those obstacles.
3. **Electrifying building heat**. As we've already covered, this is still a young area, with lots of room for improvement. I expect a rush across northern Europe, especially Germany, to switch to electric heat pumps, and a fair bit of innovation alongside that.
4. **Offshore wind and floating offshore wind.** Europe's natural gas demand spikes in winter. As we electrify building heat, even more of the *electricity* peak of Europe will be in winter. Solar is a summer-peaking resource. To provide winter power, Europe is going to look at long duration storage, yes, and possibly nuclear fission and geothermal. But the bulk of the winter heavy lifting will be done by wind power. And given Europe's population density, that's going to mean a lot more offshore wind, and also a lot of *floating* offshore wind, an even younger technology with huge upside potential. Floating offshore wind alone could power the world several times over. It can also be placed further from shore, where it can't be seen, reducing NIMBY objections. Today it's expensive, but there's no reason it has to stay that way. Floating offshore wind is already blowing past most projections. I've long been bullish on this tech. I expected it to be much more important, cost effective, and pervasive than industry expected already. The war will just push it forward faster.
5. **Green hydrogen.** A third of natural gas usage is for "industrial" uses such as making fertilizer and chemicals, or high temperature heat. That "hydrogen" chunk in the plan is the deployment of electrolyzers that use solar and wind electricity to electrolyze water into oxygen and "green" hydrogen,

which you can then use to replace natural gas in these applications. That's another young technology that was already surging. It will surge faster now.

6. **Nuclear fusion, geothermal anywhere, and other next generation "clean firm" resources.** Finally, there will be more enthusiasm than ever to develop and deploy next generation "clean, firm" resources (as Princeton professor Jesse Jenkins likes to say) that can produce power any time of day, any day of the year, 24/7/365. One of those is "geothermal anywhere", a broad set of technologies that could enable geothermal power across much more of the planet. Another if nuclear fusion. Fusion isn't going to be commercialized by 2030. But I already see a surge in interest. The White House held a Fusion Summit, which my colleague Dr. Carly Anderson attended, in late March. (She moderated the session on fusion in the private sector. Carly is a badass.) On top of that, the CEO of a fusion startup in Europe told me that a prominent European politician called him two weeks ago, asking what help he needs. Every sector and technology involved in reducing dependent on Russian gas is going to be turbocharged, with ripple effects around the globe.

And that's just natural gas. This is also likely to accelerate the transition away from oil.

N.S.: Of course we should be doing the same thing in the U.S., right? How good was the Build Back Better bill, and how much does that bill's death set back U.S. and global decarbonization efforts? Is this a minor setback or a catastrophe?

R.N.: We absolutely should be passing more policy in the US. The energy provisions of the Build Back Better bill are fantastic. They're not a panacea, but they would amount to the most substantial federal legislation advancing clean energy of all time. The provisions advance clean electricity, electric vehicles, expansion of the power grid, new technologies like green hydrogen, and even carbon capture and direct air capture. Multiple analysis found that BBB would have gone a long way towards the US hitting its Paris commitments and more. And it would most likely lead to lower energy prices for American consumers, as solar and wind are just plain cheaper than coal and gas, and electric vehicles are increasingly becoming cheaper than gas-guzzlers (especially when you include the cost of fuel and maintenance).

Unfortunately, Build Back Better *appears* to be dead. By which I mean that the omnibus bill is likely dead. Manchin has actually said that he would be open to an energy-only BBB bill, with some initiatives in it to increase US fossil fuel production as well. The theory is that increasing US fossil fuel production would help increase US resilience to oil price shocks. In reality, that doesn't do much, and the private sector has all the approvals it needs to drill a whole lot more for oil and gas. Renewables and EVs really do much more for energy security. Even so, I'd take such a deal with Manchin. Deploying more renewables makes them cheaper. Deploying more electric cars and trucks makes them cheaper. Scaling green hydrogen technology makes green hydrogen cheaper. The same just isn't true of fossil fuels. It's a battle of technology's always-improving economics on one side, vs a "resource" play that has supply / demand dynamics that cause prices to fluctuate, sometimes wildly, on the other side. Technology will always win. Subsidize both of them equally, and the tech side will gain more.

Alas, Sinema has thrown cold water on such a deal.

Even so, I have hope that congress will pass ***some*** energy tax credits this year. They often do. They might not be as big as we'd like, but there's a decent chance of them.

In the meantime, 30 US states have clean energy standards or renewable portfolio standards on the books. Purple states like North Carolina have passed pro-clean-energy laws. Blue states like California and New York (and Colorado, Main, Nevada, Oregon, Washington) have laws that require getting 100% of electricity from clean sources by 2050 or before. Those laws are getting more aggressive, with shorter timelines, every few years. States are passing laws accelerating electric vehicle deployment, or scaling electric vehicle charging infrastructure, even in "Red" areas like the US Southeast. States are actually way ahead of the federal government here.

Even in states where there aren't binding standards, renewables are booming. Know which state in the US has the most combined wind and solar power? Guess. Is it California? No. It's Texas. Why? Because Texas has an open electricity market that encourages direct price competition between different energy production resources, which advantages solar and wind, because they've been plunging in cost. Texas is also sunny, windy, has a lot of land, and makes it easy to build transmission, and to build things in general (which blue states ought to learn from).

So however you look at it, clean energy is going to win in the US. That's no longer in doubt. It's inevitable. The only question is how far, how fast.

N.S.: What do you think are the most exciting technologies in the clean energy space right now? In my recent interview with David Roberts, he suggested that electrolysis is seeing exponentially decreasing costs, which could make hydrogen viable for long-term energy storage and industrial process heating. Do you agree with that? And are there any other green technologies we should be keeping a close eye on?

R.N.: David Roberts is obviously a great person to talk to on this. And he's exactly right. Green hydrogen technologies are plunging in cost, specifically the electrolyzers that use electricity to split water into hydrogen and oxygen. They've got their own learning curves, that are similar to those of solar or wind (somewhere in the middle, most likely). Which means that they're going through an exponential price decline right now. And the solar and wind power that provide the electricity is also getting cheaper. So you have a period over this coming decade where 'green' hydrogen, at least in sunny/windy parts of the world, is going to go from being completely non-competitive to being actually kind of affordable. That's important for a number of sectors, including heavy industry like steel and cement, or anywhere that you need high temperature heat. You can also use that green hydrogen as an input to make so called electro-fuels, fuels from solar and wind, that are liquid fuels you can put into an engine to power ships and planes. That might be green ammonia in the case of shipping, or a drop-in e-kerosene or e-jet-fuel in the case of aviation. That will take time to develop, probably more than this decade, to be honest. Maybe two or three decades, depending on policy. But it gives us a lot of hope to decarbonize some tough to decarbonize sectors.

Other areas that are seeing incredible price declines are energy storage for the grid, batteries for EVs (as we've already discussed), carbon removal technologies, alternative methods of industrial production that don't even use hydrogen, and more. I invest in all of these sectors, in any technology that has the potential to improve the lives of billions of people. The bulk of my startup investments are in climate and energy. The rest are all about improving humanity and the planet in some other way. There are a lot of exponential technologies going through rapid price decline or performance improvement right now. It's an exciting time to be alive.

N.S.: That's awesome. So what should policy be doing to accelerate progress in these technologies? Are subsidies the right move, so that we can take advantage of learning curves as fast as possible? What areas should we be putting basic research money into? How much would carbon taxes or equivalent policies help in terms of accelerating innovation? And are there any other important policies I haven't listed here, that we need to be doing?

R.N.: The most effective policy depends on how early or developed a technology is. For the technologies that are in the most nascent stages, say, ultra-long-duration storage that can store power for weeks, or batteries that can store 10x the energy per unit weight of lithium ion, or plastics stronger than steel that could reduce the weight of everything, you want to invest in basic R&D. Basic R&D is good at all stages, really. But it has the biggest impact in sectors that are the most nascent and least solved. For technologies that are hitting commercialization but aren't yet big and aren't yet cheap, you want policies that scale those industries. Those can be direct subsidies, like the solar and wind tax credits that we have in the US (the ITC and PTC) or like Europe's Feed In Tariffs that got everything started, or they can be performance standards that dictate that a certain percentage of the grid has to be clean electricity by this date, or that a certain fraction of auto sales have to be electric by this date, or that combined fleet fuel economy has to hit a certain number, and so on. Those performance standards are probably the most important and under-rated policy there is in clean energy. Those are the policies that 30 US states have. That's how China has worked to scale electric vehicle sales (with EVs there now making up more than 10% of all new vehicle sales, in the largest auto market in the world). So if I had to pick one, that's where I'd go. But direct tax incentives are also good.

The other policy we don't talk about nearly enough, that's even more under-rated, is getting out of the way of building things. In the US, a host of regulations empower NIMBY activists, land owners, and conservatives who just don't like clean energy to block the development of solar and wind. Even worse policies make it practically impossible to build new electricity transmission in the US. And long-range, coast-to-coast power transmission is actually one of the *cheapest* ways to increase how much solar and wind we can use on the grid, to increase grid *reliability* across the country, and to lower the cost of energy. But bad regulation at the federal, state, and local level makes it hard to build. We have to fix that. The Left has to own up to this and fix it. This is a complete moral failing on the left, in my opinion. You want more clean energy? Fix NEPA. Get rid of the Jones Act so we can actually build offshore wind in the US. And Congress has to reform permitting of transmission lines to make it at least as easy to build a transmission line as it is to build an oil or gas pipeline. It's hilarious that today it's much much much easier to build a dirty, polluting natural gas or oil pipeline in the US than it is to build an electricity transmission line to carry clean electricity. And fixing that requires action at the Federal level. And it also requires defeating lefty NIMBYs at the state and local level. You want progress? Get out of the way.

Finally, we need open markets for competition. Utilities are, in most states, regulated monopolies that don't *have* to choose the cheapest energy. They get rewarded for building things, whether those things work well or were the cheapest option for their customers or not. That's completely messed up. There are a lot of things broken about Texas, and a number of things broken about their electricity market (ERCOT) in particular. But one thing they get right: Energy resources compete on price. And building transmission to your new solar or wind farm is relatively doable. That's why Texas is seeing such a massive solar boom right now. In much of the rest of the country the same isn't true.

So: Fund early stage R&D, especially in the least solved areas; Use performance standards and/or targeted subsidies to scale new technologies; get rid of bogus regulatory barriers to actually building the things we need; and ensure some reasonably regulated competition between energy sources. While you're at it, make it legal to buy a vehicle direct from the manufacturer in every state. That's my high level policy prescription to address climate change.

N.S.: Is it possible to be any more specific at this point? Do you have a short list of technologies that are in the more nascent, research-intensive stage?

R.N.: I don't want to be *too* prescriptive on the "how" of the technologies. But in terms of the goals, yes. Here are some of the biggest unsolved climate problems:

- **Ultra-long duration storage** – economically storing weeks of electricity.
- **Cheap clean industrial heat & industrial processes** – making steel, cement, plastics, and chemicals without carbon emissions, at a price similar to or cheaper than how it's done today with coal or natural gas.
- **Clean "firm" energy resources** – Next generation energy resources that can produce 24/7/365, anywhere on earth, in a compact footprint, including next generation advanced geothermal, advanced nuclear fission (thought that already gets the most funding of any energy technology), and energy fusion.
- **Decarbonizing aviation and shipping** – Super high energy density batteries, or more likely, clean "electrofuels" made from solar and wind, at the same price or cheaper than jet fuel or bunker fuel are today.
- **Decarbonizing building heat** – Can we make heating a building with clean electricity, including the installation and retrofit, as cheap as it is to burn natural gas.
- **Decarbonizing agriculture and ending deforestation** – This is a big one. A quarter of the world's emissions come from agriculture forestry and land use – AFOLU in the IPCC's lingo. That comes form deforestation which is mostly caused by using land to grow livestock or biofuels. And it comes from

fertilizer applied to the fields, which decomposes into nasty stuff like N2O and NOX that are potent greenhouse gasses. And then the animals themselves, especially cows, burp up methane. Each of those could use billions and billions each year in R&D funding.

- **Stabilizing fragile ecosystems** – Even at 1.5 degrees C of warming (which we're going to exceed) you're going to see a lot more forest fires, and we could see a nearly complete loss of shallow water coral reefs. What can we do to intervene to make these ecosystems more resilient? Can we plant trees that don't burn so easily? Grasses that sequester more moisture or carbon in the soils? Can we engineer corals that can survive higher temperatures and acidity? Or can we improve coral reef microbiomes to make them more resilient? Can we create robots or other ways of replanting corals that don't require expensive, non-scalable human divers.
- **Direct climate system interventions**. **Geo-engineering.** Most controversially, I will say that our biggest single climate policy miss, by far, is that we are doing essentially zero to advance the state of science of intervening in the climate system. I'm talking about a range of things here, from cloud brightening, to stabilizing glaciers that are melting, or somehow intervening in methane release from a thawing arctic, and all the way up to solar radiation management geo-engineering. Everyone seems to hate this idea. But I have news for you. We are not going to stay below 1.5 degrees Celsius of warming. It is just not going to happen. We have missed that boat. We might stay below 2 degrees Celsius if we get our act together and deploy the technologies we have ready or have in the pipeline. We have a really great shot at staying below 2.5 or 3 degrees C. And we could even pull it in to below 2, I believe. But we've just plain missed 1.5 degrees Celsius. I want people to get that in their heads. There is no plausible scenario in which the world decarbonizes fast enough to hit that goal. Unless… Unless you reflect a tiny bit of the sun's energy back into space. You'd probably do it by spraying aerosols into the stratosphere. It looks like it would be really cheap. People are terrified of the idea. But in part they're terrified because we don't understand the side effects. Actually, we might understand them better than people think. But okay. If that's a problem, let's do some very small scale experiments. And let's fund 100x as much modeling of this as we have today. Let's get serious about understanding how geo-engineering would work. Let's have it ready as an option. It's far better to have these tools available and not use them, then to find out that we're up against a wall, that some climate tipping point is going much faster than we expected, and that we don't have the tools that could help save us. So I will plant my flag here. Today, the world spends roughly single digit millions of dollars a year on geo-engineering research. Does that sound like a lot? It's not. We spent more than $60 billion. Billion with a B. On venture capital investments into clean energy last year. In 2022 we're going to spend probably a TRILLION dollars deploying solar, wind, batteries, and electric vehicles. That's awesome. But it's not enough. Let's spend an addition, say, 1/1000th of that amount, or $1 Billion / year, on researching solar radiation management geo-engineering and other direct climate interventions. That would increase research in the area by roughly a factor of 100, which is about right.

N.S.: That's an awesome list. And in fact, it makes me want to segue into the next part of this interview, which is to ask about futurism in general. A number of folks, myself included, have been getting very optimistic about an *acceleration in technological progress this decade. Do you agree with this general optimism, and if so, why?*

R.N.: That's an interesting question. Well, I think I'm going to both make you happy and disappoint you.

First, I have been and continue to be an optimist. Over the long run, the world is clearly getting better. On almost any metric you can name, whether it's child poverty, hunger, life expectancy, GDP, education level, fraction of humans living in relative freedom, or something else, the world has broadly improved over the last couple centuries and more. There are bad years and sometimes bad decades, but overall progress has seemed to rebound and continue. Even in environmental metrics, most things (aside from climate change) have been getting better since the 70s, and it looks like we're going to eventually turn the corner on climate.

That's been driven by some fundamental forces. First, the accumulation of knowledge, embodied as technology. As I argued in *The Infinite Resource*, knowledge is just a positive sum resource, continually accumulating, non-rivalrous, and able to substitute for or multiply the value of labor, land, materials, energy, or just about any other resource. Second, the increasing ability to collaborate and communicate, and the creation of new more powerful tools to augment our individual and collective intelligence has continually increased our problem solving abilities. Third, the general spread of markets has led to more competition between and recombination of ideas, and more incentives to employ human labor and mental power towards solving problems others care about. And finally, rising human rights, declining human poverty, increased freedom around the world, greater equality for women and minorities, and the like has increased the fraction of human capital we're tapping into.

All of these forces continue to make the world better.

Now, this has been a shitty decade or two on multiple of these fronts, to be honest. The spread of freedom, in particular, seems to have stalled. Poverty declines and hunger declines don't seem to be happening as quickly as they once did. Life expectancy in the US has been stagnating and even declined recently (even pre-covid). Totalitarian states have found ways to employ the technologies of mass communication to control people. Even in free nations, mass communication technologies, which I thought would be nearly universally positive, have been utilized (intentionally or unintentionally) to foment distrust and division. There are some scary signs out there.

Even so, I'm generally an optimist.

But do I think this coming decade is special, or that we're going to see a sudden burst of more rapid improvement?

No, not particularly.

In fact, I think many of the purely technical challenges we're coming up against are much more daunting than techno-optimists (which I generally consider myself to be) broadly acknowledge.

In particular, everything about biology is just really, really hard. In 2003, I was writing my first book, *More Than*

Human, and was writing about life extension technologies, gene therapies and gene editing of both adults and children, human augmentation tech, brain augmentation and neural interfaces. And guess what? All of it has gone much, much more slowly than I forecast then.

As forecasters, it's absolutely essential that we actually look at what we predicted and see what we got right and got wrong. On energy, I've gotten a lot right. I've been one of the most accurate forecasters out there. I can say that with a straight face. My models of the improvement of technologies like solar and batteries have simply been shown, time and again, to be far more accurate than those of the leading energy forecasters like the International Energy Agency, the US Department of Energy, or any of the large energy companies. Some of that was luck. A lot of it was coming from a different field (computer science) and just being able to apply a different mental model, one of exponential technology improvement, to a field that wasn't comfortable with that.

Okay, great, I'll take credit for that.

On human biology, though? On life extension? On brain augmentation? I was wrong. These technologies have not improved quickly. They've fallen short of my expectations. They've fallen short of the expectations of all the transhumanist and extropian and futurist thinkers of the 1990s and 2000s. They've even fallen short of the expectations of the critics of biotechnology who were scared of the ethical

So now when someone talks to me about life extension, or longevity escape velocity, or uploading, or neural interfaces, I take it with a much much larger grain of salt.

We have to face up to phenomena like Eroom's Law. In multiple fields, and particularly in pharma and biology in general, the difficulty of making new discoveries and bringing them to market is rising exponentially. Yes, our tech is getting exponentially better. But the problem is also exponentially harder the deeper you get into it. That's why I argued years ago that The Singularity Is Further Than it Appears.

Now, you asked about this in the context of energy and other tech like that. Okay. We do see progress there. But as a function of time, we're going to see cost declines slow down. The cost of solar electricity dropped by a factor of 5, 6, or 7 over the course of the 2010s. It's not going to do that again over the 2020s. We'll get a factor of 2 or maybe 3 reduction. That's because these things get cheaper as a function of scale, and you have to exponentially increase scale to get each step in cost reduction.

So I guess what I see is a middle path. I think there's every reason to believe that tech is going to keep getting better. And, if we make some decent policy choices (which is not a given) we'll harness that to improve human wellbeing.

But there are also things that are going to get worse. Climate impacts are going to get worse before they get better. We've had just over 1 degree Celsius of warming. We're most likely to get close to 2 degrees Celsius – or perhaps a bit more – before we get this under control. And the pain and cost of climate change rises non-linearly with temperature increase. 2 degrees C is going to be a lot more than twice as costly as 1 degree C. And it's going to bring with it the risk of all sorts of tipping points in the climate system, and all sorts of risk of societal unrest, low-developed-state failure, civil wars, and political upheavals. That's a little scary.

Add to that our political problems, and then add on the way that biological problems get exponentially harder as you make progress, and we have some significant headwinds to overcome.

I am, in the words of the Extropian philosopher Max More, a "Dynamic Optimist". That means I believe that things will get better. But not because they just magically get better on their own. I believe they're going to get better because we're going to make them better. It takes action. Or perhaps it's better to think of it the way that Bill Gates and Melinda Gates French have talked about – as being "Impatient Optimists" who believe that the world is getting better, but that we have so much more that we could do to make it get better faster.

It's up to us. We can't just be bystanders. If we want a better world, we need to act.

N.S.: Wow, I ended up being more techno-optimistic than the author of The Infinite Resource! This feels like an accomplishment!

OK, but let me push back on your cautions a bit, just for fun. First, on biology. Yes, fantastical technologies like life extension are slow going. But isn't that always how it is in any field of technology? Better engines didn't give us interstellar travel but they did give us cheap air travel. Better computer chips didn't give us mind upload or godline AI, but they did give us smartphones and cloud computing. Don't these more modest marvels still count as rapid progress? In bioscience, we're already seeing mRNA vaccines suddenly attack previously intractable diseases from malaria to cancer. 3D-printed organs seem closer to reality. Genetic engineering seems to be progressing at an astonishing pace since the discovery of Crispr -- I just saw a story about a company making hypoallergenic cats. And so on. Aren't these marvels marvelous enough?

And on energy, yes, the pace of cheapening will slow, but isn't that just the beginning of the wave of follow-on innovation? Energy is an input to everything else in our economy, and the last time we got cheaper energy -- the oil boom a century ago -- it transformed our world with cars, air travel, and so on. Won't cheaper energy -- and even more importantly, energy portability via batteries -- change our world simply by enabling things like cheap desalination, ubiquitous long-range drones, battery-powered appliances, and so on?

R.N.: Well, I want to be clear here. I do believe that the most likely path for the world is one of rising material abundance. I believe we're going to continue to reduce poverty worldwide, to increase access to information, to reduce hunger, to increase access to fresh water, education, life-saving drugs, good roads and transportation options, more physical living space, heating and cooling, all of that. I also believe that – *most likely* – we'll reverse this trend of stalling or even falling democracy, and we'll return to a path of humanity become mostly more free over time.

That's my default, based on both technology trends and the last 150+ years of human progress (or even hundreds or thousands of years of human progress, depending on how you measure it).

But I think there is also an underestimation of risks and barriers, and some irrational exuberance about some technologies.

Some of the areas I think are overly hyped include:

- **Space**. The prospect of self-sufficient colonies in space any time this century seems dim. Not because we can't develop the technology to do it, but because the incentives to do this are extremely minimal. Remember that both the moon and Mars make Antarctica look like a balmy, lush, easy-to-survive paradise. And our "colonies" on Antarctica are really just government-funded research labs. Will we build a moon base or even a Mars base? Sure, why not. But the idea that these will be self-sufficient colonies any time soon seems pretty far fetched to me.
- **Human biology, and especially "life extension".** In medicine, we're doing amazing things. Yet progress is more difficult with each increment. 3D printed organs would be awesome. They will also add a lot more to average quality of life than stopping smoking. Will we totally cure cancer? Maybe eventually. But certainly not this decade. And even if we did, how much would it add to life expectancy? About 3 years in the US. Globally, life expectancy rose by more than 30 years in the 20th century. Sanitation does more for life expectancy than high tech medicine.
- How about **energy**? This is my top area of focus for the last decade. And we can see that wholesale power from solar and wind is plunging in cost. EVs will be cheaper than fossil fuel cars this decade. Yet the total cost of electricity isn't dropping. In the US, even as the cost of generating electricity has dropped, the cost of *delivering* energy (transmission and distribution) has gone up. And while solar and wind are getting dang cheap, we also need storage technologies – beyond even batteries – to provide power for the hours of the year when you don't have solar and wind, and where hours of batteries aren't enough. We also need to massively build out the grid. And we need to overcome NIMBY to do this. So there are headwinds.

None of this makes me a pessimist about the future. I think the future is better than the past. But I am a skeptic of the narrative that overall progress (as measured in quality of life of the median human) is really rapidly accelerating. I'm definitely a skeptic of the narrative of a rapid take-off of some sort. The world will likely continue to improve, but I don't see much evidence that the pace of improvement in the 2020s will be substantially faster than the pace of improvement in the 2010s. Could it be? Yes, it could be. But it could also be slower in terms of actual benefits delivered to people.

N.S.: OK so, last question. A lot of smart people out there want to get involved -- to build the future, instead of just reading about it and hoping for it. What should they be doing now? What are the actions they should be taking?

R.N.: This is maybe the most important question of this whole interview. And the answers are multiple.

At a technical level: Get involved. If you have professional skills, how do you deploy them? Do you work on optimizing ad clicks? On marketing consumer products? On fossil fuel production? Can you deploy those same professional skills to working on clean energy or climate, or computing advances that can accelerate progress, or helping craft business models or marketing plans for products that improve humanity?

On a civil level: Can you help cut through the hyper-polarization that exists? Can you reach out to people with differing opinions, learn how they think, and help persuade them to see the other side? Can you help elect leaders that move us forward instead of backwards? Can you criticize the worst ideas *on your own political side.* If you're a conservative, can you stand up for democracy? If you're a liberal, can you support free speech on campus and in the private sector? Can you help overcome NIMBY?

On a social level: Can you help cut through the heavy marketing of outrage and fear that media use to get clicks? Can you calm the discourse down? Can you help overcome "if it bleeds, it leads" in news media? And maybe most importantly, can you help spread this notion of dynamic optimism, showing people how the world is getting better in so many ways, and inspiring them to take action – whatever action they can – to continue to make it better?

I'm sure there are other ways, but these are the ones I think about.

Thanks for a great interview, Noah. Always a pleasure.

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Michael Haley Apr 23 Liked by Noah Smith

great interview, he explains things really well, I have read some articles about natural gas/Russia but they didn't

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