The Single Best Guide to Decarbonization I've Heard

The energy expert Jesse Jenkins walks me through the path to our climate goals.

Tuesday, September 20th, 2022
Ezra Klein

I'm Ezra Klein. This is "The Ezra Klein Show."

This is a long episode. It is a hefty pod. And it is worth it.

I've been wanting to do something like this for a long time. The backdrop here is very simple. Decarbonizing the economy, it is the — or at least one of — the central tasks of our era. A lot of how we think about politics and policy has to work backwards from decarbonization and that means really understanding the path between here and there — what we need to do, what industries we need to change, what we need to build, what people need to buy, which policies and technologies we have to throw at this problem and which we still don't. The challenge of doing an episode like this is finding someone who has all of that in their head all at once and can communicate it.

But Jesse Jenkins can. Jenkins is an energy and climate expert at Princeton University. He was central to the Net-Zero America Project, which laid out some of the clearest and most detailed pathways to decarbonization. And then, he was really, really central to modeling the different versions of the climate bills to understand their effect on emissions and how it was changing as people added policies and took them out. And that made him a key source for almost everyone, the people inside the negotiating rooms, the people trying to cover what was happening in the negotiating rooms, everyone who is trying to understand what this legislation will do.

When we spoke, Jenkins was just back from the White House celebration marking the Inflation Reduction Act's passage. And what I wanted to do with him was try to get a holistic look at both the decarbonization that is needed, and then how the bill will make it easier, and then how there are things that have not been solved by this bill. And I think we did that. Even as someone who has covered climate policy for

years, I learned a huge amount, doing the research here, and even more by having this conversation. And I hope you will too. As always, my email, ezrakleinshow@nytimes.com.

Jesse Jenkins, welcome to the show.

Jesse Jenkins

Thanks for having me. It's a real pleasure. I'm a big fan of the show.

Ezra Klein

I appreciate that. I'm a big fan of your work trying to pass climate bills. I want to begin the conversation here with what we're trying to achieve. You'll often hear this idea or this goal of net zero. Net-zero emissions — when, how? Talk me through what that actually means.

Jesse Jenkins

Yeah, net-zero emissions of all greenhouse gases, so all climate-warming pollutants. And that is basically the point where we stop digging a deeper hole. The first rule of holes is stop digging, right? Then you can figure out how to climb out. And until we reach the point where the total emissions of climate-warming gases from human activities is exactly equaled out or more so by the removal of those same greenhouse gases from the atmosphere each year due to human activities, we're basically contributing to the growing concentration of climate-warming gases in the atmosphere. And that's what drives climate change, those cumulative emissions and the total atmospheric concentrations of greenhouse gases. Carbon dioxide being the most important and most prominent, but also things like methane, nitrous oxides and several other climate-warming gases as well.

So when we say net-zero greenhouse gases, we mean all of those greenhouse gases. And so that the total contribution of human emissions is exactly equaled out by the total contribution of removals from the atmosphere and storage of CO_2 in either back in geologic storage, or in forests and agricultural lands and in the soils or in the oceans, things like that we can accelerate and increase due to human activities as well. So that's the goal for the world to reach. That's what is going to be key to

stopping, preventing the worst impacts of climate change is reaching net-zero greenhouse gas emissions globally as rapidly as possible.

Every year matters. Every tenth of a degree of warming matters in terms of the impacts and damages and suffering that can be avoided in the future. And so we need to get to net-zero emissions globally as rapidly as we can. If we want to keep warming below 2 degrees Celsius, which is a goal that the IPCC has mapped out for us — the U.N. Intergovernmental Panel on Climate Change — and the goal that the world community committed to at the Paris Climate Accords, we need to do that by 2100 or sooner. And if we want to have a reasonable shot at keeping global warming below one and a half degrees Celsius, which is the more aspirational goal that the global community has set, we need to do that quite a bit sooner, in the neighborhood of 2070 or earlier than that.

That means that countries like the United States that have the wealth and the technological capability and, arguably, the moral responsibility given our historic contributions to climate change to date, we need to be on a faster track than that. We need to be reaching net zero by 2050 at the latest really. And that's the goal that the Biden administration is committed to. That's the goal that we looked at in the Net-Zero America Study. And that's the track we're trying to get on now.

Ezra Klein

So let's take the big picture of that. It gets called decarbonization, but as I understand it, basically every theory of how to hit net zero by 2050 looks like this — you make electricity clean, you make much more clean electricity, you make almost everything run on electricity, and then you mop up the kind of small industries or productive questions that we have not figured out how to make electric. Is that basically right?

Jesse Jenkins

Yeah, that's a pretty good summary. The challenge today is that about two-thirds of our demand for energy in the United States is for liquid and gaseous hydrocarbons, so that's natural gas that we use to heat our homes, gasoline, diesel, jet fuel, other liquid petroleum-based fuels, and then the petrochemical feed stocks that we use to produce plastics and medicine and all kinds of other things. And it's just really

difficult to find drop-in substitutes for those kinds of liquid and gaseous fuels at the scale that we consume them. And so the only way that we're going to get to net zero is to knock down the scale of demand for liquid and gaseous fuels. And so that means growing the role of electricity and steam and hydrogen, and other carbon-free energy carriers that don't contain actually any CO2 when we use them.

If we can find ways to then produce those carbon-free carriers with carbon-free primary energy sources or inputs, then we can decarbonize a good chunk of the economy. And so we have to basically grow the one third share that we currently get from those carriers, like primarily electricity, to probably something more like two-thirds and knock down the scale of demand for liquid and gaseous fuels, so that we can use a combination of tools that are generally more expensive and less mature than clean electricity options to go ahead, and as you said, mop up the rest. And so that means a combination of carbon capture for large point sources of CO2 emissions, like say a steel or iron facility, cement production facilities, and large power plants, we can capture the CO2 emissions from those smokestacks and then store them safely in geologic basins. So that's one way to keep it out of the atmosphere.

The other option is to develop liquid or gaseous fuel substitutes that come from carbon-free sources originally. So say we take CO2 from the atmosphere or from plants that originally absorbed it from the atmosphere, and we add some hydrogen that we produce from clean electricity, and we add some more heat and some more electricity from carbon-free sources, well, we can make synthetic jet fuel or other liquids that way. It's very energy intensive, but it can be done in a carbon-free way. And so we can then use some amount of those synthetic liquid fuels to, say, power aviation or other really hard to decarbonize sectors.

And then the final option is — and this is really the fallback plan that we really want to use in limited quantities — is that we just keep using fossil fuels in the most high value applications, and then we remove an equivalent amount of CO2 from the atmosphere to offset that. That's negative emissions. And there's a limited amount of negative emissions that we can really do at any kind of sustainable scale. And so that's really the final option that we want to keep to a limited scale.

So I'm going to break the fourth wall here and say, if you were listening to that, and you're not deep in energy world, energy wonk world, and you're a little lost, that the point of this podcast is, by the end of it, I hope all that is about to become clear. We're going to sort of peel the different pieces of this apart.

But I want to begin on the question of electricity because every path that I seem to see really puts that at the core of everything. And you write and your colleagues write in the Net-Zero Report that, quote, "expanding the supply of clean electricity is a linchpin in all net-zero paths."

So right now most electricity isn't clean. If you plug something into the wall, you're not necessarily getting clean electricity. I don't think it's completely intuitive why electricity is so much better than a liquid you put into something, even in a potential world for the climate. So why electricity? Why has electrifying everything become almost synonymous with decarbonization in climate world?

Jesse Jenkins

Yeah, there's basically two main reasons why electricity is such a key linchpin. The first is that it's a carbon-free energy carrier. And by that I mean it's a way to move energy around in our economy and convert it and make use of it that doesn't emit any CO2 directly when we do use electricity. So think about all our alternatives, we could move energy around in the form of liquid fuels, like gasoline or diesel in a tanker truck or a pipeline, or we can move natural gas around in a pipeline to our homes.

But those are hydrocarbon fuels, and so when we consume them, we break the chemical bonds that link the hydrogen and the carbon, and we release CO2 into the atmosphere. And that's the problem. And so electricity is a way to power our lives — heat homes, power factories, move cars around — that at least when we use the electricity on that end, doesn't lead to any CO2, or frankly, any other air pollutants and other combustion-related pollutants that cause public health impacts.

So then the challenge is we need to produce that electricity from a carbon-free source, and that's the second reason why electricity is so key because we do actually have a lot of different ways to produce carbon-free electricity. Right, about 40

percent of our electricity today is already carbon free. About half of that comes from nuclear power plants that we built out over the ‘70s and ‘80s. And the other half comes from hydro power and more recently, the large-scale growth of wind power and solar power. And we have other options that could be coming down the line in the future as well.

And so if we can grow the share of carbon-free generation, we can decarbonize both the front end of the supply of our energy carriers. And then when we consume that carbon-free electricity on the other end, it doesn’t emit CO2 either. And there’s just a lot more ways to produce carbon-free electricity than there are to produce liquid fuels or gaseous fuels, which are pretty much limited to biomass-based fuels, as the only way to kind of make a drop in carbon-neutral fuel that doesn’t itself use a lot of electricity to produce.

Ezra Klein

But this is a really big job. You had this statistic in a lecture that has been knocking around in my head — that it took 140 years to build today’s power grid. Now, we have to build that much new clean electricity again and then build it again, so we have to build it twice over in just 30 years to hit our goals.

Jesse Jenkins

That’s exactly right.

Ezra Klein

That seems really hard.

Jesse Jenkins

Yeah.

Ezra Klein

That seems really hard.

Jesse Jenkins

I mean, we never said deep decarbonization was easy. The good news, we can talk about this later, is it is actually pretty affordable and has a huge amount of public

health benefits that go along with this path. But it is a massive transformation of our energy system, right? We're going to have to rewire the country and change the way we make and use energy from the way we produce it, to the way we transport it, to the way we consume it at a very large scale. And so, yeah, that is the statistic.

If you look at the challenge for electricity is really twofold, we have to cut emissions from the power sector, right? Which already is now the number two, used to be the number one, emitting sector of the economy. Since we have made some progress, electricity is now number two and transportation is edged into the number one position for biggest greenhouse gas polluting sector.

But we have to knock out the rest of those CO2 emissions. That itself is a big enough challenge, right? To go from 40 percent carbon-free electricity to 100 percent as soon as we can. But at the same time, we have to dramatically expand the supply of overall electricity to power electric cars and to power heat pumps that can efficiently heat and cool our homes instead of relying on natural gas or to power industrial processes or make clean hydrogen, which is another option for an energy carrier when we can't use electricity directly.

And so our estimates are that demand for electricity by 2050 in the United States could grow by more than double, by about 115 to 170 percent across a range of different scenarios in the Net-Zero America Study. And so, yeah, we have to eliminate the large share of fossil energy generation in our grid today and more than double the overall amount of supply. And what that means is we have to basically build two U.S. power grids over the next 30 years.

Ezra Klein

The big technological project that America's been engaged in, I think, in my lifetime has been digital. Like the dominant story of how America is changing technologically has been digital. And one thing about digital technologies, Facebook just doesn't take up a lot of land in the real world. They have some offices. I'm sure they have some server banks.

But this is a throwback, in a way, to times when we had projects of national size, like the interstate highway system or the original effort to electrify America that requires

land. And so give me a sense here of the literal size of the land that you estimate we're going to need to use fully or partially for electricity generation and transmission.

Jesse Jenkins

Yeah, in many ways, this is the return to growth in infrastructure that we really haven't seen in my lifetime or yours, Ezra, right? We have been living off of the nation-building phase in the United States that really spans from the New Deal era through to the end of the 1970s. And since we were born, we've been kind of living off of and barely maintaining and expanding that national scale infrastructure that was built out, whether that was rural electrification and the hydro power dams and the nuclear plants and the whole grid or our national highway system or our ports and airports. We really just haven't seen an era of significant investment in national infrastructure in a generation or two. And you can't build a clean energy economy without rebuilding large amounts of that infrastructure.

And so we are going to need to enter a new era of nation building, right? A new era of investment in physical infrastructure that can build a better country. There are huge benefits associated with this, but are going to mean, we are going to see large-scale construction, and infrastructure, and impacts on lives. And so we have to guide that process in a way that doesn't recreate some of the harms of the last era of nation building, where we drove interstates right through the middle of Black and brown communities, and they had no say in the process. So that's the challenge at a high level is like how do you build a national social license and sense of mission or purpose, and how do you guide the deployment of that infrastructure at scale, which doesn't concentrate harms and spreads benefits amongst the people who really should be benefiting.

Ezra Klein

We're going to get into all this. Give me the scale here. I want to hear the scale.

Jesse Jenkins

Yeah, so let's go to the scale. The total like visual footprint or spatial extent of areas that would be sited with solar and wind farms —

Ezra Klein

Wait, hold on. What do you mean by visual footprint? Is this the land that things are going to need to go on or just the amount of it that we can see?

Jesse Jenkins

Yeah, so if you think about the — I don't know if you've driven by a wind farm, but you've got wind turbines that are spaced out quite a bit. And that's in order to avoid shadowing each other with the wakes of one wind turbine. That means they span a very large area. And so I'm talking about the total area around all of the wind turbines that make up a wind farm or all of the solar arrays that make up a solar farm.

Ezra Klein

Got it.

Jesse Jenkins

And so the visual impact is actually even further than that. Because if you think about a giant wind turbine, you can see that quite a bit further than the boundary of the wind farm site itself. So but as a proxy for that, it's a similar order of magnitude. The most cost effective of our net-zero scenarios spans an area that is equal to Illinois, Indiana, Ohio, Kentucky and Tennessee put together. And the solar farms are an area the size of Connecticut, Rhode Island and Massachusetts.

Ezra Klein

Holy crap.

Jesse Jenkins

So these are big, big areas.

Ezra Klein

And that's in the efficient scenario where we make all great decisions and use our land as efficiently as possible to generate electricity?

Jesse Jenkins

Well, that's in the lowest cost one. It's not necessarily the most land-efficient scenario. There is a more land-efficient scenario that uses about half that much land area. But in order to unlock that scenario, we have to build a very large amount of new nuclear power plants, or natural gas plants, carbon capture, or advanced geothermal, other more energy-dense or compact technologies that are generally more expensive and less mature today. That could be an option too.

But those technologies face their own siting challenges and their own social license issues. And there's a scenario that actually used double that. If we want to go entirely renewable, we want to completely get rid of fossil fuels in any way and don't use any carbon capture or continue to emit any CO2 and use negative emissions from fossil fuels, then we actually need double that amount of land area. So there's a huge, huge scale here, and we get to choose which of those paths we want to go down, but we can't really avoid the need to build large amounts of infrastructure.

Ezra Klein

I know it's bad form to shout in audio formats. So there's a weird tendency sometimes in a podcast when you're talking about something completely insane, but everybody has a totally normal tone of voice. But I want to say that if you're listening to that you're like, oh my god, that sounds completely beyond anything that we have done as a country, functionally, in memory, I think that is correct.

And there's something from the report that I want to quote here. You write that achieving the required additions by 2030 of utility scale solar and wind capacity means installing 38 to 67 gigawatts a year on average. The U.S. single year record added capacity is 25 gigawatts, which we did in 2020. So we need to on average be somewhere between — be around doubling our best-ever year in solar and wind capacity installation year after year after year after year.

By no means is that impossible, but it is a profound construction challenge. If you want to know why I have become so obsessed with building on the show, this is why. It is a building challenge that is a real step change from where we've been as a country for some time.

Jesse Jenkins

Yeah. It is a substantial project to build new infrastructure across the country. We can accelerate these rates. We have seen records smashed in the past. The challenge is to basically smash new records every year for the rest of our lives.

So we just have to keep the pedal to the metal and keep growing. The good news is while we did hit that peak in 2020, as we reported in the study, which came out at the end of 2020, we actually have now exceeded that peak in 2021. And for solar, the U.S. Energy Information Administration estimates we're actually on track to already have doubled the 2020 peak by the end of this year.

Ezra Klein

Wow.

Jesse Jenkins

We built about 10 gigawatts of utility solar in 2020. The E.I.A. thinks we'll build about 20 gigawatts this year. So things change, we can grow.

Ezra Klein

That's really exciting actually.

Jesse Jenkins

Yeah.

Ezra Klein

One thing that I want to hit on the other side of this is that as much as the scale of what we're talking about here is pretty intimidating in a way. The fact that we can talk about it as a pathway is almost something close to a miracle that we're only able to talk about these decarbonization pathways because solar, wind, and battery costs have just plummeted in price way, way, way beyond what was forecast over the past 10, 15 years. And even as our politics hasn't moved as quickly as people hoped, the technologies here have moved much faster than even optimists expected. Can you talk a bit about that drop in price and what it has unlocked?

Jesse Jenkins

Yeah, this has been absolutely transformative. And I do think it's the fundamental factor behind the increased policy ambition and the increased private sector commitments that we've seen in the last few years. Part of that's the urgency of climate change, the fact that we're seeing real damage all around the world from climate disasters every week, it feels like. But the other part of that is that the cost of action has transformed.

The last time Congress took up and failed to pass climate policy in 2009 and 2010, solar PV cost 10 times as much as it does today, and wind, onshore wind farms, cost three times as much as they do today. So we've seen a 90 percent decline in the cost of both solar PV and lithium ion batteries, which are the major cost component in electric vehicles and our main source of growing grid scale energy storage to help deal with the variability of wind and solar on the grid. And so those costs have come down by a factor of 10, and we've seen about a 70 percent decline in the cost of wind over the last decade. And that changes the whole game, right?

If you think about what it would take to get 10 times as much political will to act, that's a huge effort, right? There's a lot of organizing. There's a lot of transforming politics to get 10 times as much political will. That's basically what we unlocked by driving down the cost of solar PV and lithium ion battery packs by a factor of 10.

We made it 10 times easier to take action. So for a given amount of political will, we can do 10 times more decarbonization in the power sector and in transportation, which are two most heavily emitting sectors than we could do a decade ago. And that's, I think, what has enabled us to contemplate this audacious goal of building a net-zero America.

Ezra Klein

So this period we're talking about, this is pre-Inflation Reduction Act, pre the decarbonization financing and investments and rules and ideas in that, in the bipartisan infrastructure bill, and the Chips Act. So how does this set of bills, but I think it's primarily the IRA, how does it make scaling wind and solar easier?

Jesse Jenkins

So what the Inflation Reduction Act does at its core is focus on making clean energy cheaper. And it does that in two main ways. The first way is with subsidies, right? So there's a big package of tax credits that does the bulk of the work. But there's also rebates for low-income households to do energy efficiency and electrification.

There's loan programs that can help offer lower cost financing for projects. There's grants that go out to states, and rural utilities, and others to help install things. And all of that is designed to make the cleaner option the good business decision, the good household financial decision. So that when you're a utility thinking about where you want to purchase new electricity from, or you're a fleet manager for Amazon thinking about what kind of delivery vehicles to buy, or you're you or me thinking about how we want to get around town, what kind of vehicle do we want to purchase when the current one wears out. All of those decisions, we basically are putting the thumb on the scale heavily for the cleaner option over the dirtier option.

So that it just makes good economic sense. And that clean energy is cheap energy for everybody. That's with subsidies upfront, but it's also going to kick off the same kind of innovation and incremental learning by doing in economies of scale that unlock those tremendous cost reductions for solar, and wind, and lithium ion batteries over the last decade. The reason that these aren't expensive alternative energy technologies, as we called them in the 2009 era, and are now mainstream affordable options is because we used public policy.

We, in the broad human sense, right? So Germany and Spain and China and the United States and a whole bunch of different countries decided to subsidize the deployment of those technologies when they were expensive, create early markets that drove innovation and cost declines and made them into tremendously affordable options for the future. And so we're going to kick off the same kind of processes as well with this bill, building on the demonstration and hubs funding and things like that in the infrastructure law for the next generation of technologies that can take us even further down the path to net zero beyond 2030.

Ezra Klein

So let's dig into to some of the pieces at the core here. For most of the time I've been in politics, there has been a theory of what we'll do about climate change. And that is

that we will in some way or another price carbon higher, price activities that emit carbon and other greenhouse gases in some accordance with their true social cost, the true cost of climate change, and then the market will adjust to the new prices and create a clean energy economy. In this case, as you say, we are instead of pricing carbon, we're subsidizing decarbonization.

So what? So there are these clean energy production tax credits. How do you get one? What do they do? Like, what is the difference between the pricing theory that people may have heard about for years and years and what we've actually settled on, both have had in the past and are expanding now, which is tax breaks, tax credit, loan guarantee subsidy theory?

Jesse Jenkins

Yeah, so if you think about it — unless you are valuing either the damage caused by pollution and climate-warming greenhouse gases, or you're valuing the public good of not emitting those things in our economy, you can't expect businesses to just sort of magnanimously go and choose the cleaner option, at least not at the scale and pace that we need. And same with households. You shouldn't expect everyone to just be altruistic. We have to make it make good financial sense for everyone to make the clean choice. And so there's two ways to do that. You can make fossil energy more expensive to price in the true cost of consuming fossil fuels for society, which includes all of the climate damages that are going to occur down the line because of accelerating climate change, but also air pollution and public health impacts, water quality impacts, all the other impacts of our fossil energy system. So if you're an economist, you want products to represent their true cost, right? That's the most efficient way to orient an economy towards the best outcomes. And that's true from an economic theory perspective, right? We want to make sure that when people consume fossil fuels, they know that they're causing a certain amount of damage and that the benefits they're getting from that consumption exceed those damages. And if not, don't consume.

Now, the challenge of that, of course, is that making fossil energy more expensive is not a very politically attractive proposition. I mean, look how challenging inflation and the run up in energy prices has been for politicians around the world over the last year. So the alternative to that, which is admittedly less economically efficient,

but much more likely to succeed in the real world, is to recognize that cleaner energy sources deliver some public good. They deliver a benefit of cleaner air, less air pollution and deaths and mortalities and asthma attacks and less climate damages. And to subsidize their production, so that we get more from the clean sources.

And that's effectively what this bill is doing. And it's essentially shifting the cost of energy consumption to some degree or the cost of investing in the energy transition off of household and business energy bills and onto the much more progressive federal tax base. And not just all taxpayers, but in particular, the Inflation Reduction Act is funded by a new 15 percent corporate minimum tax on companies that make a billion dollars a year or more that haven't been paying much in taxes to date. And by expanding I.R.S. enforcement on tax cheats.

So if I sort of sum up the whole bill in one nutshell or one tweet, it's that we're going to tax billionaire corporations and tax cheats, and use that money to make energy cheaper and cleaner for all Americans, and also to build more of those technologies here in the United States, which we can talk about later. And so if I sell it that way, that sounds like a lot better prospect from a political perspective, than, I'm going to make your fossil energy more expensive. So you consume less of it and spend more money on cleaner sources, which is effectively what the alternative strategy is.

Ezra Klein

So I want to talk through some of the challenges and criticisms here. And I'll start with this one. The way you describe that, I think the way the bill really works is it implies, in a way, that the problem here is money. And one problem here, certainly, is money. That if there were more money to build these things, more subsidies, we would build more of them.

But to what we were talking about a few minutes ago, the amount of land you need, the difficulties of permitting these in particularly places where you have richer constituencies that are very good at organizing against things, you have all these other difficulties. You have supply chain problems. Is the problem here just money? Pumping a bunch more money into the system, will that get us the deployment, the ability to permit the site to build fairly, to have good processes that we need?

Because nothing in this bill really changes our capacity to plan. There's no central coordinator, or the federal government doesn't have vast new powers to decide where things go. So I worry a little bit that we're solving the money problem, but there's a lot of other reasons we end up building things slowly and over budget than just money.

Jesse Jenkins

Yeah, I mean, I worry about those things too. Those were big emphasis points in the Net-Zero America Study. Once you start to really unpack the scale and pace of change that we're talking about, you inevitably start to be concerned with some of those other kind of rate limiting factors that constrained how quickly we can make this transition.

But let's also not forget that the money talks, right? That finances is a necessary condition, if not sufficient. But what this bill does is aligns all of the financial incentives, or at least most of them, behind making the right clean energy choices. And without that, there's no way we're going to make progress at the pace we need. So it is a huge shift in the economic calculus for everyone across the country that will make it so much easier to move down that path but, yeah, will not solve all of the problems.

I do want to say, though, that all those problems, whether it's expanding and permitting transmission, or growing the clean energy work force, or figuring out how we're going to transition parts of the country that are dependent today on fossil energy for their local economy and give them a stake in the new clean energy economy. I mean, all those challenges exist already, absent this bill. But what changing the financial incentives does is it means there's billions of dollars of profit for companies to make and billions of dollars of savings for local regulators to unlock for their ratepayers and energy consumers, there's billions of dollars of economic development to secure by county officials and local elected officials if you can overcome those sorts of barriers. And so aligning the incentives isn't sufficient, but it does mean we now have a lot more very clear reasons for a lot more constituents to try to get to work solving the next set of challenges. And so that's a huge step forward.

Ezra Klein

One striking thing about the past decade in American politics to me, though, has been that money talks and sometimes politics really shouts. I covered the Affordable Care Act really closely, the Medicaid expansion was just backing dump trucks of money up to states to give them more capacity to put people on Medicaid. The Federal government paid at the beginning all of it, later on 90 percent of it. It has been a huge, huge, huge fiscal boon to states and still 12 states, primarily red ones have not expanded Medicaid for political reasons.

So when I look at the report, I look at the top 10 states for wind capacity — Texas, Missouri, Iowa, Illinois, Nebraska, Minnesota, New Mexico, Montana, Oklahoma, Arkansas. I look at the top 10 states for solar capacity — California, Texas, Florida, Georgia, Pennsylvania, South Carolina, Virginia, Alabama, Missouri, Nebraska. It's a lot of red states on there. In fact, a bunch of those haven't expanded Medicaid even now.

And so one of the risks I see here is politicization — that if solar and wind energy become part of the partisan culture war, you could see a sort of non-money based reason that a lot of states don't do the permitting or fully participate in this. How do you think about that?

Jesse Jenkins

Yeah, I think that that's a concern. But with Medicaid expansion, you are talking about state-administered programs that benefited largely constituencies that the Republican governors were not out to go win as their base of political support. The Inflation Reduction Act is primarily implemented through the federal tax code, so states don't really have any role in implementing that. It's the I.R.S.'s guidance and Treasury guidance that says what are the rules for implementing these tax policies. And then it's the private sector and individual households that go and make different decisions based on those financial incentives from the federal level.

And so there's really nothing that governors can do inserting themselves into the direct implementation of those policies. There are a few state-administered programs, like rebates for energy efficiency and efficiency upgrades in low-income households. And I do have concerns that those may not be universally rolled out

across the country for political reasons. But the vast majority of the incentives and the vast majority of the emissions reductions work done by this bill is done through the tax code.

The second reason that I think it's a little bit different and by deliberate design is that the bill, in addition to making clean energy cheap, represents a substantial industrial policy that is designed to bring real economic tangible benefits to communities of different types all over the country and in many ways disrupt the current politics around climate and energy policy. And so for example, there are a set of tax credits for advanced manufacturing of solar, wind, battery and electric vehicle components and assembly in the United States, as well as critical minerals processing, as well as a set of incentives that encourage investment in new clean electricity and advanced manufacturing in communities that today are dependent economically or derive a lot of their economic activity from fossil energy activities.

And both of those are designed to really deliver tangible economic benefits all over the country in a diverse range of communities, including in purple states, and red states and counties and areas across the country. And so maybe another analogy to think about is the way the defense industrial complex works, where we sort of scatter these facilities all over the country, so that every congressional district has some stake in the next military appropriations bill. In some ways, that's what the Inflation Reduction Act is going to do. Not quite as directed and controlled as the military budget, but there are a set of incentives in the bill that are designed to make sure that a broad swath of the American public and a diverse range of communities have a direct tangible economic stake in expanding and continuing to grow the clean energy economy.

And so when it's not just some hypothetical thing that liberal states are proposing, but it's a new battery assembly plant in your neighborhood that employs your friends or your cousin, or it's the new advanced nuclear power plant that powers an old coal plant and sustains the tax base and the IBEW Union jobs in your community, those are the kinds of things that I think shift people's real world experience around what a clean energy economy means and shifts the way they think about the politics and policy.

This is sometimes where I think Elon Musk's turn into a conservative shit poster is a good thing.

Jesse Jenkins

[LAUGHS]

Ezra Klein

Because to have a major industrialist whose whole thing is the clean energy economy — Tesla and solar installations and building gigantic battery plants. To have him code it as very conservative, somebody who really doesn't like the left anymore, strikes me on the margin as valuable.

Jesse Jenkins

Yeah, it drives me crazy, but I think you're probably right in terms of the net impact on society. And there is, of course, our tribalism and identifying our champions, and who's in or who's out, and that kind of drives a lot of this. But I do think it's going to be those on the ground realities that dictate, in the end, whether or not we can sustain these kinds of transitions or not.

And so I do think it's a really important element of this bill that it's not just trying to make clean energy cheap to reduce emissions; it's trying to make clean energy cheap so that people benefit in terms of lower energy costs and lower household bills. And it's trying to distribute the economic investment and revitalization that is going to come along with all that building and all that manufacturing into communities that really need that benefit and will potentially transform their economic stake and therefore, hopefully, their political views about where we go next.

Ezra Klein

Well, let me get at that point about revitalization, about trying to spread a lot of this money geographically, widely. When I've talked to the Biden administration about this bill, something they're always very keen to tell me is that it isn't just money, it is standards. This bill is full of standards.

And then when I talk to critics of the bill, one thing I hear is that a real problem is that this bill is full of standards. That if you just look at the decarbonization task —

the land use we were talking about, the speed we need to do it. It is inhumanly hard already. But all over this bill is the tying of decarbonization money to other kinds of priorities, so project developers only earn one fifth of the clean energy production credit's original value, unless they meet worker training and competitive wage conditions. Part of the credits value in a bunch of different places is based on whether you source components from domestic manufacturers. And I can keep going on like that. And all of these standards are getting at things that I support — good jobs, and geographic equality, and revitalizing a bunch of communities that need it, and we keep talking about it. But there is this concern that adding these standards on top of a task that is already so difficult, makes it that much less likely that the task is achieved. How do you think about that?

Jesse Jenkins

Yeah, I think that has it exactly backwards, really, because already the Inflation Reduction Act is insufficient. It's a huge step forward. But our estimation from the Repeat Project is that it cuts about two-thirds of the annual emissions gap that we need to close in 2030. It still leaves about a half a billion tons of emissions on the table that we need to tackle with additional policies. And that's just 2030.

We still have to go all the way from there to net-zero in 2050. And that, of course, is assuming that we can build transmission in wind and solar at the pace that makes economic sense. So if we can't do that, we're going to fall even further short. So this is a big step down the road to net zero, but it is not the last step we need to take. And we need to sustain and accelerate this transition.

And so when I think about the challenge of decarbonization, I think about how you unlock feedback loops and how you change the political economy of decarbonization by disrupting current interests that might oppose clean energy transitions and building and strengthening interests that would support them. And so the bill is not just trying to cut emissions at lowest cost through 2030, so we can hit some interim goal on our path to net zero. It's trying to transform the economics, and therefore the politics, of the clean energy transition. And I don't think we can get to net zero, unless we can do that.

And so, yeah, you do have to onboard new workers through apprenticeship programs and pay them prevailing wages if you want to build wind and solar projects. OK, you can do that. That's not going to slow down the clean energy transition in any significant way. But it is going to build the work force that we need and expand the number of people that are employed in good family-sustaining jobs in those sectors. So that when they see a wind project go up, they say that's our economic future, not that's this big eyesore, and money, and taxpayer dollars going to import stuff from China.

I just don't think we're going to sustain the clean energy transition and diversify the set of communities that have a clear political stake in continuing that transition if we don't drive some of these kinds of broad benefits that the bill is trying to do. And so I think that it may make things more challenging over the next couple of years as we establish these kinds of new standards and the industry gets used to complying with them. But in the long term, I think when we look back in 2030 or 2032, a decade from now at what this bill did and how significant it was, it won't necessarily be the direct emissions reductions, it will be the way it has reshaped the politics of clean energy in America.

Ezra Klein

One of the places where I think this argument has a little bit more bite is around supply chains. So I agree with you that it does not slow down clean energy to do apprenticeship programs, to pay good wages. I'm pretty comfortable with those. There is a lot in this bill about how much of this or that needs to be sourced from American supply chains. We'll talk about the electric vehicle tax credits later.

But that's a place where you have these very big tax credits that are looking for electric vehicles produced efficiently through a domestic supply chain, that most of them wouldn't apply really to vehicles that are sold in America today. And same thing's true on batteries, where there's a really big push in the bill to create domestic battery supply chains. And I want all that.

But supply chains are slow to build up. There's mineral questions, resource questions, and that is a place where I could see the other goals of the bill, as laudable

as they are, slowing things down — in some cases, substantially. So I'm curious how you think about that dimension of it.

Jesse Jenkins

Yeah, I do think those concerns are a little bit overwrought. They are real in the very near term in the sense that the personal vehicle tax credit that's available to folks like you and I that might want to buy a new electric car, there will be a limited number of vehicles at the outset that qualify for that because of the domestic or North American sourcing requirements. And in particular, in a couple of years, the prohibition on sourcing any materials for the batteries or critical minerals that go into those batteries from China, in particular, which currently controls a good chunk of that supply chain. And so it may be that we don't have a substantial number of vehicles that can claim that tax credit over the next couple of years.

On the other hand, automakers are already selling every E.V. they can make. And that's in an environment where the most popular electric vehicle makers, including Tesla, GM, soon Ford, Toyota, as well, have all run through the current subsidy. There's a limit under the previous law that each manufacturer can only produce 200,000 electric vehicles before the subsidy expires. And so the most popular E.V.s I've already blown through that. And yet demand for them continues to be more robust than the manufacturing capacity.

So in the near term, if you're just worried about the speed of the transition, I don't think there will be any impact either way whether or not we have this subsidy or not on the total volume of E.V.s sold in the next couple of years because we are still scaling up that supply chain and demand already outstrips supply. The question is, as we build out that supply chain, which we have to do in either case, do we build it in the United States or do we build it in China, or Europe, or elsewhere? And what the bill is emphatically saying is you should build it in North America.

And in particular, we'll pay you to do the battery assembly in the United States to the tune of a particular production subsidy, as well for battery materials and assembly in the U.S. And so there are going to be probably a trillion dollars invested in this sector over the next decade. We've already seen a couple hundred billion dollars of commitments made by automakers and battery manufacturers to open new facilities

to meet the growing demand for electric vehicles. And what this bill is going to do is it's going to drive that investment into the U.S., instead of elsewhere. And I think that, again, is really good in the long term for sustaining the economic interests and the political coalition that we need to continue down the path to net zero. So, yeah, I think the big headache is that they're going to be in the near term models, they'll be on the list, and then they're off the list. And it'll be hard for consumers to necessarily know what to expect over the next couple of years. But by 2024 or 2025, these new investments in factories that we're seeing every week get announced are going to start coming online, and that's going to really change the game.

[MUSIC PLAYING]

Ezra Klein

We've been talking here primarily about wind and solar, which I think is appropriate because they're pretty core to the future that's being envisioned. But they have problems. The sun doesn't always shine; the wind doesn't always blow. You have this nice analogy — that trying to build an entire grid on weather-dependent sources it's like trying to win the NCAA finals with a team of all point guards.

And I'm not really a sports guy, but I guess it's probably hard to do that. So build out the rest of the team for me. Beyond wind and solar, what do you see as playing the central or most promising roles here?

Jesse Jenkins

Yeah, the other analogy I often use is that of a balanced diet. You can't eat only bananas, and you don't want to only eat burgers, you want to eat a diverse mix of different parts of your diet. And so whether it's trying to have all the right star players playing the right position on the court or trying to balance out your diet, what we need to build is an effective energy system that consists of team of different roles. And we break it down in our research as basically three key roles.

The first is the one that wind and solar fill and other weather-dependent variable renewable resources. And we call those fuel-saving resources. If you think about what a wind farm is, it's a bunch of steel, and copper, and capital that you invested upfront that then has no fuel costs. You can't count on when the wind is going to

blow, but when you have it, you can stop using some other more expensive fuel-consuming resource, like a natural gas power plant or a coal plant. And by the way, also avoid the pollution and climate-warming gases that go along with using those power plants.

And so the role of wind and solar is effectively to displace the fuel consumption of other potentially more dependable resources in the grid, maybe not necessarily to shut down the power plant as a whole, but to use it less and less. And that is real value because every time we burn natural gas or coal, we're consuming something that costs money. And if we can avoid that, then the wind and solar farms are effectively delivering value in the value of the avoided fuel, and of course, the social value of the avoided emissions.

Now that's a big role, but it's not the only role that we have. And because their output is variable, as well as demand for electricity which goes up and down. We need a second key role, which we call fast-burst or balancing resources. And that's where batteries, battery energy storage, as well as smart charging of electric vehicles or other ways to flexibly move around when we consume electricity — or you live in California, I think, Ezra, the flex alerts that you got recently during the heat waves, people can cut back on their energy consumption at the most challenging times through demand response programs. They should get paid to do that, by the way, not just do it out of altruism. And all of those forms can give us kind of short bursts of flexibility that can help better align supply and demand with those variable demand and variable wind and solar resources. The problem with those is that you can't really sustain their output for a long period of time. You might be willing to participate in that flex alert from 6 p.m. to 10 p.m. on a couple of really hot days, but you're not going to do that every day for a month. And the batteries can go for a few hours, but you're going to drain the battery after four or six or eight hours. And so those are really good for kind of within the day kind of variability or occasional needs.

But what we need are technologies that are not constrained by the weather and are not constrained by a duration limit, that can go as long as we need them, whenever we need them. And that's what we call the third category, which are firm resources or clean firm resources, because we want to replace the dirty ones with the clean

ones. And so today, we rely on natural gas and coal and our existing nuclear fleet for that firm role. But if we want to build a clean energy system and we need all that new clean electricity, we're going to need to build about an equivalent amount as we have coal and gas plants today of clean firm options, whether that's new nuclear power plants, advanced geothermal or similar options like that.

Ezra Klein

OK, let's talk about a couple of these. And I want to begin with the one that people are probably most familiar with, which is nuclear power. You've mentioned that nuclear power is currently providing about half of our clean electricity. My sense is the expectation is that doesn't go up very much, but I also run into people all the time who think it should go up radically. How do you see both the likely path of nuclear and also what the possible path of nuclear could be?

Jesse Jenkins

Yeah, so when I think about nuclear power, I always try to think about there's really two separate questions here. One is what do we do with that existing nuclear power fleet that, as you said, is providing about half of our carbon-free electricity, and, in my view, provides a really critical foundation to build on to enable more rapid emissions reductions. Because if we have to simultaneously replace all of those existing nuclear plants and try to replace the and nuclear and — I mean, the coal — and try to simultaneously replace the coal and natural gas power plants that are emitting CO2 and air pollution, we have to sprint twice as fast in a challenge that's already incredibly difficult.

And so there's sort of an opportunity cost right now where until we've shut down the last coal plants and the last natural gas plants, every single megawatt-hour of new clean electricity, new energy efficiency that we can add to the grid that goes to replace a nuclear power plant is a wasted opportunity to accelerate our emissions reductions and get rid of those dirty fossil fuels. And so when it comes to the first question, what do we do with the existing fleet? I think it is critical that we preserve the operation of any nuclear power plant that can continue safely operating. So that's the existing nuclear fleet. But you can't grow that; it's probably going to shrink.

Those plants are getting long in the tooth and quite old. And so we are going to need to replace those resources eventually with new clean firm capacity. I just hope that we do that after we've already eliminated the coal fleet that is causing far more damage to public health.

Ezra Klein

But I also want to talk here about the path not taken. I get this question a lot. I've tried to look into it myself. We created the Nuclear Regulatory Commission in 1974. Since then, almost no new civilian nuclear plants have opened in this country.

We're not on the kind of learning curve that we could be with nuclear, that we are with on other technologies. And there are a lot of nuclear fans who think this is the great sin of our energy policy — that since the '70s, we could have been on a path of making nuclear much cheaper, much safer, getting better at it, making the regulations more flexible, and we could just have all of this clean, nonpolluting stable non-intermittent energy by now. Next generation nuclear plants have been pretty safe. Even things like Fukushima didn't have — the nuclear meltdown there did not have the death toll people think it does. It's actually really hard to find anybody who died because of the nuclear issue there. And there's just a feeling that we screwed this up and that we're afraid of this energy source that could have been this tremendous generator of clean power without the land use that you need for wind and solar. Are those people right?

Jesse Jenkins

Well, I have less interest in rehashing the past than I do in thinking about the role it can play in the future. To the degree, we can learn from the past in order to inform our future for our decisions. That's good.

Ezra Klein

Right, but if they're right about the path, then we could take that path now.

Jesse Jenkins

Potentially. I mean, things have changed since the 1970s. And so I think that the challenge for nuclear primarily is not the regulatory conditions that exist around

nuclear power plants. I think those regulatory conditions are what has kept the nuclear power fleet incredibly safe, which I think is a prerequisite for continuing to rely on nuclear fission. The challenge in the West — and this is not a challenge globally — is that we forgot how to build big complicated civil works projects.

You know, yes, there were some shifting regulation that occurred while plants were under construction that added to costs of specific nuclear plants in the '70s and '80s. Those are concrete examples of where changing regulation midstream after you've already started building a project, clearly is going to add to the cost of that project. But I don't think the regulatory standards that we have in place right now are the primary barrier to building new nuclear. In fact, we had this whole era of supposed nuclear renaissance in the 2000 when a number of — something like a dozen sites were permitted for new nuclear power plants.

Only four of those started construction. Two reactors at two different sites — one in South Carolina and one in Georgia. It was a disaster. We tried to build large scale gigawatt scale nuclear reactors that provide enough electricity for about a million people each — huge reactors. And they cost tens of billions of dollars.

They're multiyear, incredibly complicated construction, procurement, and engineering projects. And the U.S. isn't very good at that. And it's not a thing that's unique to nuclear.

Look at how long it took to build the Bay Bridge East Span replacement. Look how long it took to do the Big Dig in Boston. We are not particularly good at large scale infrastructure like that in the U.S. because we've lost the practice.

If you go to China or the Middle East, like the U.A.E., where they're building four new nuclear reactors of a Korean design, they have experience building lots of infrastructure in recent memory. And they have much more efficiently and cost effectively built out new gigawatt scale nuclear reactors. So what do you do with that?

Do you say, OK, we're just going to go all in the U.S., and we're going to take the huge costs of those first few reactors and just say you know what? It's going to cost a

ton, and we're going to plow through that. And we're going to commit to building, and learning how to do this again, and drive down those costs. That's an option.

It's a really, really expensive and risky option. Because if it doesn't work, you've committed something like a couple hundred billion dollars to building your first dozen plants. And so I just think that's a challenge to try to get done politically given the risks involved. And so where I see the future for nuclear in the West, and I think where the bulk of the industry and the investment now is focused is on smaller and more modular reactors that instead of trying to power a million people per reactor are trying to power 50,000 or 100,000 people, like a 1/10 or a 1/20 the size of a large scale reactor.

And that means that the bets on each individual one are so much smaller that you can build one for a billion dollars instead of $15 billion or $20 billion. And I think that makes it much more likely that we can get our muscle memory back and get the economies of scale and learning by doing and trained work force developed around building them in series. That's going to be key to building low-cost reactors.

Ezra Klein

So then, something that does end up playing a huge role in a lot of the decarbonization pathways here, and a somewhat controversial one, is carbon-capture technologies. Can you tell me a bit about why they're central, and a lot of the modeling, and just what they are?

Jesse Jenkins

So carbon capture is a term for a broad range of different processes that take CO2 from some kind of combustion or industrial process, capture that CO2 and then either store it somewhere back in geologic basins, the same place that we extract the oil and gas from that has kept it down there for eons or try to mineralize it. They've been demonstrated at a variety of scales. Some of them commercial scale and a variety of applications. Some of them at pilot scale.

And so like new nuclear power plants or advanced geothermal, they're all still very nascent. And we've seen the first demonstration or first a couple of examples of them. And the challenge will be can we scale them up to operate reliably and

affordably? And somewhat uniquely for carbon capture, can we also build the network infrastructure to take that CO2 and do something safe or useful with it? Put it underground or use it in some industrial process. So there is a network challenge there to enable CO2 capture at scale, which is kind of similar to the transmission buildout challenge for wind and solar that building a new nuclear fleet or a geothermal fleet maybe doesn't have to face.

Ezra Klein

I think this is another place where the physical scale of what we're talking about is easy to miss.

Jesse Jenkins

Yeah.

Ezra Klein

I look around, I can't really see any CO2 around me. So it feels like capturing a bunch of CO2 would not take up a lot of space, but your report says, quote, the scale of CO2 transport and storage in 2050 in these scenarios ranges from 1.3 to 2.4 times current U.S. oil production on a volume equivalent basis. So imagine all the oil we are producing and moving around the economy, you're saying that the carbon capture that is being envisioned, which we don't do all that much of now, is going to take up volumetrically — is more than that. That's really striking to me.

Jesse Jenkins

Yeah, it is. And that's if we scale carbon capture to roughly sort of a gigaton scale. We emit about 6 billion tons of greenhouse gases about five and a half now in the United States. And so this is something like roughly one-fifth of all of our greenhouse gas emissions today. If we want CO2 to be able to play that scale of role, like something like a fifth of the solution, then that is the scale of infrastructure that we're talking about.

Now on the one hand, we have already built that scale of infrastructure for oil and natural gas across the country. And if you add up both the natural gas side as well, it's even larger than the amount we need for carbon transport and storage. So that

shows that we can do it from a physical existence proof perspective. But the big difference here, of course, is that oil and gas are a really valuable product that you make a lot of money digging out of the ground and then using somewhere else. CO_2 is a waste product that we are trying to dispose of.

And so unless there's a real economic value stream there, for someone to capture that CO_2 and do something with it, it's just not going to happen at anywhere near the scale that we're talking about. And so that's where, again the Inflation Reduction Act comes in, it increases a tax credit for capturing CO_2 and storing it to $85 per ton up from a $50 per ton credit in place now. And we think that's going to help the industry get off the ground in a variety of different sectors, including some of our most heavily emitting industries, like cement and steel production, where you have to deal with emissions not only from heat and combustion, but also from the actual chemical process used to produce steel or cement which directly emits CO_2 as well. And so we have to find some way to eliminate that, also, and carbon capture is an option in those sectors as well.

Ezra Klein

So there is a segment of the climate movement that just hates this part of the bill, hates this part of the theory, does not want to see a substantial part of our decarbonization pathway built around things that allow us to continue producing fossil fuels in a putatively cleaner way. And I think there's also some skepticism that it really will work technically in the long run. What is that critique? And why aren't you persuaded by it?

Jesse Jenkins

Well, there's two — I think, two elements of that critique. One is that fossil energy companies are themselves primarily responsible for our lack of progress on climate change. That because of their vested economic interests, they have actively disrupted efforts to confront climate change over the long haul. And so climate campaigners, in this view, are trying to delegitimize fossil fuel companies and industries as social actors, the same way that tobacco companies were villainized and basically delegitimized as legitimate corporate citizens. And so that's an effort, that's a

political strategy, that's meant to try to weaken the ability of oil and gas companies to impede progress.

There's a second, and more substantial or tangible reason to oppose carbon capture, which is that if it perpetuates some amount of fossil fuel use — it's going to be dramatically less than today — but some amount of fossil fuel use, then it also perpetuates some of the impacts of the extractive economy and the transport and processing of fossil fuels that have primarily been borne by low income and Black and Brown communities and Native American communities across the country. And so there's an environmental justice argument that continuing to use any fossil fuels is simply unjust and therefore unacceptable.

And so I'm sympathetic to both of those concerns. And I think that I'm humble enough to think that they may be right in the end. And maybe that strategy is the one that will work. But I also am concerned that it raises the political bar to progress. Because if that's your view, you have to defeat head on one of the most powerful industries in the economy — the oil and gas sector.

And an alternative strategy to that is to provide an economic role for those industries in the future and to remove their reticence to embrace decarbonization by allowing them to transition, to find a way that they can transition to play a role — a diminished role, I think — but a role in the new net-zero economy. So it's sort of a question, do you try to turn them, or do you try to beat them, or do you try to do some combination of both from the sort of political perspective? And then there's the environmental justice argument, which is really one of, are we trying to minimize harm, or are we trying to eliminate harm? And if we can make more rapid progress on decarbonization and the reduction of fossil fuel use by using carbon capture, then by trying to wage and all-out battle against fossil energy companies, then that could actually improve environmental justice outcomes in some cases as well. So I think this is complicated. I don't pretend to have a clear answer. And the Net-Zero America Study presents five pathways to get to net zero. One of which we explicitly exclude, carbon capture and any fossil fuel use to try to understand what that pathway would look like. And it's relatively affordable. But by eschewing carbon capture entirely, it raises a whole number of other challenges that we have to be

prepared to address as well. Like I mentioned before, doubling the amount of wind and solar deployed and the amount of transmission we have to build, for example.

Ezra Klein

Yeah, there's a way of framing carbon capture as a political option. You need to do it because you couldn't pass this bill through Joe Manchin. But when I read the Net-Zero America Report on this, that actually isn't how it read, at least solely to me. I mean, obviously, that's a dimension here. But if you don't believe that we have a surefire shot of building the level of wind and solar installation you would need to do a full on renewable energy transition, which I just don't think we do.

When I look at those numbers, when I look at that land use, which is bigger than we've even talked about, I don't think it's plausible. In that world, this carbon capture becomes a hedge. I mean, you're going to be using some transitionary fuels one way or the other over time. And it looks a little bit like given that we're not going to do a rapid expansion of nuclear, it looks a little bit like you're asking the question, are you going to use natural gas with carbon capture or without carbon capture. Because we're just not going to get that kind of wind and solar build out that quickly.

And I think people wish we didn't have to do this middle thing. But given the realities of our building capacity, it seems to me this is playing not just a political role. But again, in a lot of the models I looked through, a kind of just unhappy, necessary role.

Jesse Jenkins

Yeah, I think that's right as well. And that's true for a lot of things, like not everybody wants to spend any money developing new nuclear technology, as well or not everybody wants to embrace geothermal energy because it involves drilling and some potential seismic impacts in certain cases. Every energy technology has certain impacts. And they also have certain kind of — it's odd to see how much values and sort of personal, like supporting your own favorite sports team, you see in the energy world, like people have their technology that they feel like they're part of the tribe, and that's the technology they really prefer.

And that's because certain technologies align differently with different people's values. People would prefer to only use the things that they like the most. And I think one of the challenges, and one of the things I have to try to communicate all the time when we try to unpack energy systems is that you just can't use only the thing you like the most, right? Any time you try to do everything with one technology or a limited set of technologies, you'll inevitably run into situations where you're forcing a solution to try to play a role that it's just not cut out to play. And that makes this already really hard challenge that much harder.

You have to build that much more wind and solar because so much of the wind and solar you build is never used. You're building it for that day when the sun isn't very strong and the wind isn't very strong, and you really just need a little bit more to top up your batteries. And the rest of the time, they're producing way more solar and wind than you could possibly use or could afford to store in batteries or to turn into hydrogen or something. And so you're building a ton of infrastructure that's just poorly utilized if you want to pursue that strategy. And that raises the land use, and it raises the economic challenge, it raises the transmission buildout, mostly because you're pushing wind and solar, again, to not be the star point guard but to do all five positions on the court.

And so it is an important reality of complex energy systems that we need a complete team of resources, and we need a range of options because we're a big, diverse country with different resource spaces, different geographic constraints and different values, frankly. So that some parts of the country really do want to build nuclear power or really do want to continue to use natural gas. Other parts don't want to touch them.

And we need solutions that work in all of those contexts. And so keeping our options open, rather than trying to constrain them is definitely the lowest risk way to proceed these days. Because if you bet on a set of limited set of technologies, and you bet wrong, you've bet the planet, and you've failed. The stakes are that high.

Ezra Klein

But there is a bet here that the technology works. And I've certainly seen a lot of people in the climate movement who are skeptical that carbon capture works or

worry that there will be a lot of crappy installation of it, such that you're not actually capturing what you think you are or you're not storing it in a way that is long-term, that's safe. And so there's a confidence that when you build a wind turbine, you really are creating zero-carbon power. Are you confident that we have or are near to having the carbon-capture technologies to reliably capture, and store, or use carbon for very, very long periods of geologic time?

Jesse Jenkins

Yeah, I'm much more confident, I guess, than some of the critics that you're talking about. But I'm not perfectly confident. I don't know for sure that we're going to be able to scale all of these industries up to the gigaton scale. I think about a decade ago, we know when you build a wind farm now, that we can reliably get carbon-free electricity from it. A decade or two ago, we were talking about whether or not the wind — we could even get to 10 or 20 percent wind penetration without the grid blowing up, without the variability of wind causing all kinds of havoc on the grid.

And we didn't think that was an affordable option. It costs three times as much as it did today, 10 times as much for solar. And so the reason we count on those as mature, sure things now is because we bet on them when they were risky, right? We didn't bet exclusively on wind and solar; we supported a bunch of things. But wind and solar were the technologies that were the bet paid off over the last decade and where they're now mature sure fire things that we can scale up to substantial levels, probably something like half or more of our overall electricity generation by the end of the decade.

That is because we tried them out, and we deployed them at scale, and we got better and better at it over time. And so we don't need carbon capture at scale this decade. The things that are going to do all of the emissions reduction work, really, the bulk of it, are technologies that we bet on a decade ago and are ready to scale now. What we need to do over this next decade is to repeat that same kind of success that we had for wind and solar and batteries with the full portfolio of options that we think we might need at scale in the 2030s and 2040s. And that includes carbon capture, and includes nuclear, that includes advanced geothermal, that includes all different ways to produce hydrogen, which is a critical energy carrier in the long run.

And the policy environment is now finally aligned to do that with the Inflation Reduction Act and the infrastructure law providing both demonstration funding for the first kind of n-of-a-kind, first handful of projects in all of those categories, as well as the first market-ready deployment subsidies, so that we can scale up, and drive down the cost, and improve the maturity and performance of all those technologies over the next 10 years as well, just as we did for wind and solar.

Ezra Klein

I'm really struck by this International Energy Association estimate that almost half of global emissions reductions by 2050 will come from technologies that exist only as prototypes or demonstration projects today. So we've kind of flicked at some of the things that are trying to be incentivized here that we don't fully have figured out like advanced hydrogen or geothermal. What bets that are being made in this bill, in CHIPS, in the Infrastructure Bill are you excited about? What do you think when you look 15 years into the future we're investing in that may come to be central in the way that wind and solar are central to our future now?

Jesse Jenkins

So I do think that we are going to see basically the full range of all of those clean firm power generation technologies get trialed out over the next few years and have a chance to scale. And that makes me confident that we're going to complete the clean electricity tool kit that we need or the low carbon team for electricity production. We are seeing advanced geothermal energy technologies a couple different routes to producing reliable and affordable geothermal power across a much broader range of the world than is possible today. Those are being demonstrated on the first commercial projects and demonstration projects as we speak, like they're being drilled right now. And we're seeing a huge ramp up of federal funding for those kinds of efforts.

And geothermal, unlike a big nuclear plant, they're really modular. You only need to build them in 5 or 10 megawatt increments. And so they don't cost a whole lot to demonstrate. We're talking about tens of millions of dollars to demonstrate, rather than billions of dollars. And so I'm confident that we're going to see a lot of success there.

One thing we've gotten really good at in the oil and gas sector in the U.S. over the last decade, it's drilling horizontal wells, and doing multistage fracturing, and all that kind of stuff. And a lot of that innovation can translate over into geothermal, plus we're going to see new innovations applying those kinds of techniques in a new geology for a new purpose are going to unlock as well.

We're going to see the first nuclear power plants built at the end of the decade. There are a variety of technologies that are getting licensed by the Nuclear Regulatory Commission and are going to build their first commercial projects in the late 2020s. We're going to see the first carbon capture projects in the power sector that use oxy-fuel combustion move forward over the next few years. Also and then there's clean hydrogen production, which again, I mentioned at the beginning of this, the importance of carbon-free energy carriers.

Hydrogen is just hydrogen. It's not a hydrocarbon. So there's no CO_2, or carbon in those bonds. And there's no CO_2 emitted when we use hydrogen. And so it is an option as a gaseous fuel or just as an intermediate energy carrier and storage option that is itself carbon free like electricity.

And if we can produce it from clean sources, from clean electricity, from nuclear power, from biomass that we can gasify and turn into hydrogen and then capture the CO_2, and store it for actually negative emissions because that CO_2 came from the atmosphere originally. Or if we can take it out of natural gas, which is CH_4 — so take the carbon out and keep the four hydrogen atoms — we can make clean hydrogen that way as well. Again, all of those options are supported. Actually, probably quite generously — I argue in many cases maybe too generously — in the bill. And I think we're going to see an explosion of investment in hydrogen over the next decade too.

[MUSIC PLAYING]

Ezra Klein

We've been talking about all the policies and efforts to generate a lot of clean power. But we're also trying to move a lot of homes, and cars, and industries, and businesses to use clean electricity mainly, though not only. And let's start on the consumer side of it. The things that people, like individual homeowners, might buy

in the next 10 years with support from the bill. Tell me about that effort to electrify the transportation and home-heating industries.

Jesse Jenkins

Yeah, so transportation is the one that's already really in full swing, right? If you look around, if you follow automotive news, or you're following announcements of the automotive companies, they're all kind out trying to outrace each other to transition their offerings to electric offerings and to invest in the manufacturing and supply chains to do that. That's an area that's going to be again dramatically accelerated. It's a trend that's already underway that will be accelerated by the Inflation Reduction Act and the infrastructure law.

The infrastructure law is going to help build out the public charger networks that are going to make it easier for people to find a place to quickly recharge when they're on the road away from their homes. And the Inflation Reduction Act is going to provide a new tax credit or a more robust tax credit for private sector charger deployment, whether that's at an individual tax credit for homeowners or others or whether that's a business tax credit for property owners or offices that are going to try to electrify their parking garages.

And so that's going to create the sort of infrastructure that will make people comfortable to tackle the range anxiety that is currently a kind of psychological limit to E.V. adoption. And then the other thing is that an E.V. today is already, according to "Consumer Reports," cheaper to own over the first five years, including the upfront purchase cost than an equivalently outfitted and sized internal combustion engine car. And that's something a lot of people don't realize, that you save a ton on fuel and on maintenance because you don't need to go in for regular oil changes and the brake pads don't wear out as fast and other — there's less moving parts to fix in an electric car.

And so between cheaper fueling and cheaper maintenance, that offsets more than the — more than offsets the upfront cost premium today for buying an E.V. It's just a challenge for a lot of people to go to the dealership and look at a car that costs $5,000 or $10,000 more and plopped down that money up front. And so what the Inflation Reduction Act does is it tries to remove that trade off by offering up to a

$7,500 tax credit, again, if automotive manufacturers can meet the sourcing requirements for batteries and assembly, then they can get that full credit.

And that will knock down that upfront cost. And our estimates are that by the mid 2020s, it will just be cheaper the minute you get to the dealership to buy an E.V. when you combine the cost declines we expect to continue for batteries and the scale of manufacturing that will be achieved for E.V.s and also lower cost with those tax credits. And so it'll be cheaper the minute you get to the dealership, and maybe half the cost when you go home, and start using it, and charging it, and not going to the gas station. And so that's going to, I think, really just supercharge the electric vehicle transition.

There's also I think an under-looked tax credit for business adoption of electric vehicles that doesn't have any of those headache-inducing domestic sourcing requirements that we talked about earlier. It's just a straight up $7,500 credit for light-duty vehicles and 30 percent of the purchase cost up to $40,000 for medium and heavy-duty vehicles. That means things like Amazon or UPS delivery trucks, or long-haul freight or the trucks that move things around in ports and consume a lot of diesel and pollute communities that are adjacent to ports. And so those credits are likely to electrify buses, and shipping and freight and fleet vehicles and rental car fleets, and things like that and aren't tied to any of those domestic sourcing requirements. And so those are going to kick things into high gear in those sectors as well.

Ezra Klein

The worry I hear about the electric vehicle credits is that these are going to end up a pretty big corporate welfare program. You just mentioned that automakers are making as many electric vehicles as they can. They cannot make them fast enough to keep up with demand.

If you add a $7,500 credit on top of that, maybe just get Ford selling the electric F-150 for $5,000 more than they otherwise would because you've changed the demand curve and consumers can afford $5,000 more, given there's a $7,500 cut through the credit, or Tesla pockets it, or whatever. There's a fear I hear that this just isn't

needed. And it's going to end up being a big giveaway at taxpayer expense. How do you think about that?

Jesse Jenkins

Well, it's possible that that's the case. Any time you have a tax credit that goes on the business side of things, or for that matter a tax increase, like the corporate minimum tax in the bill, it isn't usually passed on 100 percent to consumers. It really depends on how much competition and substitution there is in the market and how much consumers respond to changes in price. And so we are in a kind of unique environment right now where really all automotive — the whole supply chain is constrained. And so getting any car, let alone an electric car, is challenging and there's you're seeing markups and we're basically seeing consumers being not particularly responsive to the price, right? Willing to pay whatever it takes because they need a new car. And that's particularly true for electric vehicles in the short term, particularly because there's just not that many of them available and there's not that many models available from different automakers. So if you want an E.V. in a particular trim, in a particular class or size, there's only a couple of options. And so in the near term, it's possible that lack of competition will mean that some of the automakers can try to set higher prices and just absorb the value of that credit.

But as competition expands and as more and more vehicles, there's dozens of new E.V. models coming to the market over the next couple of years. As those come out in the market, one of those automakers is going to start pricing aggressively. And we tend to see pretty close price parity in the most competitive segments of the automotive sector where you have multiple manufacturers offering similar products. And so I'm much more concerned about this sort of capturing credits in places where you only have two or three players in the market, high degree of market concentration.

But the automotive sector is incredibly competitive. You've got a lot of different automakers producing very similar vehicles and marketing them heavily. And I think that over time, as the range of E.V. offerings expands, you're not going to see the ability to hold on to much of those credits.

Ezra Klein

Let's talk a bit about heat pumps, both because I think it's important and because our mutual friend, Leah Stokes, will kill me if I don't talk more about heat pumps.

Jesse Jenkins

[LAUGHS] Yes.

Ezra Klein

How big of an issue is home heating? And for people who just don't know what a heat pump is, what are we even talking about? If I wanted to have a heat pump tomorrow, what am I actually doing to my home? Who's doing it? How is it getting financed? It's actually a little bit of a big infrastructural upgrade that I think a lot of people aren't familiar with.

Jesse Jenkins

Yeah, it's a little bit unfortunate, the term heat pump. We've had lots of debates on Twitter about different branding for a heat pump. I don't know if anybody's come up with anything all that much better. But the reality is that you already have a bunch of heat pumps in your home. If you've got an air conditioning unit at all, that's a heat pump. If you've got a refrigerator, it's running on a heat pump. What a heat pump does is it just moves heat around.

So it uses a little bit of electricity and a series of things that compress gases and expand gases to move the heat around. And it basically — if you think about your refrigerator. What it's doing is it's pumping heat out of your fridge and into your dining room or your kitchen. And if you think about an air-conditioner, it's pumping heat out of your house and into the outside. In fact, if you stand next to your air conditioning unit as it's blowing, like you can feel the heat coming out of it, right?

And the reason heat pumps are magic, are so useful, is that they use very — they're not making energy — so they're not converting energy, they're not taking chemicals and breaking bonds, and releasing energy from that by converting to some other source, they're just moving energy around. And so they can take a very little bit of electricity and move a lot more heat around. And so for example, you could take one unit of electricity with a heat pump and pump a little bit of that ambient heat that's

outside even on a cold day into your home and get about three units of heat for every one unit of electricity you consume.

And so the magic of a heat pump is think of it as just a reversible air conditioning unit. Where your air conditioning unit today pumps heat out of your house and into the outside during the summer, a heat pump just does both things. It does that during the summer and it pumps heat from the outside in the winter into your home to help heat your home.

Or you can have a heat pump water heater that does the same thing to heat up your water for washing the dishes or taking a shower. And so they're a key technology in the decarbonization challenge because, again, they don't involve burning anything, so there's no direct emissions of CO2 or all the pollutants that come from burning natural gas in our homes, in the form of our boilers in our basements. And they're much more efficient than a boiler because you're getting multiple units of heat for every unit of electricity that you consume.

The same is true for E.V.s, by the way. They're much more efficient at turning the energy in your battery, about 90 percent of that makes it to the wheels of your car, whereas an internal combustion engine only gets about 15 percent or 16 percent of the energy in your gas tank into the mobility or traction that you're getting in the wheels of the car. So both electric vehicles and heat pumps are much more efficient in final energy conversion, converting the energy carrier to useful service. And they both use electrons, so they're using a carbon-free energy carrier that we can then decarbonize by building all that clean electricity.

Ezra Klein

And what does the Inflation Reduction Act do to encourage heat pump adoption?

Jesse Jenkins

There's — and this is an area, again, where I think it could have done more. There are two main things that it does. One is it offers a tax credit for homeowners or businesses to install heat pumps for both water heating and space heating. It maxes out at $2,000, though, for a heat pump. So $2,000 is not a huge share of the cost,

particularly for a central air conditioning and heat pump system that might cost something like $15,000 or $20,000.

So whereas, a lot of other credits will cover something like 20 percent to 30 percent of the upfront cost, this might only be covering more like 10 percent of the upfront cost. And that's going to help, again, change the calculus, which right now is the same as an E.V. It's pay more upfront, but save over time in lower energy costs. And it's going to help take a couple thousand dollars off the upfront cost and help shift that calculus. But I don't think it's enough to make it universally, just like so obviously, good business sense for everybody that it will drive the kind of scale of adoption that we're likely to see for E.V.s.

Ezra Klein

I'm going to leave the decarbonization of industry for another podcast. So I want to hit two more topics before we close up here. And one is transmission infrastructure. So we're going to be making all this clean electricity somewhere. We've got to get it to all these cars, to these heat pumps, to these businesses. The report suggests we need a 60 percent increase in transmission lines and approaches. Just give me a sense of scale of that. How many moles of new transmission are we talking about? Are you confident that we can build that much new transmission this quickly? Like how much of a challenge is that?

Jesse Jenkins

Yeah, so the number that we came up with in the Repeat Project is that to make good on the kind of billion ton reduction in emissions in 2030 that we think the Inflation Reduction Act could deliver, we need to basically more than double the pace of transmission expansion that we've seen over the last decade. We need to grow and expand the amount of transmission capacity by a little over 2 percent per year to deploy all the wind and solar that we see in our modeling and to get that power to where we consume it.

And over the last decade, we've built out, expanded the transmission grid at about 1 percent per year. So we've got a roughly double the pace. And that sounds hard. On the other hand, if we look back to the eras when electricity demand was growing,

from the 1970s to about 2005, when we started to see electricity demand flatline, we expanded the grid by about per year, historically.

So we're coming out of an era of flat or stagnant electricity demand growth into an era of growing demand again due to all those electric vehicles and heat pumps. And we're going to need a bigger grid to do that. And there are going to be more investment opportunities because of that growing demand for electricity. And so we have to basically get back on the same track that we were in the last era when the grid was expanding and off of the current track that we're on where the grid grows that are really anemic pace of only about 1 percent per year.

Ezra Klein

So people may know that to get the Inflation Reduction Act passed, in that final deal with Manchin, Schumer agreed to attach this separate deal on permitting to must pass legislation, like the government funding bill. And part of that deal is trying to shorten and focus environmental reviews, part of that deal is this weird list of important projects, part of it is Manchin trying to get a carve out or getting a carve out for the Mountain Valley natural gas pipeline, which environmentalists really don't like. And I think for good reason.

But then part of it, the part that people in Congress who've been working on this deal, who are climate hawks are excited about is an expansion of the federal government's authority to site, to plan, to allocate the costs of interregional and interstate transmission lines. I'm curious, Jesse, if you're kind of familiar with that piece of the permitting reform bill, and if so, what you think of it.

Jesse Jenkins

Yeah, so when you think about building out wind and solar, they're really kind of three big challenges. First is where do you put it, right? So how do you actually get the siting of wind and solar facilities themselves done and get local community buy in for siting wind or solar farms. And the second is how do you move the power, right? So what transmission lines do you need to build out?

And the third is how do you pay for it. How do you allocate the costs of those transmission lines? And there's two main types of transmission lines that we have to

be concerned about. One is connecting a wind and solar facility just to kind of get to the backbone transmission grid — or we sometimes call those spur lines or interconnection lines — because they primarily serve just that one wind facility. And then you have long-distance transmission, sort of upgrading the backbone grid, which in many cases can be multistate. It can span multiple state boundaries.

And that's really critical to get wind and solar from wherever we produce it to our cities. It's also critical to enhance the resilience of the grid and to unlock competition because we can move power across broader parts of the grid, so that, for example Texas, which is not strongly interconnected with the grid — when it had the Texas freeze in 2021, they weren't able to call on their neighbors to send in more power in areas that weren't suffering from power plant shutdowns during cold temperatures.

If we did have a stronger, more linked up grid, we could move power in bulk over long distances. And you could help out your neighbors when they're in trouble, and you could also unlock greater competition and lower costs over a wider region. So those are all the reasons we want to build out a bigger grid. The challenge has been that unlike for natural gas or oil pipelines or interstate highways, the states are in charge of permitting all transmission lines, even those that cross Interstate boundaries or even those that are critical for interstate commerce. Which, if you know anything about the Constitution, is a little bit weird. Because generally speaking, the federal government has regulatory purview over interstate commerce. And so even though transmission lines are especially bulk transmission lines are clearly related to interstate commerce and that Congress has used the Commerce Clause and the fact that the federal government should regulate interstate commerce to enact all kinds of Federal Regulations over wholesale or bulk power generation, they have not expanded so far federal permitting authority to site and permit transmission lines of that are important for interstate commerce.

The draft legislation at least would do that. It would give the Federal Energy Regulatory Commission the same kind of authority they have over interstate natural gas pipelines to be the primary siting agency for transmission lines of national importance, I think is the way that language frames it. And there's a few criteria. But basically, anything that's important for national policy goals, for competition, and for grid reliability.

And so that would really shift things. Because now, instead of having to go through permitting processes in four different states when you want to go from point A to point B, you would go to one central permitting process at the federal level. States would be consulted as stakeholders as part of that process, but the ultimate decision would be a single regulatory decision at the federal level.

The other thing it does is it addresses that who pays for it question, particularly for inter-regional transmission lines that span different grid regions. It basically says that the beneficiaries of those transmission lines need to pay for those lines in proportion to how much they benefit. It's a principle called beneficiary pays that's really the kind of cornerstone of good transmission regulation and cost allocation. And the challenge right now, again, is that there are regional grid operators who can manage that kind of cost allocation for stakeholders within their region.

But any time a line crosses between those two regions, there really isn't any arbiter at the higher level to decide how much region one and region two are going to pay for those lines that link the two regions. And they end up fighting for long periods of time over how much to pay and that can often kill or delay projects for a long period as well. So the bill draft directs FERC, the Federal Energy Regulatory Commission, to use this beneficiary pays principle to allocate costs between regions in proportion to how much those regions benefit, which would be a really good policy.

Ezra Klein

Yeah, I think that piece of it is exciting. And it gets at this, I think, broader thing, which is that if we're going to be in this decade or multi decades of super intense infrastructure building, we're just going to have to tweak a lot of how we build the regulations for how we build, the way we coordinate and plan and share cost to make all this go as fast as it actually needs to go. But I want to end on something that I don't think gets talked about enough as a benefit which you've alluded to a couple of times in the conversation, of if we do get here.

So climate change, people know, is having effects in the real world now. You see it in intensified heat waves, and drought, and natural disasters. But we are, to a large extent, trying to prevent the worst of what could happen. But there's this whole other question of air pollution, which is so much worse for people than I think is

broadly realized and does so much more damage and could be pretty substantially cut by a decarbonized America. So I want to see as we come to a close here if you can put some flesh on that, on what this could do as a secondary benefit for air pollution, and through air pollution for our health, our cognitive abilities, the world we live in.

Jesse Jenkins

Yeah, I feel like the more we learn, particularly about fine particulate matter, which is sort of the really small pieces of combustible material that are released by coal plants, and diesel buses and trucks, and gas vehicles, the more we learn about these fine particulates and their health impacts the more concerning it gets. These are very, very small particles that penetrate deep into our cardiovascular system. Because they're so small, they get into our lungs, and they cross over into our blood. They get into our brain, and all over our body. And they cause a huge range of different impacts.

And particularly, they cause premature deaths on the order of tens of thousands annually in the United States. And so we think of — we've made a lot of progress in air pollution in the U.S., and that's true, I mean, compared to cities in China or India. It's clearly we're better off here in the US. But we still have a long way to go.

And one of the clear, tangible, near-term benefits of transitioning away from fossil fuel combustion, whether those are coal-fired power plants or buses or gasoline vehicles is that we're going to substantially reduce fine particulate pollution and other ozone forming pollution that also creates smog and impacts urban air quality and air quality across the country. And so our estimates that were put together by Professor Erin Mayfield at Dartmouth College for the REPEAT Project, are that we could avoid on the order of 35,000 premature deaths over the first decade of implementation of the Inflation Reduction Act due to the improvements in our clean energy economy, through the reduction of coal combustion and vehicle-related emissions.

And so we're talking about 35,000 or more premature deaths over a decade. I mean those are real people's lives that are going to be saved, not In the distant future, but in the here and now over the decade ahead of us if we make this transition. And even if you don't care about climate change, even if you don't care about re-onshoring

manufacturing and improving our competitiveness, all the other kinds of things that this bill is trying to do, in many ways, the public health benefits of the clean energy transition alone justify moving much more quickly away from fossil combustion and towards cleaner energy options.

And I think this is an important element to the current debate about permitting reform as well, or about are we going to build more transmission lines, or are we going to streamline those permitting processes. Because there's a lot of concern about the environmental justice implications of streamlining permitting for the Mountain Valley pipeline or for particular fossil energy projects. And those are really real concerns.

But we do have to think about, again, the road not traveled. If we are not able to build wind and solar facilities fast enough and the transmission lines that we need to connect to those facilities fast enough, then we're going to be in a tricky position where we see demand for electricity going up and up because of electric vehicles. And coal plants and gas plants that we would otherwise be able to shut down, sticking around to supply that energy. And that could blow a big hole in the emissions impacts of the Inflation Reduction Act and in the public health benefits that the bill is going to deliver.

Because those benefits are going to be concentrated in the communities that bear the brunt of the impacts of our current fossil energy system. So the pollution that we feel today are people that live near coal plants, that live near highways, that live near ports and bus depots. Those are the people who are going to benefit the most if we can unlock that clean energy. And if we can't, they're also the ones who are going to suffer the most from that failure.

And so I think we have to add that to the message. It's not saying that one outweighs the other or these trade-offs are easy, but it is an important element that we can't forget. That the more transmission we build, the more wind and solar we build, the lower the air pollution and public health impacts on vulnerable communities are as well, and we can save tens of thousands of lives in the process.

I think that is a great place to end. And I really appreciate you going through so much of the bill with me and so much of the task here. And I know there's much more. But always, our final question — what are the three books you would recommend to the audience?

Jesse Jenkins

So I've got two books. And since I am a professor, I have one academic paper. I hope that's OK.

Ezra Klein

Amazing. I love it. It's also great because papers are so much shorter than books.

Jesse Jenkins

It is much shorter. And honestly, I don't have a whole lot of time to read books these days. But all of them relate to how we make strategic policy interventions that can help us shift the politics of climate change over time and really lower those sorts of barriers that we need to lower — to enable more ambitious action and accelerate emissions reductions.

So we're just getting on this path. We've got to do a lot more. And a policy victory like the Inflation Reduction Act doesn't come along very often. And so we need to make sure that when we make a win like this, we make the next fight down the line and the next one after that much easier. And so that's kind of the name of the game, I think, in making faster climate progress, is unlocking those sorts of feedback loops that can make each successive victory more likely and easier. And so there's a whole interesting interdisciplinary literature on this. And I wanted to pull a few examples of that out.

The first is "Making Climate Policy Work" by Danny Cullenward and David Victor, which explores the political economy and really real world history and experience of using market-based instruments, like carbon taxes or emissions cap and trade programs to try to tackle climate change. I think the book does a really good job of summarizing both a range of scholarship and the kind of real-world experience that we've gotten in the few places that have succeeded in implementing carbon pricing to show how political constraints inevitably make them far less effective than ideally

they are or they are in economic textbooks. And they offer some useful recommendations on how we can design targeted policies and regulations, including industrial policies, like those in the Inflation Reduction Act, to try to unlock greater progress over time.

The second one is not the book; it's the excellent article in "Nature Climate Change" from 2018, called "Sequencing to Ratchet Up Climate Policy Stringency," which is the lead author is —

Ezra Klein

Oh, a great title.

Jesse Jenkins

Yeah, exactly. It gets right to the point. And the author is Michael Pahle and a variety of others who said — both economists, political scientists and policy analysts, who again, are trying to face down this reality that current policy ambition is inadequate. We've got to go further and faster. And so they're trying to think about how do you order these policies. So that policy one helps unlock policy two and makes bigger progress over time by overcoming political economy technology and infrastructural constraints.

And then the last one, we've already talked about the remarkable cost declines for solar P.V. and wind, and solar, and batteries. The last one I recommend is "How Solar Energy Became Cheap: A Model for Low-Carbon Innovation" by Gregory Nemet, which unpacks that remarkable story of how solar P.V. declined in cost by 99 percent since the 1970s and about 90 percent in the last decade alone. And so there's a lot to learn from that technological history about how we took solar P.V. from this kind of niche technology that really was so expensive it could only be used by NASA in space missions and turn it into the cheapest source of electricity in the world today. Not just clean electricity, but any kind of electricity.

And I think that's going to — the book has a lot of critical lessons for how I can inform contemporary policy because we have to repeat that kind of miraculous success for a range of other clean energy and climate solutions going forward.

Ezra Klein

Jesse Jenkins, thank you very much.

Jesse Jenkins

Thanks, it’s been my pleasure.