Hey, it's Sean Fennessey, one of the hosts of the Prestige TV podcast.
HBO's Barry is back for a fourth and final season, and that means I'll be back recapping the show with co-creator and star Bill Hader to dive deep on the themes, scenes, and major moments in the series.
Bill will provide insight into how every episode was made and why it's ending.
New Prestige TV Barry recaps will go live every Sunday night when the episode ends, so make sure you're subscribed to the Prestige TV podcast wherever you get your podcasts.
Today's episode is about the future of energy.
This is a mega pod with two guests.
First, Ramesh Nam is a writer and speaker, one of the best technologists I know at explaining the progress we're making toward building a clean energy economy.
And Vinod Kosla is one of the most famous venture capitalists in Silicon Valley, the founder of Kosla Ventures, and an investor in several sci-fi sounding companies, including one that is working on fusion technology, fusion technology, which might be one of the most exciting and important technologies we ever build.
But before we get to the interviews, I want to say something about energy.
The history of progress is, in so many ways, a history of energy.
As the author, Vaclav Smil has written, quote, the course of history can be seen as the quest for controlling greater stores and flows of more concentrated and more versatile forms of energy, and converting them in more affordable ways at lower costs and with greater efficiencies into heat, light, and emotion.
And quote.
That's it.
That's history and progress in a sentence.
And for the most part, it really has been a story of progress.
An average person in the world today has, at their disposal, seven hundred times more useful energy than the typical person at the beginning of the 20th century.
But here's the rub.
You know how every age of human civilization tends to be named after the tools that we use to build it?
You know, like, in the Stone Age, we used rock to fashion arrowheads.
In the Iron Age, we used metal to shape swords.
You could say the last 100 years or so have been the plastic age or the carbon age.
Between 1870 and 2000, we invented cars and planes, refrigerators, TV, computers, containerships.
We built these things with material, like silicon and plastic, that nature did not know how to recycle.
And we powered these new, incredible machines with energy from coal, oil, gas, which was finite and non-renewable, created heat and electricity at a very high cost, filling the skies and the seas with carbon.
And now we face the bill, climate change, despoiled natural environments, acidifying oceans.
Now, there's a school of thought that says, let's just stop.
We've gone too far.

Let's stop.
Let's turn back the clock.
There are some who sometimes go by the name de-growthers, who say the only way to save the planet now is to purposefully pull back, shrink human welfare to appease nature.
I think they're wrong.
I think de-growthism is a political and philosophical dead end.
I think the path forward is both simply stated and very, very, very difficult to accomplish.
Number one, we have to electrify as much of the economy as we can.
And number two, we have to generate that electricity from clean and renewable energy sources, wind,
solar, geothermal, hydro, nuclear.
As you're going to hear, I think we can do this.
I think we can do it.
Rather than just tell people we can eke out survival, but only if everybody sacrifices their own personal definition of flourishing, I really do think we can electrify just about everything and build a world with more clean energy.
That's the promise.
And here's the bad news.
Sometimes people say decarbonizing the grid requires a new Manhattan project.
You'll hear that sometimes.
We need a new Manhattan project for energy.
That is almost comically insufficient.
The Manhattan project, which gave us the atomic bomb, cost about $33 billion in today's dollars, and it barely made contact with most people's lives.
It was literally a secret.
The global energy transition is the very opposite of a secret.
It's going to cost tens of trillions of dollars at least, and it's going to touch everything.
Every station of human existence, how we eat and farm and drink and the clothes we wear and the air we breathe, and much of the tech that we need we don't even have yet.
But the carbon age has to end.
What we need now is a new theory of growth, a new theory of growth that works in concert with nature.
That's what solar is.
That's what wind and geothermal energy are.
We have to move from a carbon age to a bio age, and it's going to take just about everything we've got.
I'm Derek Thompson, and this is Planet Russian.
Derek, such an honor to be here.
Before we dive into the nitty gritty, I am interested in getting out of you something like a thesis statement about the direction of America's clean energy transition.
What makes you most optimistic about our opportunity to move to clean energy, and what makes you
most pessimistic?

Derek, can I swear on this podcast?
Absolutely.
I'll say this.
What makes me most optimistic is the exponential price decline of clean energy technologies.
Very clean energy technology, whether it's solar power, wind power, batteries, electric vehicles, hydrogen, is decades or a century ahead of where we thought they'd be on cost just 10, 12, 13 years ago.
For renewables and for electric vehicles, they are now either cheaper than fossil alternatives, fossil power, fossil transport, or about to be.
That's what makes me optimistic.
What makes me pessimistic is the limited amount of time that we have.
There is no bright line in climate change.
There is no threshold at which everything ends and the world is completely doomed.
Nevertheless, we talked about two degrees Celsius as an important threshold, 1.5 degrees Celsius as an important threshold, 1.5 has become more popular.
We have missed 1.5 degrees Celsius.
We have warmed already 1.3 degrees Celsius.
We're going to pass 1.5 degrees in the 2030s at some point.
Aside from doing solar geoengineering, which I think we should be investing much more in, we're not going to make that.
When I started in climate around 2010, we seriously thought we might be headed for six degrees Celsius of warming, 12 degrees Fahrenheit.
That might not sound like a lot.
That's more than the difference between now and the last ice age.
That was truly catastrophic, not human extinction level, but civilization ending climate change.
We have bent that curve.
Over the last 18, 24 months, there have been a raft of papers looking at new either country pledges or just pure economic analysis of current policies and economic trends in clean energy that say we've bent the curve to less than three degrees, maybe to 2.5 degrees, maybe to two and change, maybe to 1.9 degrees Celsius.
We have gone from a truly apocalyptic scenario to if we maintain momentum to being one where things will get worse with climate before they get better, but we could have a world of 10 billion, 11 billion people living first world lives with better human well-being than we have today, not without damage.
Here comes the profanity.
The way that my friend Jesse Jenkins at Princeton talks about this is that in climate change, we're no longer totally fucked, but we're not totally unfucked either.
We're in the messy middle.
Every tenth of a degree Celsius that we can shift that future warming matters tremendously, and that's what gets me up in the morning is fighting to bring it down.
I've said to others that I am a rate optimist and a level pessimist when it comes to climate change.
That is, the rate of progress, and we're going to talk a lot more about rates, is really

shocking in a wonderful way, but the level of carbon already in the biosphere cannot make anybody optimistic.
It just plain sucks.
Yes, the level of carbon, it's also the rate that we see as a first derivative of rate.
Solar and wind are growing exponentially.
So Vaklav Smil had some quote the other day, the guy I love to hate, said, all the work we've done in clean energy has made no difference whatsoever.
Well, that's actually false, but it hasn't slowed down.
It hasn't reduced carbon emissions.
It's not just that the level is high, over 400 ppm now, but that carbon emissions are still at an all-time high, like the new amount we add every year is at an all-time high.
But what's happened underneath that, those are trailing indicators.
The temperature is a super trailing indicator.
CO2 in the atmosphere is a little bit upstream of that, but still trailing.
Emissions is upstream of level, but trails deployment.
Deployment is upstream of clean tech, and shutting down fossil is upstream of emissions.
But what's upstream of that is the exponential price plunge that makes clean energy disruptively cheap.
To build new renewables, then keep operating coal or gas plants, makes it cheaper, so if people switch to EVs, then they keep driving their gas guzzlers, and the continued drum beat and advancement of policy.
So that's how I see it, is that the leading indicators are really positive, but those might not even be first derivative, they're going to be second or third derivative changes that we see, and eventually they have to get down to lowering the actual CO2 in the atmosphere.
So let's go all the way upstream here.
One of the thesis statements that I've heard from you is that clean energy will win on cost, but only if we get out of our own way and allow it to be built.
That's two different statements.
Number one, the clean energy will win on cost, and number two, that we have to get out of our way and allow it to be built.
I want to jump into each of those hypotheses specifically.
Number one, what does it mean that clean energy will win on cost?
So energy is a fungible commodity.
For most people, when you flip on the light switch at your house, you don't know what the power source is.
When you get into a vehicle, you just want to get from point A to point B, you're not thinking what the fuel is.
People will, in general, buy the cheapest forms of energy services, really.
Heating, cooling, lighting, manufacturing, transport that they can.
A decade ago, in 2010, 13 years ago, there was no place on earth where solar or wind or electric vehicles were cheaper than fossil power or fossil cars.
That was their first phase, their policy-dependent.
By 2015, and around 2011, I started forecasting that we would see this exponential price decline.

We had been seeing this potential price decline in solar, and it would continue.
That's a similar thing in batteries.
I came from tech, so I was very used to Moore's law.
I was called crazy.
Nevertheless, it happened.
It happened actually twice as fast as I thought.
2015, we passed the threshold I said would happen around then, which is new solar, new wind was cheaper in some parts of the world than building a new coal plant or a new gas plant.
By 2020, we started to enter the phase, the third phase, where the cost of power from a new solar farm or a new wind farm in sunny and windy parts of the world is cheaper than the fuel cost of the fuel going into a coal plant or a gas plant.
That's their third phase, where it's disruptive.
It just makes sense, even without subsidies, even without the inflation and Russian Act, even without Europe's incentives, it just makes sense in an increasingly large fraction of the world economically to build renewables or to switch to an electric vehicle because you cut your maintenance costs and your fuel costs so much.
It's just plain cheaper.
Basically everywhere on Earth, those things will just be cheaper alternatives by 2030.
That's what it means that they're going to win on cost.
This is unlike anything we've seen in the history of physical energy or physical infrastructure.
I'm so interested in the fact that even the most optimistic experts have been surprised by the rate of price declines.
You have pointed out that solar has fallen by a factor of 40 in the last three decades.
Wind energy, the price of it has fallen by a factor of 30 in the last 40 years.
Batteries down 40X in 30 years.
These are extraordinary numbers.
Something like this doesn't happen with something like fossil fuels, which are commodities, which just sort of fluctuate.
They go up and down and up and down.
Solar energy prices are just a straight line down.
Help us make sense of this.
At a high level, how has this happened?
Yeah.
Fossil fuels are a commodity.
They suffer supply versus demand dynamics.
What happens is that when you have fossil fuel abundance, when you're overproducing, the price gets low and the producers all reduce their production.
You also have fields get played out.
You drill a well, and that well produces for a while, but then it dies down.
You're also competing against depletion.
Commodity prices fluctuate.
We look at Oxford had this study that came out with the data from 1880 to 2020, found

basically no clear trend in the long-term trend of coal, gas, or oil.
Solar batteries, wind power, electric vehicles are technologies.
And it's not that they have no fluctuations.
There are times you have supply chain challenges or other things that cause for a couple years, maybe three or four years, prices to stagnate or go up.
But fundamentally, like other technologies, like everything from your television screen to phones to computers, technology just gets cheaper over time.
And so that's really what's going on.
They follow this phenomenon called Wright's Law.
Everyone in tech knows about Moore's Law.
Gordon Moore, the founder of Intel, coined this phrase that we'd doubled the number of transistors per unit area every year or 18 months.
That turned into an economic law.
We would cut the price of computation by half every 18 months.
It turns out Moore's Law is just a special case, something called Wright's Law.
And Wright's Law is that when you manufacture something in a factory, not build it in the field, and especially if it's a simple, single part component, even if it's very complex to make, it's a simple, low moving part count component, like a chip or like a flat screen TV, and you make huge numbers of them every time you double scale, you bring down cost by a certain percent.
That's an exponential.
And so basically, all technologies follow that, but the technologies that have the smallest number of moving parts and are built in factories like solar panels and batteries or electric vehicles that have 90% fewer moving parts than gas vehicles, those things get cheaper or faster.
And so that's what's happening.
It's this phenomenon that we found in at least 65 technologies throughout history that's happening, especially in clean energy.
This is where I think a lot of people listening might be experiencing a little bit of cognitive dissonance because they're hearing us say, oil is a commodity.
It's something like gold, but solar energy and wind energy are technologies.
They're like flat screen TVs.
The price keeps coming down over time.
If you simply knew that fact and tried to map it onto America's energy mix in 2023, you would assume just by knowing those two pieces of information that solar and wind might be dominating in terms of the current energy mix.
Instead, solar and wind are both, as I understand it, correct me if I'm wrong, less than 10% of the total energy generation in this country.
So if the technology is so magnificent and the price is coming down so historically, why is the energy share still so low?
Well, one thing that the faceless meal gets to write is that energy transitions do take a while.
This is physical infrastructure.
We build power plants to run for 30, or 40, or 50 years.

So you have some cost of having built a coal or gas power plant, and you have inertia.
Nevertheless, solar and wind just passed coal generation in the US.
That's a big deal.
And globally, solar and wind were somewhere between 80% and 90% of all new electricity capacity generation in 2022.
The UK think tank, Ember, I know you had Nat Belard on the show recently.
He chaired their recent release two days ago.
They project the 2023 over the first year that on a global basis, fossil fuel power generation, meaning coal and gas, will shrink because of the rise of renewables.
Fossil generation, coal generation, is already plunged in the US.
It's plunged to levels not seen since the 1800s in the UK,
even with the war in Ukraine.
We see fossil generation, I can't be very low there.
But these things, exponentials grow from a small base.
A solar a few years ago was just 1% of global electricity.
Now it's 4%.
They've also been, unfortunately, compensating for the decline in nuclear, or stagnation at least, in nuclear power.
So a lot of what's happened with solar and wind growth is that nuclear has been underperforming.
And so solar and wind have made up for a combination of demand growth, people needing new electricity,
solar, and nuclear declining over time.
But now we're past that point, and we're at the point where solar and wind growth
are just at the threshold of just plain driving down fossil generation around the world.
This is a race against time, and we are already in a climate crisis.
Going back to one of your thesis statements, clean energy will win on cost,
but only if we get out of our own way and build it.
Why aren't we building clean energy faster?
What are the most important bottlenecks to think of?
There are a number of bottlenecks.
If you look at, I'll talk about the US, but we'll talk about globally also, look at the US.
Right now we have bottlenecks of getting clean energy hooked up to the grid.
There's a thing called interconnection cues.
That is the cue, that's the line to get hooked up to grid power in your local area.
And those interconnection cues are now longer than three years in different parts.
In fact, one of the largest utilities or one of the largest utility areas,
independent system operators in the US basically put a halt to all new solar and wind projects entering their cue, requesting connection to the grid, because it's just overwhelming for them.
That's one issue. A second issue is transmission. People think like long range transmission.
People think that solar and wind mean you can go off grid.
They certainly help. Solar and batteries help you going off grid.
But the reality is that solar and wind-
And I just want to stop you there, because when you say off grid,

I think some people will get it and some people might not.
Just spell out a little bit of what you mean by going pure off grid.
So by off grid, I mean people having their homes powered just by solar and batteries.
The problem with that is you've got to build out enough energy storage
to deal with the longest, non-sunny part of the year.
So if you're in Arizona, that might be okay.
If you're in New York, you'd have to have batteries to last you for potentially months.
If you're in Seattle, where I live, you'd have to have batteries to last you for six months.
So that's not really economically viable.
Solar and all energy power resources are weather dependent.
The Texas ice storms were caused by natural gas failures.
But solar and wind, you'd say, are probably somewhat more weather dependent
than are other energy sources.
So every model, every simulation, shows that the best way to get the highest amount of renewables
on the grid at the lowest cost and the highest reliability for customers
is to build thousands and thousands miles long high voltage transmission lines.
If you look at the length of power lines China is building,
we could literally move solar power from New Mexico, where it's sunny most of the time,
to New York, where it's not, well, New Mexico, we have a lot more land.
To New York, we have a lot less.
We could take the Great Plains that have tremendous wind resources
and take power from there to both the east and west coast.
But building that long-grain transmission is a regulatory nightmare.
In fact, there's multiple regulatory nightmares.
There's regulatory nightmares in building renewables.
You have to get permits from state level, county level, federal level.
Building wind farms in particular has gotten really hard in the US,
but even building solar is getting hard in high population density areas.
But then building transmission to get the power where it's needed is even harder than that.
We just had the other day a $3 billion transmission project that moves power from Arizona,
where there's lots of land and it's easy to build things to California.
It was approved fantastic.
It took 18 years for them to get regulatory approval because they needed the Federal
Bureau of Land Management, every state along the way, every county, and every landowner
to all come to terms.
That process, we don't have time for that.
So clearing that red tape right now, in my opinion, is one of the most vital things
that we have to do in order to accelerate the clean energy transition.
So I'm hearing at least three big categories of bottleneck.
Number one is local nimbyism.
That is local areas that make it hard to or outright refuse to build wind farms.
That's gotten hard to build solar farms.
That's getting harder.

That's energy generation.
That's where the energy comes from.
The energy, as you said, can't just be generated in this new future.
It has to be transmitted because parts of the country are much sunnier than others.
Parts of the country are much windier than others.
We want to power the country coast to coast.
But long distance transmission, that continent size grid is really difficult to build without revolutionizing the way that we permit those long distance transmission lines.
So we have local nimbyism at the energy generation.
Part number one, continent wide transmission number two.
Then I also heard you talk a little bit about utility integration,
that sometimes the ISO simply refuse to let this energy come online.
Let's talk about where this transition is actually happening fastest.
And it seems to me, correct me if I'm wrong, that it's happening fastest in Texas.
Why is it happening fastest in Texas?
It might stop happening fastest in Texas as the Texas legislature has their way.
But historically, over the last few years, so early on in the U.S.,
it happened fastest in places like California and New York,
that passed bills that had mandates for this much power has come from renewables.
But Texas currently, up until just now, has been the fastest,
A, it's the number one state for solar and wind generation combined in the U.S.
Be as the fastest growth as a solar market in the U.S.
And that's happened because Texas has a lot of land, a lot of sun,
and easy permitting for building the solar projects or the wind farms,
and relatively easy transmission hookups, and an open competitive utility model.
Most Americans live in states where they have a regulated monopoly utility.
You don't have a choice. I don't have a choice. I live in Washington State in Seattle.
I have a utility that owns the wires that come to my house, owns me as a customer.
I can't choose somebody else, and either owns or contracts the generation of resources that sell the power to me. I'm a captive audience for them.
Texas, very much like most of Europe, has an open competitive market, what we call retail choice, where in Texas, the company that owns the distribution lines, the power lines that come to your house has to transmit whoever's power you decide to buy from. And so you can decide to buy from any provider who can either build their own generation assets, buy power from somebody else, and then sell it to you. And that, and similarly, it's pretty easy to build a new generation of resources, a new wind farm or solar farm, and sell the power on the wholesale market or directly to retail customers, homes and businesses. That is a more modern system. Texas, what we call ERCOT, their grid. They're a separate islanded grid from the rest of the US. That's a mistake, actually. They have their own flaws. They don't really have a way to ensure sort of backup generation for reliability, but that open competitive market removes some disincentives for utilities. Because if you're in a region where your monopoly utility owns the power generation and sells you that product, and nobody else can sell you that product, they don't actually have the incentive to bring in cheaper power from a neighboring state or

someplace a thousand miles away. They might have better sun and wind. They would rather not do that. They'd rather build more generation assets themselves and sell you their own power on their own terms. So that monopoly utility model is itself a barrier to progress in the US as well.
The Biden administration, obviously, wants to accelerate decarbonization past a bunch of laws last year, including the Inflation Reduction Act, which might be the single biggest line item in terms of spending on subsidizing any clean energy transition anywhere in the world. Did anything in the IRA, or anything that's come out of the Biden administration on the legislative side or the regulatory side, deal with this utility problem? Not really. They did try to deal with permitting problem in a separate bill. The IRA had to go through the reconciliation process, so it could only deal with budgetary matters, not regulatory changes. But to get it passed, Joe Manchin got an agreement from Chuck Schumer that they would bring forward a separate permitting reform bill. That permitting reform bill, unfortunately, did not pass. It did get at least one Republican senator voting for it. It also got one Democratic defection, Bernie Sanders. It would have made it easier to build fossil infrastructure in the US, but it would have made it tremendously easier to permit a new clean energy infrastructure and especially new transmission. So they took a shot at that. They failed. I hope that we'll get a chance to try that again at some point. But the utility regulation comes down to something that is often much more state by state. Now, FERC, the Federal Electricity Regulatory Commission, is working on some rule making process administratively to try to both ease transmission and they've passed some rules that force even monopoly utilities to do a few things to be a little bit more competitive.
Like a few years ago, they passed a rule that forced every utility in the US to treat an energy storage system to let that participate in the wholesale markets, meaning that if you build a battery, you can buy and sell power on the grid. Things like that that are nibbling away at the edges. But utility reform in the US, we had a wave of it, of deregulating utilities.
Deregulation is a word that people on the left, I'm not liberal, that deregulation is a word that liberals often don't like. But that deregulation of utilities means making utilities compete instead of making them a monopoly. And monopolies are just bad, honestly.
If these long distance transmission lines have to be built across the Midwest, and as I understand it, that is absolutely where they're going to have to be built, among other places. What does that mean in terms of the political coalitions that are going to have to be built? Because that's a lot of rural Republican areas that we're relying on to make national decarbonization a reality in this country. But it's not clear to me that rural Republican areas care very much about decarbonization in terms of their political priorities.
I have not done a full survey of rural Republicans. So I apologize if someone listening is a rural Republican and they really wanted to carbonize the grid. But it doesn't seem to be issue number one for them. How does that figure into the political challenge here?
It's really interesting. And I think there's a mismatch between voters and their elected representatives in many cases. If you look at things like Yale 360 does a survey of people's attitudes on energy. And if you leave out the word climate or decarbonization, and you just ask, what's your favorite energy source? Americans overwhelmingly say it's solar.
The number two is wind. And by a distant third, it's coal. And then, sorry, by a distant third, it's natural gas. And then coal and nuclear are deep down at the bottom. If you ask Americans, should the U.S. do more to encourage electric vehicles, they say yes. Once you add climate

or decarbonization into that, you get more opposition. People like solar because they
perceive it as clean. They perceive it as energy independence. People like electric vehicles
because they're slick because Tesla has reinvented what an EV meant versus where we were 13, 14
years
ago. And you see an interesting phenomenon. Congressional districts in the U.S. that have
the highest amount of renewable power generation are actually red districts that have lots of wind
power. So that's why in 2015, for instance, a GOP House and Senate passed a five-year extension
of the federal solar and wind tax credit, and then did a little bit more for wind than solar in
years following because a lot of their enough Congress people come from counties where wind
power generates income for ranchers and farmers, and even solar power generates income, that
once
you get away from the tribal battle over climate change and just talk about energy, you start to
get a little bit more bipartisanship. Now, was it enough? I mean, David Roberts, formerly from
Vox, now at Volts, would laugh at me for saying this, be any point out that the Texas legislature
just passed a horrible bill for grid resiliency, they say, that'll basically build 10 billion
dollars of fossil fuel infrastructure that doesn't make a lot of sense. So there's infection of
legislatures as well with the tribalism, sort of an anti-renewables stint. But renewables are still
much more popular than climate action. And so if we focus clean energy arguments on clean energy,
that better technology, it's cheaper, it's cleaner, it generates jobs, I think we have a better shot
of persuading people in these rural, Republican areas, that is a good idea.
So to sum up where we are now, the MEZ plan is something like step one, overcome NIMBYism to
build as much solar and wind and other renewables as possible, along with advancing battery
technology
to store the energy that we are generating. Number two, reform permitting so that we can
build long distance transmission lines to carry that renewable energy across the country, so
that places that aren't windy and aren't sunny can still benefit from the energy created by wind
and sun and other renewable sources. And then step three, which is kind of an ongoing challenge,
win, this is very much easier said than done, win the war of political persuasion, win it in Texas,
win it in Republican rural areas, win it in blue states and blue cities that have their
own NIMBY problems, but find a way to win that war of political persuasion. Maybe I shouldn't even
call it a war, but that tug of political persuasion in order to help people see, and this is something
that I think Saul Griffith is very good on, that the renewable energy picture that we're painting
is not the 1970s picture of everyone has to sacrifice, everyone has to do a little bit less,
turn the lights off, dim their sense of a brighter future. No, we are talking about
clean energy abundance, which is also sort of clean electricity abundance as well.
One word that we haven't mentioned yet that a lot of people want to fold into this picture
is nuclear. There are some folks, sometimes called the nuclear bros, who will say that it is a pipe
dream to imagine you can get anywhere near 100% renewable or 50% clean energy without nuclear.
That's because solar simply takes up too much land, wind simply takes up too much land.
You either get to the promised land with a major build out of nuclear,
or you do not get there at all. That's their case, what say you?
Well, let me come back to that. I want to address what you brought up that Saul said,
and I love Saul Griffith, and he's totally right. We have to win this persuasion, and we're not

asking for sacrifice, but I will say I don't view it as a war. What decades of research on climate attitudes and attitudes on other highly politicized topics says, and I think Chris Mooney wrote articles about this a decade ago, that people have solution aversion. People don't mind solving climate change, they just think that the solution that's being proposed is live a smaller life, have a smaller house, drive less, eat less meat, and so on. And so to persuade people of a different political view, it is incredibly important to acknowledge their worldview, to understand their values and frame things in their values. And if we frame this transition as about cleaner air and water, everybody loves that, as about a better life for your kids, as about technology and innovation, as about cheaper energy for all of us, as about economic growth and jobs, that is tremendously more successful than to do anything that is about, you have to stop flying, you have to stop eating meat, you have to turn the thermostat down, all of those sort of do less arguments. It's a very important point, I think, when trying to politically persuade people.
Can I just jump in there, because Saul said something really interesting to me. We were talking about how would you sell clean electric abundance to a Trump voter, a profound Trump voter. What would you tell them? Now look, maybe you would just allow the culture war mullet to play out, where you let the Tucker Carlson's of the world scream about the culture wars in the front, and then Secret Congress cleans up, permitting in the back. But if you want to make the direct argument, and I like the idea of making the direct argument, Saul said, what you say is, imagine, think about what you have to do to power your internal combustion engine today. You have to buy gas. That gas is enriching Iran. It's enriching Saudi Arabia. It's enriching countries that you probably don't like to think about, and might not even like in the first place. If you have a solar panel on your roof, and you have a battery, and you have an electric vehicle, then your house, and your car, and your neighbor's house, and your neighbor's car, is being powered by your own neighborhood. You are enriching your own neighborhood. That's really keeping it domestic. That's making America great again. America powering America, not America relying on some country that whatever you might not like. I thought there was, even if it is kind of co-opting the xenophobia of people who I don't exactly share political priorities with, an interesting way of reframing this for someone who might have a particular aversion to the solutionism you're talking about. I think that framing of energy independence is a really good one, actually. I think if you look at what's happening in Europe right now, Europe's always been a leader in climate action, but the war in Ukraine is accelerating Europe's energy transition, because now they see getting off of natural gas as an issue of energy security. I think that's a really good one. But look, I know lots of Trump voters. My family live in a rural county in the Midwest. I know their friends, their dear people to me. I love them. We disagree politically. Guess what? Most of them really love solar power and electric vehicles that they have longer driving instances. They think it's cool. They think it's cool because it's cheaper. Nobody likes a coal plant in their backyard. Nobody likes when they see emissions from a smokestack when they see smog.
I don't think it's actually that hard if we can just skip the politicization parts.
When I talk to a Republican, I don't say climate change. One of the seven old moments in my life was giving a talk at a hedge fund conference, and I'd been giving talks about what we had to do for climate action. I was like, oh my god, I have to change this. I just removed climate change from

the talk and just talked about the economics of clean energy and didn't mention climate to the last slide. I said whether you like it or not, other people believe in climate change and policy is going to get more aggressive too. But the fundamental message was this is cleaner, cheaper, better. And that's what's going to win. And I think that, plus the energy independence argument that you're making and so on, clean air and clean water matter to Republicans also. Those are the things that I think persuade people across the aisle. I'm glad we went on that little call to sec to bring it back to nuclear. And just to remind the question, there just are a lot of people who say, Mez, beautiful dream of wind turbines and solar farms across America. It takes up too much space. It's terrible for nature. You're going to have to wipe out all these species in order to colonize all of that land to put solar panels on it. We need nuclear as a part of this vision.
How much do you think nuclear needs to play a part in the future that you're imagining?
So I'm a believer that we should have more tools in our toolkits than we might need.
We have more arrows in our quiver than we might need. And so I think let's go full steam ahead on nuclear R&D. Let's streamline the NRC's regulatory process for nuclear. But I think the statement that you just related is overstated. If you look at the U.S.,
if we wanted to power all electricity in the U.S. by solar, it would take about 1% of U.S. land area. That's equivalent. So we take about 30% of U.S. land area,
a little bit more than that, for agriculture, most of which is grazing land. Actually, now we know we can superimpose solar on agricultural areas, animals like it, some crops like it.
Wind farms take up a large amount of space in indirect space, but the actual footprint of the wind powers themselves is small. And wind farms often coexist with grazing and farming. And if we had transmission, we could put them in places like the Great Plains that have the lowest population
densities. And just to be clear, when you say it coexist, you're basically saying there are a bunch of farms in America that also have wind turbines on them. So the goats and the cows are just intermingling around the huge turbine itself. Wind farm owners pay a few hundred million dollars a year to farmers and ranchers for lease rights to put wind towers on their farms. And the farming keeps on happening and the grazing keeps on happening right up to the wind turbine. These things are heavily co-existing. And with more transmission, we could put wind turbines in even lower population density areas, where they're even further away from homes and so on.
Plus, we have offshore wind coming. Liberals are a little bit in the way of that with the Jones Act that prevents us from using foreign ships to build offshore wind. We have floating offshore wind coming that can be far enough offshore that even the Kennedys can't see it from Cape Cod. We'll get rid of some more NIMBY. So we have a bunch of options. But nuclear is one of the things we should be trying to make work. When I look at how do we get the last 10, 20, 30 cents of electricity, we know that we can get renewables up to some large fraction of electricity in the grid.
Maybe it's 50%, maybe it's 60%, maybe it's 70%. Depends on where you're at. In Arizona, you can get further than you can in New York for a variety of reasons. To get to the rest, the things we can do, those continent scale grids are actually the cheapest and best option.
Overbuilding renewables for seasonality. Energy storage is getting better and better.
We have eyesight on ultra long duration energy storage that can store weeks of power. But then we have what Jesse Jenkins and Princeton would call clean, firm power, meaning compact power sources that are not dependent upon weather, that don't have much footprint and don't have a

weather
dependency. That can be nuclear. There's possibly a renaissance coming with what we call small, modular nuclear reactors. I'll come back to why they're important. It could be next generation geothermal. We have a number of starters working on geothermal energy that works not just near volcanoes and hot springs, but works anywhere on earth. You can tunnel deeper into the crust to get magma or have fluids that are more efficient in pulling heat back up. We have a variety of other technologies, some of them so crazy, like space-based solar, we haven't talked about. The problem with
nuclear to date is that while the cost of solar and wind and batteries have been plunging exponentially,
the cost of building a new nuclear reactor has risen over time. The average cost overrun of a solar farm is basically zero. The average cost overrun of a nuclear power plant built in the last few decades is something like 108%. That's a time overrun, too. Nuclear power doesn't have a learning
rate. Things that have rights law, especially cheaper, are things you build in factories that have a low part count and especially a low moving part count. Nuclear reactors are built like skyscrapers. They're stick-built. They're assembled in the field and they're mega-projects. The most expensive building on earth, the Burj Khalifa in Dubai, cost $1.5 billion. The cheapest nuclear reactor you could possibly imagine building in the US would cost you $8 billion. And guess what the bigger the project is when it's a project like that, the higher a percent overrun it tends to have. So I want to believe in nuclear, but I need to see the industry actually do stuff that brings that cost down. Now, the current hope is what we call small modular nuclear reactors. That phrase has gotten abused and a lot of people call small modular or not what I would consider that. But what it means to me is something that you build in a factory the size of a shipping container, you move to site and you just plug it in and it runs. And the very first of those by a company called Newscale got design approval in the last several months. They don't yet have their first construction approval. I wrote a book in 2011 where I was optimistic about them. It's taken 12 years longer than I thought or at least five or six longer than I thought to get to this point. They'll probably be expensive at the beginning, but if we get enough of them ordered, we might see that factory manufacturing process drop and drop in cost to the point that they're economically feasible. So I don't know. I'm not sure if that'll happen or not, but I've got fingers crossed for it. You mentioned a few technologies that are on the frontier of possibility. Small modular reactors might be coming online. There might be some breakthroughs in geothermal, basically allowing us to dig so deep down into the earth that we could theoretically turn any part of the United States into the equivalent of Iceland, which runs extraordinarily on geothermal. So it's kind of like, you dig straight down, it's like finding a nuclear reactor underground. Aha, here we go. In fact, it is. Half of that heat produced by the Earth's crust is actually in nuclear as to decay. I didn't even realize that. I was kind of making it up as I went along, but it's nice to know that sometimes I stumble into a true statement. What's the most important thing we need that we haven't invented yet? Like allowing yourself to dream a little big, because everything we've talked about so far, just but everything we've talked about so far, the declining cost of wind and solar and batteries, this is all real. What's not real that would just be so fantastic to have? So I'll try to say this by answering the big picture.

If you look at where carbon emissions around the globe come from, I'll simplify. Let's call it four quarters. One quarter is electricity. That's what we're making the most progress. A second quarter is transport. That's less than a quarter. Ground transport, electric vehicles are going to win. We don't have a solution for ships or planes yet. I think Nat Belard said electrofuels, drop-in fuels that we can burn in existing airplane engines, existing ship engines, that's important. Another quarter is industrial emissions and building heat. So making steel, making cement, we're working on that. But probably the hardest one in my mind, fortunately it's not really growing, but it could, is the emissions from agriculture, forestry, and land use change. The IPCC calls AFOLU. That basically means mostly that is cattle, and the deforestation caused either to graze cattle or to grow the crops that we feed the cattle. But it's a hodgepodge of other things. It's manure decomposing on fields. If the application of fertilizer that then decomposes synthetic fertilizer that decomposes into nitrous oxide, a very, very powerful greenhouse gas. So if I look at, I think like I said this in a TechCrunch article years ago, cows scare me more than cars. And so I think I'm with Nat on electrofuels being a huge one, but we're making progress on
that. Industrial decarbonization is a really big one. We're making some progress on that. But I think all of those things, I said they're fungible commodities. People like to just flip on the switch, buy a product, get in a vehicle. They don't care how it was made, where it came from, for the most part. But food is different. Food is highly, highly, highly cultural. A lot of investors, deep tech investors from the node coastline, Steve Jervitsen, to a whole bunch of people that have been in this field for a long time, have invested in alternative proteins, whether they're plant-based, microorganism-based, or fermentation-based, or what we call cellular agriculture or cultured meat. I'd love to invest in that, but I'm actually somewhat skeptical. I think that cultural adoption of new foods that are not what we are raised with is actually a very, very long, slow process. And the economics of some of these things, like actually using beef cells in bioreactors to make artificial beef, is actually really, really, really hard. And it's not proven that it's going to drop exponentially. And so I think we have to find a way to make traditional, on-field agriculture, not vertical farms, but agriculture out in the open, on farms, tremendously more productive. We've got to grow more food per acre and find ways to shop down or reduce the emissions from all the related stuff, like fertilizer and manure, and use regulation to protect our forests and peatlands and so on globally to get that chunk of emissions under control and shrink it.
Mes, thank you so much. This was like, I mean, not even like a college lecture, this was like a college course. I so appreciate the extraordinary density of information and the honesty that some of these problems are in the process of being solved, and some of them are really big, and we need new big ideas to match their scale. Thank you so much for doing this, man. I appreciate it.
Absolutely, my pleasure. Great to see you. Talk again soon.
That was our interview with Ramesh Nam. Next up, we have legendary venture capitalist, Vinod Kosla, talking about the future of clean energy tech we don't have yet. I think as Bill Gates once said, about half the technology that we're going to need to decarbonize the economy fully, we haven't yet invented. This second part of the interview is about those uninvented challenges. Here's Vinod. Vinod Kosla, welcome to the show.

Well, great to be here. Great to be here. I always love talking about climate.
Well, and you've been in the climate space for a long time, and I actually wanted to get your perspective first on a little bit of history in what feels like a very molten moment for this domain of technology. When most people think of Silicon Valley, I think most people think about software, consumer tech, apps, social media, maybe enterprise tech, a bit of fintech payments. There are a few clean energy standouts like Tesla, but do you agree with the premise that climate tech has been a harder nut to crack than software? And if you do agree with the premise, why do you think that's been the case? Well, first, the set of investments in clean tech 1.0 were actually more successful than the narrative goes that it was a failure.
If you invested in Tesla, it didn't matter what else you failed at.
If you invested in impossible early, it didn't matter what you failed at. If you invested in quantum scape early, it didn't matter what else you failed at. So my view is there was a set of good solid sound investments early. They took much longer than anybody anticipated, including myself,
to mature. And part of it was there was investments in climate. Then there was a phase of getting enamored and unreasonable valuations. And you might remember that about other recent cycles in consumer and fintech and others. Greed kicked in, people wanted to get on the bus, invested at high valuations. And then when others stopped investing,
there was a case of musical chairs, not enough chairs for all the startups and not enough funding for all the startups. So that was the narrative. But people who sustained through that and people got off the bus, felt their losses. We took a very different approach. We stayed patient.
Because of that, we have companies like quantum scape. No matter what the valuation is now, whether stock is up or down, we have a huge return. Companies like Impossible Foods, no matter what the valuation is, we have a huge return because it was single digit millions free money valuation. And so whether it's single digit billions or multiples of that, it doesn't really matter. So people who sustained through the tough times and it did take triage and careful planning of reserve funding and because funding outside became less available, they did fine. In all of venture capital, whether it's climate or others, it's a hits business.
You get one or two hits in a fund out of 40 investments. The fund does well. If you don't get them, it does poorly. So I do think funds that stayed with it did well. It took much longer.
And the technologies are much harder to not only develop, but deployment is much harder.
That's where I want to drill down a little bit further. And just to catch up some listeners, you mentioned Tesla, Impossible and Quantum Scape. Tesla, everyone knows that's EVs, Impossible, like Impossible Burgers, that's food. And Quantum Scape is a battery manufacturing company. I want to drill down on this question of, yes, Impossible and Quantum Scape might have had huge returns for Coastal, but they're not necessarily the brand names of social media or some of these B2B or FinTech companies that lots of people know, whether Venmo or Snap or Facebook. And I wonder whether, when I look at this space, I think, well, the physical world is more regulated. And maybe atoms are harder than bits. And maybe there is a deployment challenge
in climate tech where you're dealing with heavy equipment, you're dealing with physical objects that is not the same as it is for software, where you're basically talking about an infinitely scalable piece of code. Do you agree here that there are just differences in

scaling technology that is hardware versus software?
Well, let me do a better analogy. So yes, physical bits are harder, but longer lasting.
You don't go in and out of fashion like in software, you can't.
Compared to it can catch you just as easily. The other thing I want to point out is these are much larger markets. So quantum scale, $100 billion of revenue would be a very small share of the battery market. $100 billion of automotive revenue for Tesla is a very small share of that market. Lanza Tech, one of the early Gen 1 opportunities, sustainable aviation fuels, $100 billion would be a small piece of the market. And that's another success story.
So I could repeat success story after success story or going after markets much larger than Google, but will take much longer to establish. So like I said, this is a molten moment for clean tech. And there's been incredible developments we've heard about in solar and wind and battery technology. I want to talk about fusion technology. You've made a bet on the company Commonwealth Fusion. Tell me about why you made that bet.
Well, I met Bob Mumgard at Commonwealth Fusion when he was a senior fellow at the MIT Plasma Fusion Lab. And he started talking and he wanted to start a company, but there was no business plan,
per se. And it seemed like in a classic Naseem Talib, consequences of failure was you lose $100 million or $200 million. The consequences was success was trillion-dollar markets. That seemed like a very asymmetric kind of payoff. You lose one time to your money. You can make a thousand times your money. But it was worth taking those risks. And it was hugely contributing to the largest, one of the largest problems on the planet, climate change, and one of the largest markets, energy. So it was very much the consequences of failure was small. The consequences of success were really, really consequential for humanity and financial markets. Yeah. Can you take a step back and actually explain,
I know you're passionate about fusion technology. What is fusion? How is it different from what most people think of as nuclear power, which is fission technology? What is the promise here?
Here's the promise. In fission, you have fuel, which is radioactive. You need to refine it, put it in. Your waste is radioactive. Some of the technology used in fission are not only bad input, bad output, but also have huge consequences in nuclear proliferation in weapons, nuclear bombs, and all that. So lots of upside in fission, but lots of downside. Fusion only has upside. So fission is breaking a heavy atom like uranium into parts. Fusion is combining simple things like deuterium, which is isotope of hydrogen and tritium together, fuse them together, as fusion implies, and you get energy out of that. No waste products. A year's worth of supply could fit in your bedroom or your office or fuel supply. So very small amounts of fuel, very clean, no risk of nuclear proliferation, no nuclear waste to speak of.
And so fusion is lightly regulated compared to fission. Because the risks are small, the production method is exactly the opposite, combining molecules, not splitting a molecule into parts. And so it is not even regulated by the Nuclear Regulatory Commission. It's more like a linear accelerator in your nuclear medicine facility at your hospital,
if it has such a facility. So lightly regulated, very easy to deploy. And more importantly, it can be compatible with today's energy infrastructure. So you could build power plants with fusion, much simpler to build what I call fusion boiler. Just build a boiler that replaces your coal boiler at an existing power plant. You don't need new permits, new plant sites,

new grid connections, new turbines, you just generate steam like your coal boiler does, your natural gas boiler does, replace the boiler, feed it into turbines, and voila, you've suddenly converted every power plant in this country. And I believe that will be entirely possible within the next, within the early 2040s to replace every coal and natural gas plant in this country and replace the boiler with renewable power from fusion. Very exciting vision. That would represent one of the most important energy breakthroughs in the history of humanity. Currently, fusion supplies 0.0% of America and the world's energy needs. So let's talk about that journey from 2023 to the 2040s. What don't we have? What are the key breakthroughs that we still need to make fusion a viable energy source on a large scale?
So today, we haven't proven fusion works, which means energy output from a fusion reaction is higher than the energy you need to put in. That's called the Q factor and Q equal greater than one, that is more energy out than inside in, is a critical milestone. Now, we are well on our way, I believe, approving it. A year or two this way or that, but I'm almost convinced in the 20s, multiple parties will be able to demonstrate Q greater than one, and a few Commonwealth being among the leaders in fusion will be able to demonstrate it with technologies that directly produce power plants, not sort of a demonstration, but production technologies or pre-production technologies. So nothing will be designed in a way that can't be scaled immediately.
So a timeline would be, you prove it by 2025, 26, aliens claiming it can do it sooner and be great for humanity if they did. But in the 20s, we will demonstrate fusion, which is Q greater than one, more energy out than in. Hopefully, with production technology, we'll build the first power plants in the early 30s, and then we'll start to scale them. And if you take my strategy, if you build your fusion reactors to be compatible with coal boilers, not coal power plants, so they don't replace coal power plants. And we can come back to the political dynamics of that in a minute. You're in a very good shape. You're just building boilers. They happen to be fusion boilers. And I'll tell you a story. In the Second World War, the 10 years before we had built something like five or less than 10 Liberty Warships in the 10 years before the Second World War, in the five years post the war starting, we got committed to building Liberty Warships. And starting at the San Ramon Ironworks, not far from Silicon Valley here in North of San Francisco, we built 5000 warships in five years because we were committed to it. I contend a fusion boiler will be simpler than a Liberty Warship and much smaller in size. And so can we build by the early 40s once we have the production technologies scaled up a thousand a year? Absolutely. We could replace every coal and natural gas power plant in this country with a fusion boiler in less than five years is my belief. And that is my hope for humanity and vision for the future of fusion.
There's a question on the tip of my tongue. I know it's an optimistic view. It's very optimistic. I brought you on for the optimism. So you're giving me what I wanted. The question on the tip of my tongue is a little bit hard to express, but I hope I get it in my first go. You're optimistic that this breakthrough moment in fusion where the experiment generates more energy than it consumes
is coming sometime in the next few years. But as you said, even the scientific experiment that this technology is based on has never actually been successfully held ever. What makes you optimistic? What are you seeing? What kind of proxies or clues are you or people like Sam Altman? And again, you guys have Commonwealth. He's invested in helium. What are you seeing that makes you think this is possible? The following things. First, for the last 50 years, the best talent didn't go

into nuclear technology's vision of fusion. That's changing rapidly. The best minds, the best PhDs at MIT and Caltech and Stanford want to work on really impactful and exciting problems. Much more capital is going into very diverse experimentation. If you do a plan for something like an ITAR reactor, which is a global effort, that's a 50-year plan. Nobody in their right minds should do a project that's 50 years long. Commonwealth fusion in three years demonstrated a 20 Tesla magnet, which was the single largest risk to making fusion reactors not only possible, but economic in three years. They did what took ITAR 30 years to do in three years, and they have a stronger, better magnet for the first time. We set our minds on some number less than $100 million, much less than $100 million, proving we can build the most critical component, which is the fusion magnet. Now it's building the reactor. I visited the site, a construction facility. The building is almost complete in Devon's Massachusetts. I was there two weeks ago. Very, very exciting for me to see it come together in a way where I totally believe manufacturing will be possible relatively soon thereafter. What's different? The people are different. The experiments are much more modular and shorter. They will prove fusion
10 times faster from magnet to fusion proving than ITAR plans. Maybe it's five times faster. Very compressed timelines, very entrepreneurial efforts, not government efforts, long-term government efforts. That's exciting, but maybe even more exciting. I have a particular point of view. Sam has a different point of view, and I respect his opinion a lot. There are very few things Sam does that I call dumb. I'm presuming Helian is a serious, credible effort, and there's probably half a dozen others that I would say credible efforts in the US alone, not counting all the foreign efforts. Those are really, really important. So diversity of efforts increase the probability of success that one of them will be successful and transformed energy for the humanity in a very, very significant way, very likely. At this point, I'd say it's much more likely than not that we will have fusion power plants, fusion proven in the 2020s, power plant in the 2030s, and massive scaling in the 2040s. Last question on fusion. If this is still speculative, why talk about it? Why not just say, well, we've got fission technology. We've got OG nuclear reactor technology. Let's just stick with that. My view is, even if I got a new reactor design, getting a permit to build it near San Francisco would be 10 or 15 years just to get through the public hearings because it's nuclear fission. Fusion won't have that barrier. In fact, the facility in Devons really is right next to a community and nobody cares. The biggest problem we've had is when they invited all the townspeople to have a joint, get to know each other. There was traffic jam for the first time in Devons. But other than that, there's no problems at all. So, siding will be accelerated by 10 to 15 years relative to fission or a coal plant for that matter. So, accelerated permitting, simple, safe, and of course, cheap power.
I want to transition now from fusion, which is this brilliant sci-fi futuristic technology that currently doesn't exist anywhere in the world, but might someday be the most important technology that we come up with, to something that's the opposite in every single way, and that is cement. Cement is boring. Concrete is boring to most people. It is boring in part because it's so ubiquitous. Concrete is the most used material in the world after water, and it is an incredibly energy-intensive manufacturing process. Talk to me a little bit about why you find cement interesting
and what you've invested in to help green, so to speak, green in quotations as a verb,

the process of making cement and concrete. So, let me start with the story. In the Second World War,
the U.S. needed to apply planes to China. They took old skeletons of calcium carbonate out from under the ocean, dredged them up, laid them out, crushed them out, and they reset as cement that was airstrips a plane could land on. That is what cement is. Calcium carbonate going from one form to another, or more complex chemicals, including silicates and a few other things, but essentially you take limestone, which is rock, drive off the carbon dioxide by heating it to a thousand degrees or higher, and taking the lime, which is calcium oxide, and essentially recombinating it into carbonates.
But you're producing the one using a lot of energy to heat up rock and gigatons of rock and driving a lot of carbon dioxide into there. If you could capture that carbon dioxide and put it back in the cement as carbonates, you've done two things. Increase the production capacity of the plant, reduce the cost per ton of cement, and produce the lower carbon cement. And if you start to replace the heating in the kilns that heat the limestone up, you've then reduced the other half of the carbon dioxide production from energy, whatever is used to produce heat.
So two parts of it. One is the carbon dioxide you drive off limestone, and the other is the heating of the kiln. This power plant in Redding, California this year would demonstrate that we can produce, capture the carbon dioxide and put it back in, and produce carbonates that behaves like cement. Sets the same, sets as fast, sets as strong, has similar characteristics, so it can be used to build your freeways or your house. So we'll be doing that. Then the second phase becomes
replacing the kiln with either electric cans or other renewable sources of energy for heat, and we have companies doing that too. And so that'll be phase two to go from a 50% reduction in carbon footprint to much lower. But there's something really, really optimistic about this.
We are not doing what some others are doing, trying to bubble carbon dioxide through cement to get it captured, which is a niche market. You can't do it everywhere. Or using some other materials like silicates and others, and I won't go into the detail, there are niche approaches that do a little bit. This is a scalable approach that does a lot. And existing cement plants.
So existing cement producers will become your friends, not your enemies, because you're replacing that. By the way, it's same story in fusion. I gave you a story of replacing existing coal plants, extending their life, making their owners feel better, and your friends, not your enemies.
That's the politics. You want to upgrade existing infrastructure much, much cheaper than any expert would say the energy transition costs. Because you're upgrading existing plants, you're simplifying the politics because those facility owners become your friends, whether it's cement or coal power plants, and they become your boosters. So timelines are much, much shorter. Permitting is
simpler. You don't have to have the capex to build all these plants. So these silly numbers you hear about trillions and trillions of dollars, it'll have incrementally, and it'll happen because this is economic to do with high rates of return on the capital needed for upgrade.
So that's why I'm optimistic about cement and fusion.
It does seem like a thesis of yours that I'm connecting across all these categories is you're thinking about deployment problems that are downstream from solving the scientific problem.
So you think, if we solve fusion, how do we take advantage of existing coal plants?

If we solve the clean cement problem, how do we take advantage of existing cement plants?
If we have to decarbonize the problem of dirty aircraft fuels, how do we find a way to do that
with the existing fleet of aircraft that exists without having to overhaul everything?
So it seems like one of your theses that's operating here on the entire climate space is,
how do we find a way to be both radical in our scientific approach and in our optimism,
while realistic about the fact that we can't simply wave a wand and just have the entire
capex expenditure of all these places, whether it's industrial development or aircraft,
we can just wave a wand and have it all disappear. We have to use what's already built.
Is that a purposeful thesis that you're applying across these categories?
So yes, we are thinking of scaling at very large scales. And I find pundits reports on scaling
stupid because they're not seeing innovation. They're extending technologies from the past.
If you scale power, solar power, what happens? Well, I'm thinking about it differently.
How long does it take to build 5,000 nuclear plants? Well, I'm thinking about it differently.
You don't have to build new plants. You don't need 15 years to permit each plant.
Land use is critical. Resource use is critical. So we do look at that. And then the capital
flows have to have high rates of return per capital to flood in. And if I can prove the rates of
return, then capital is not an issue. Last question. What do you say to skeptics who say
you're just making stuff up? Green cement, fusion, none of this stuff exists. Why pay attention to it?
First, I would say skeptics never did them possible.
You have to be optimistic. But this idea that things haven't been proven so they won't happen
is what experts and pundits do. That's not what doers do. Doers go do shit.
Sorry for that word. And they get things done.
So take AGI. Two years ago, people said impossible. This won't work. Scaling large language models
won't work. Suddenly, chat GPD grows six times power, five times faster to 100 million users,
then ticked off. So it's not proven till it's proven is sort of my view. And I look at the process
steps along the way of making something happen. We invested in OpenAI four or five years ago.
And we expected a sequence of steps that were relatively predictable. Exactly when this
Kitty Hawk moment was for AGI or AI, one couldn't predict but didn't need to. We knew it would come
and the consequences would be really, really consequential. 100 million users in 60 days.
It's just unthinkable. People would say it would never happen again.
Now, ticked off was more like a year or just under a year to 100 million users. Well, it happened.
I would suggest all the process steps to fusion are on this path of a Kitty Hawk moment,
like AGI, AI just proved to us. And so that's what makes me optimistic. It's not just irrational
optimism. That is all the time we have. Vinod Kosla, thank you so much. Great. Thank you very much.
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