

Electrification Is Everything - Michael Liebreich

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SUMMARY

Michael Liebreich discusses the current state of the energy transition, emphasizing the dual narratives surrounding fossil fuel reliance and the shift towards clean energy. He highlights the significant growth in renewable energy investments and technologies, particularly in the wake of geopolitical crises, and argues for the importance of electrification as a key strategy for decarbonization.

- The energy transition is marked by two conflicting narratives: one advocating for increased fossil fuel investment for reliability, and the other promoting clean energy as the solution to resilience.*
- Historical data shows that fossil fuel price volatility has been a persistent issue, with significant economic impacts from price shocks.*
- The "great clean energy acceleration" has seen a tenfold increase in global renewable energy investment, driven by crises such as the war in Ukraine.*
- Wind and solar now account for over 90% of new energy capacity added to the grid, surpassing gas and coal in generation.*
- Battery technology is at an inflection point, poised to transform energy storage and pricing dynamics.*
- Electrification is crucial for reducing emissions, as it can significantly lower primary energy consumption across various sectors.*
- The global south is increasingly adopting clean energy technologies due to their cost-effectiveness, challenging the notion that they will follow traditional fossil fuel paths.*
- Trade policies and supply chain considerations are becoming more complex, with security concerns influencing the push for local production in clean energy sectors.*

>> The first speaker we've got today is Michael Liebreich who is a friend of Modo for a long time. I first met Michael in 2019 and he was actually one of our first angel investors in the business. Many of you will know Michael. he's a good friend of our company and he's a good mentor a great mentor to me. I often think about Modo being a bit like Bloomberg New Energy Finance but with Python code instead of Excel sheets.

and I'm very thankful to have Michael here today. He's always entertaining and no doubt there will be one or two mic drop moments. So Michael, if you'll join me on stage and a warm welcome for Michael. >> >> Okay. Thank you very much, Quentin. Thank you. and yes, it took me back. I I am indeed one of the first investors and I don't know why I can't remember to this day why I invested but I'm very glad I did and it's great to see you all here today. and Quentin's, you know, on the same sort of journey perhaps as I followed with New Energy Finance back in the day. So I have just got back from three weeks in Singapore, Australia, New Zealand. Before that I've been in Canada, I've been in Egypt, I've been in Brussels, I've been in Westminster. So I thought I could perhaps before, you know, we're going to you're going to get into a lot of detail today and there's a lot of really really really smart people. So I'm going to try and skate across the surface and give maybe a a little bit of an

international perspective of where are we at this particular moment in the energy markets in in history of of energy. And hang on. If I do that, there we go.

Look. Navigating turbulent transition. I mean I I there is a transition and we'll talk about whether there is and what it looks like and so on. So, there's first of all, global context and there's these two narratives out there because of the war in the Gulf. And one narrative over on the right is we took our eye off the ball. We We got obsessed with net zero. We tried to do wind and solar which are not resilient and we should have invested more in making sure that our fossil that that that we had reliable supplies of fossil and you've got, you know, headlines like Denmark considering to go back into exploration and and so on. So, there's a this sense that we really need to get serious now, but there's another view which is clean energy is the way to get real resilience and that fundamentally this is a fossil crisis and the solution will not be a fossil solution. And you got these kind of two dueling views and the answer is it's a little bit of both. Short term we need to do some of this to secure supplies and maybe also for we'll talk about the last few percent resilience, but actually the way really to make our economies to insulate them is over on that side and this is why so at the moment you're in a fossil We're in this crisis and you got a lot of people saying, " you know, it's really bad cuz it's the second one in four years. How unfortunate. You had Russia invaded Ukraine and then we've got the war in the Gulf. How unlucky for, you know, two crises to come along within four years."

But the reality of fossil fuel dependence is actually that which is if you go back to the 1973 Arab oil embargo, 60 years, in fact, there's been eight times, the red ones, where the price went up by 30% or more within a single year period and six times it went down. And of course, if you're a producing nation or a producer, the crashes down are just as bad as the spikes up.

So, what you've actually got is this is When people talk about externalities, "Oh, wind and solar, they don't pay their full cost. They only look cheap." Right? Wind, solar, batteries, that system only looks cheap because of the externalities of the grid connections that you have to invest in. Well, what are the externality costs of these absolutely colossal shocks on the global economy which are not paid for through the price of oil, gas, and we no longer, you know, are as dependent on coal and it's not as volatile, but these shocks also have a huge externality cost. And the Climate Change Committee in the UK says one more shock would actually cost the UK economy more than the extra cost of getting to net zero.

Not the total investment involved in net zero, but the extra cost of net zero. So, what happens next? We have got this conflict in the Gulf. apparently it was all going to be over very quickly, this special military operation in the Gulf, but as we see just the last couple of days, I think the Iranians have a different view of the world and it could go on and could be persistent. And it's going to have persistent impacts cuz the more people understand this and you know, Strait of Hormuz closed is hitting Asia and Asian countries. We've already seen China canceling an LNG terminal, Vietnam VinGroup canceling 4.8 gigawatts of LNG of gas generating capacity. So, there will be impacts of the latest crisis even if it's resolved like that tomorrow, which it won't be.

So, let's go back and have a look at what happens to the transition in the wake of Russia's invasion of Ukraine, and I call it the great clean energy acceleration. It's a bit like the First World War, you know, when they were in

it, they called it the Great War, they didn't realize it was the first of two, so it got renamed afterwards. So, this was we're about to see the great clean energy acceleration 1.0, and I believe we're about to see 2.0 and it was because of the events in the Gulf. So, that is when I started Quentin when I started New Energy Finance, you see that little bit there?

The little dark blue bit was what I was tracking, and it was \$36 billion globally of investment in renewables. And then on top of that, we would we back calculated and put the grid investment because clean investment is you've you've got the supply, you've got the grid and batteries and so on, and then you've got the bit on the demand side, which is a lot of it is around electric heating and and transport and so on. And that is the great clean energy acceleration. That is the impact that we had or the the you can't say it's all due to the Russian invasion of Ukraine, but as people Europe particularly had to get off Russian gas and oil, there was a big and there was a price spike, which drove investment also around the world.

We saw this great clean energy acceleration. Now, that's the money. We're talking about the \$36 billion blue plus the grid, that 230 240 billion globally is now 2.3 trillion. So, a 10x growth. Bit of inflation in there, too. Now, this is the kit. That was the money, this is the kit. What is being added to the grid? And you can see great clean energy acceleration, we're now at nearly 90%. I think we may even be over 90% in 2025 of everything being added to the grid is wind and solar.

When I started when I started my business, it was called alternative energy and and now it's 90% of everything being added to the electrical grid. And then this is that was we've done money, we've done kit. This is electricity. And this is non-hydro renewables, largely wind and solar. The two of them together by now are ahead of gas. Wind and solar generating more than gas globally.

Wind, solar, and hydro generating today more than coal. King coal. And there was a statement that was unthinkable back when I started New Energy Finance. And each of wind and solar today generating more than nuclear. Just astonishing. And here's a fun thing because you're at a different point in the growth of batteries, particularly we're about to see, but I started New Energy Finance here.

And it was the most dynamic, extraordinary, amazing, tiring process to track the growth of an industry. And I sold to Bloomberg here. All of that incredible hard work by my team was this little flat bit of the chart because when it grows and it does that, you crush down the vertical scale. So, there's the great clean energy acceleration. And here's batteries. So, back in 2019, the team that I trained produced a forecast for batteries. You can see it's enormous growth. We were out there.

2019, about I don't know when it was whether it was when when when exactly which year Aurora was founded. Obviously, we now have different and better I'm not allowed to say that forecast. But, this is what happened. Great clean energy acceleration. Now, the funny thing is, go back to that green line. When you look at this, when we plot it out, do you know what it's going to look like? It's going to look like the flat bit of the curve.

Because the scale that that goes up to, you know, 25 2,000 500 gigawatt hours, that's going to be tiny. That's

going to be just the little flat bit of the scale early on. And so, it's actually going to, you know, by the time you get out there another decade, you'll look back on this period on the chart and say, "What were we all so excited about?" Well, we're excited because the growth rate, the dynamism, the way it's changing the system, it's changing pricing. I've just come from Australia, I said. And what you've now starting to see, Australia world champions at rooftop solar and also now 500,000 home batteries and big batteries. And what it's now starting to do is push gas out from being the price setter for more and more hours. And for the first time for quite a while, electricity prices dropping as a result to Australian consumers and Australian businesses.

And you're seeing that because of batteries, and we've only just got started. There's battery against pumped hydro. You know, as long as I have been doing this, if you wanted to store a lot of power, it had to be pumped hydro. Just had to be. That was it. Everything nothing else came close. You get 3 minutes of this and 5 minutes of that, or you'd do pumped hydro. And now, and I do regret >> >> this is not Aurora data, but it you can see that pumped battery is getting close or crossing over. And it's very dependent on what your metric is and where and so on. But, the reason it's so impressive is that you can put a battery anywhere. You can put it in your home. You can put it in your factory. You can put it in your community. You can put it either side of a grid constraint. And so a battery is more valuable than pumped hydro.

Never mind the cost. It's more valuable. And so suddenly we're in a different world. We are at a cusp. We are at an inflection point in the same way as 2015 suddenly wind and solar were grid competitive and everybody was like head exploded and I said I told you so. We are now at an inflection point where batteries are going to be at least as transformational as that 90% wind and solar that's been added to the grid.

Zero marginal cost generation, incredibly disruptive, blows up price formation, and guess what? We're now going to get another turn of the screw as lots of batteries hit the grid. Stationary, in cars, at or in vehicles, et cetera. Good luck. so there's the cars. Car sales, great clean energy acceleration. Again, first time we had a crisis where we didn't just reach back for the old.

We didn't just say, "Well, there's a crisis, so forget. I'm not going to buy an electric car. I'm definitely going to go diesel." Actually, what people said is there's a crisis and now there's an alternative and they bought something different. Ember summed this up. Kingsmill Bond, their strategist, I think others as well at Ember. So what we've got is for the 20 odd plus years that I was doing this, I was tracking what happens to how you make how you generate electricity.

I was doing work on the transmission grids and on battery storage separately and on EVs and heat pumps. I'm a thermo geek. I love heat pumps. But I hadn't put it all together because the point here is when you have all three reaching cost break points and acceptance and uptake, suddenly you have the whole global south that can say, "Well, we can generate it like that, move it around, and store it like that, and use it like that. Why do we Why do we need to go down the same well-trodden path?" People have been, you know, expecting India to do the same thing as China and China to do the same thing as the US and so on. That is no longer the case. So, it is a revolution.

And of course, that one, you can eyeball it, is the steepest. Right, let's have a look at what some countries have done in response. China has become the largest car exporter from number five position to number one in 3 years, enormously disruptive. China understood this. They've been playing chess. We've been playing draughts. America's been playing air guitar.

And this is what you see. There's China's domination not just of solar and batteries, and not just of critical minerals, but right up and down the clean energy stack. And so, the US has gone off to become a petrostate, and China is becoming an electrostate, and doing it very, very well. Europe. This is Europe is in is in a very difficult place. This is the industrial electricity prices.

There's Europe. There's the USA. And there's China. And Europe is a pretty big manufacturer. If you look at value added manufacturing, you know, it's not it's still a pretty heavily manufacturing-based economy. And you look at countries like Germany, obviously. But you look at Italy, and you look at France and they really manufacture quite a lot. And the question is, can you manufacture with that sort of cost difference, particularly when technologies are going electric? And if you think that that's bad, then that is the UK.

And I always like to quote a communist. Me and Zack Palanski got at least one thing in common, possibly the only one. Antonio Gramsci, the co-founder and leader of the Italian Communist Party, said, "The old is dying and the new struggles to be born. In this interregnum, a great variety of morbid symptoms appear." And really that's what's happening. You've got a new system and an old system and you've got this sort of fight cuz some people say we should you know, stick with the old.

And some people say, "No, we've got to really go all the way with the new." And we're kind of at some middle point in Europe. So, in the US, they've gone completely different direction. As I say, air guitar or oil, natural gas, coal, but also, to be fair, hydropower, biofuels, critical minerals, nuclear energy resources. the only And And what's very interesting is that they're actually in record installation territory. Because the one big beautiful bill actually enshrined the tax breaks even for wind and solar.

So, offshore wind definitely came to a screeching halt. EVs came to a screeching halt, but interestingly, what did the car companies do in the US? They were going to build gigafactories. They're still building them, but they're pointing them at stationary storage for the grid. And so, the US, by 2027, will have enough capacity to double all of the electrical storage in the US every 2 years, including pumped hydro, right? So, including the amount of pumped hydro they've got.

So, they are, despite all of this, they are actually pushing ahead with some with clean energy. Obviously, they've they're not going to benefit from the supply chain that they would have had had they pressed ahead with the Inflation Reduction Act, but nevertheless, clean energy is by no means dead in the US. This is Chris Wright, the Secretary of Energy and former CEO of a fracking company, and he said that it was on a web on a podcast, not mine, not Mando's, but he was on a podcast, and he said there's about solar he's asked about solar. Why is the US slow walking solar? And he said, "There's no there there."

If we can make about 50 years out, solar never gets to 10% of global energy. And what's fun about this is sadly, it'll take a bit longer than the duration of the current Trump administration, take a few years longer, but not that much longer, and he would quite clearly be not Chris Wright, but Chris Wrong. Now, the US is obsessed with AI. Texas, 400 gigawatts of connection queue of AI data centers in the connection queue.

There's only about 70 or 80 gigawatts of production in of generation peak in Texas. And the way to read all stories about AI data centers is divide by 10. Divide by 10, and you might have the right number, the amount that might be built in 10 years or so. it's going to be And it By the way, you could probably divide by 20 and you won't be wrong there, either. It's it's extraordinary. you go to Australia, there's 50 gigawatts. UK's got 50 gigawatts. Think about it. What do each of these hyperscalers need? They need a few gigawatt-scale data centers, two or three each, and then they need inference data centers around most of the decent-size cities. And when you add it up, you're like, where does 400 gigawatts for Texas, where does it how could it possibly be used? And then you start meeting some of the people proposing it and they're like real estate developers who've developed a 10 megawatt data center and now the next one's going to be a you know, a gigawatt two or something like that. And it's just it's quite obviously not going to happen.

Now, that's not to say AI doesn't work and co ask co those who've not noticed, I've just been playing with it and it's you know, that there is there is there there. There's no question. The question is how big how many data centers what capacity we need. Now, the I'm going to say it the bros cuz they are all bros running these companies. They are very angry. They're going through the five stages of grief. They were going to you know, rule the world and they're very about you know, for a few years it was marvelous. They were going to rule the world and then they discovered that there was a thing called electricity that was going to hold them back. So they've gone through what is it? It's denial anger No, denial, negotiation, anger, depression, acceptance and they're still angry.

because they can't just go and build anything they want anywhere they want. But they love nuclear because they think that that's going to solve the problem. They will discover the same thing that every utility discovered that nuclear works and it's slow and it's expensive and not everybody loves it and so on. So they will build some because they're incredibly rich and I'm very I'm delighted having a nuclear engineering slight background. It's great that some very very rich people are going to pour money at it and see if it works.

I love it and I and I they'll get some built and then we will know how much it costs and how slow it is and how complicated etc. Or not, maybe I'm wrong. But as a climate solution, let's be absolutely clear. it's irrelevant. The Rolls-Royce is not really small, it's quite big, but remember that green line that was very flat when I was doing my thing and then it curved upwards, the output of wind and solar power.

For small modular reactors, for the Rolls-Royce ones to catch up with, not overtake, but catch up with that green line you would build need to build not the five or 10 that would be regarded as a magnificent achievement for the next decade you would need to build 1,250 to globally to catch up with wind and solar using the Rolls-Royce model. The little ones, Oklo, Kairos, NuScale, you would need to build 8,000.

8,000 of them. And if that takes you until 2050 to build 8,000 of these little guys then of course wind and solar will be even further ahead and now you need to build 27,800 of them or 4,000 Rolls-Royces. So I really hope they can build some and I can see the use, I can see their role, I can also see the value of having a strong nuclear industry. So I'm not saying don't try, but if you think it's a climate solution, this is how many you need to build.

Now, going around the world, that was sort of US and a little digression over to nuclear. I do a lot of work on what we call most of world. Because most of the analysis you see is US versus China with, you know, Europe doing, you know, we've got the the the petro state, the electro state and the state of confusion. But 70% of the people in the world don't live in those places, they live in most of world.

And other than data centers, it's all of the power all of the energy demand growth and it's all of the demographic growth. And so I spend a lot of time, you know, in Philippines and and we're bringing on I'm talking to people about South Asia and Southeast Asia, but also there's all of Africa and so on. So if there is an electro state versus petro state struggle, then how will we know who's winning? It will be what does rest of world decide?

Does it go lots of LNG and oil from the US and a little bit of clean energy because those woke liberals in Europe like it and it's really cheap if you buy it from China, but only a bit of it. Or do they are they going to go mostly clean energy cuz it is really cheap and clean cars and clean vehicles and so on with a little bit of oil and gas because America twists their arm and you have to keep the lights on.

And I would say it's pretty clear that it's going to go the latter. Mainly clean with a bit of fossil, not mainly fossil with a bit of clean. So there you see they are buying these countries that do not have subsidy programs, do not have, you know, woke liberal worries and so on. What they're actually doing is they're buying this stuff because it's cheaper. And they don't have the luxury of expensive climate policies. They go for cheap and they're buying wind and solar.

And they're buying electric cars. I spoke at a conference where an elderly professor, he was so eminent his mustache turned upwards and was waxed and he said, "You have to understand people. No one in Africa is going to buy an electric car." And luckily I had I with a little bit of help from my friend Claude, I got some data. 60% of car sales in Ethiopia, 76% in Nepal, and he was simply wrong.

Now, there's this huge narrative that is being put out about how I'm wrong and there is no transition. The transit's over. Everything's we're we're we're we're we're we have to be pragmatic. Pragmatic in the sense of understanding that we are totally addicted to oil and fossil. That's the only way that we can provide energy services and we need to be sensible. And Dan Yergin is a some was something of a of a role model for me building IHS Sarah, wrote this piece at the beginning of last year called the troubled transition and over longer period the share of hydrocarbons the global primary energy mix has hardly budged and we're going to take a look at what primary means.

And that narrative is reflected by Chris Ron. When the IEA was founded 50 years ago a little over 80% of global and again he's talking primary energy came from hydrocarbons. 50 years later a little over 80%. And so they say

the transition has failed. Now, this is a view of the transition out of the UNFCCC and those activists who say things like keep 1.5 alive which is when it doesn't work, double down.

So, as emissions keep going up, use you say well we still need to get to the same place and therefore you need to go steeper and steeper and steeper. And that view of the transition you know, there comes a point where you need to go you need a time machine. You need to go backwards. The time machine exists. Well, it's called carbon dioxide removal. But they're still trying to adhere to this and it has failed. But let's look at a different type of transition which is the transition I think, that we are on.

And it starts by understanding primary energy. When you go from coal firing an incandescent light bulb to solar and an LED you have a 95% reduction in primary energy. Primary energy is not demand. It is only demand by the energy industry. It's not demand by us, by society, by the economy. It's just It's In fact, it's supply.

Right? It's the It's the supply the energy industry needs to actually serve us. You got the same thing with transport. You go from a fossil car to an electric car, 75% improvement. Heating, the same thing. So, primary energy The first thing we should do is scrap it. If somebody uses the word primary energy please remember there's one of two things happening. Either they don't know what they're talking about or they do, but they hope you don't.

So, let's start with, and I built this little model of a transition based on really being an entrepreneur. What do entrepreneurs do? They build things, right Quentin? You build things. You don't You don't keep your eye focused on where Modo will be in 2042. You worry about Last year you did this, next year you'll do more. Last year you had this many people, next year you'll have more. Depending on co. But you'll have more. And so, it's all about growth. It's all about growth. And the model that I built said, "Right, let's have a look at the structure of energy really.

It is already 30% clean. Not 20%, not 15%, it's 30%. We're in the middle third of the transition. And then I said, "Okay, let's have a look at what happens. The economy globally grows at 3%, 3 and 3 and 1/3% there's a bit of energy efficiency on the demand side, better washing machines, etc., etc. So, real energy demand grows at 2%." And then Oop, something happened to the alignment. Don't know about that, but you'll see you get the idea.

What I did is I said, "Okay, if clean energy just grows by 5% per year." So, in other words, demand grows at 2%, but supply of clean grows at 5%. And not just supply, but actual use of clean. And then I just let it play out over time. And you can see what happens even though the chart is a bit messed up, you can see that it forces the fossil off the system. Obviously, because the little thing growing at 5% in the end eats the bigger thing growing at 2%. Obviously.

But the model is all about the growth of the clean. It's a different model of So, that one there oops. That one has failed, but a growth-based model has not. And then you come to, "Okay, how do you keep that that chunk in the middle? How do you keep that growing? What is it we need to do?" And the answer is electrification is everything.

That's not electrify everything, it's electrification is everything. Why? Because right now you've got trans- road transport, space heating, and low and mid-temperature industrial heat, which can all electrify right now. That's 40 That's over 40 It's about 45% of global emissions, and you can electrify it with electricity that is pretty clean. Everywhere in the world, we're starting to get pretty clean electricity.

And so, if you want to see a rapid, deep, affordable switch addressing emissions, then that is everything. All the other stuff, aviation and cement and steel, and so on, the hard-to-abate, harder, more difficult sectors, doesn't mean we ignore them, but if we focus all our effort on them, then we will not be making rapid, deep, and affordable progress. So, this chart got everybody's attention because China has electrified much faster, 10% a decade versus the 4% per decade at the at the fastest that you that Europe and US electrified. That got everybody's attention, and this illustrates This is actually I I I I borrowed this from also from Ember.

Look, we could spend an enormous amount of money and effort in cleanifying our electrical system a bit more. That's by the way is clean power 2030. That's the We're actually at at 60%. But actually, if you think about it, electrification is the thing that will reduce emissions fastest and and and at lowest cost. So, we're going into We've got a COP meeting at the end of the year in Antalya, Turkey and Australia working together, and there will be electrification will be the major theme of the COP meeting. And they've set a target, 35% electricity as a percentage of final energy. So, it's the same metric, by the way, as this here.

And I just had great fun because I've got worried about this metric, and I dig it did a a deep dive into it and what you find is that it's a really bad metric. So electrification is the right thing, but what you see is to get to 35% electricity as a percentage of final energy for heat pumps because of the way that they destroy if you move from you know the the the the example I gave with the LED with the car with the heating, you actually need to get to 60 or 70% penetration before you get to 35% of final energy. So there's lots of fun and games to be had, but fundamentally the cop meeting is going to underline and everywhere I go what I hear is electrification, electrification, electrification.

Canada, Australia, Brussels, the UK, they've all got electrification front and center of mind. And so we produced this which is a little aide-mémoire for policy makers, investors, and other people without thermodynamics about what order and how quickly to to electrify different sectors. And I think the message here is that we are going to see very rapid you know this is stuff that is fully commercial now, commercial in many places, commercial in some places, and then stuff that you put R&D money into.

But this is the key to rapid decarbonization and affordable. And it's going to play very nicely with the other we've seen the steepest chart which is the battery chart in terms of the the the fastest growing sector of the electrotech revolution. So put electrification together with batteries and have a good rest of day.

>> Thank you. We stay We stay around for questions. So, I mean, firstly, thank you, Michael. Fantastic presentation again. And great to see you. We've got this full fill up This hall is filled. We've got people standing at the back. There are some chairs around the place. So, if you're sitting next to a chair, put your hand up so someone can or move across so someone can Loads of spare chairs. Great. But, with the interest of time, we did

start 20 minutes late today so everyone can get in. So, we are going to reduce the amount of questions. And actually, we have Don't Don't forget that you have Slido to ask questions. But, Michael, if I could ask you a question, please.

and yeah, we've we've discussed and argued about a few of these things before, but what do you think about So, this is this is a fantastic overview of the big picture stuff. What do you think about the policy impact of things like made in America, made in Europe, the move towards supply chains becoming more sovereign and that being a strategic imperative for each constant, if you like? And the the appetite for I really like the the framing of most of world, the appetite for Europe and the US and some of most of world to continue buying from supply chains in China, given everything that's going on.

What How does that affect what you just just talked about? >> So, I'm a I'm a free trade guy. I was on the Board of Trade under a certain Liz Truss. Actually, I was the human carbon offset to Tony Abbott because there was outrage that he was on the Board of Trade and so they needed somebody who was kind of clean energy and climate whatever. And I got this phone call saying if I was invited on the Board of Trade, would I accept? And I said, "I'd be honored."

And they said, "Good, cuz the press release goes out in half an hour." so, I think trade is just incredibly important because it is how you do this. and obviously, it's trade it's across the supply chain. And the complexity of it goes well beyond the simple sort of knockabout stuff of, you know, "Ooh, we're not going to buy a solar panel and you're going to buy a solar panel." It's like the chip in the inverter. To build that chip, you need, you know, you need Dutch technology from whatever it's called, ASML or whatever the company is, and you need you need silicon from probably coming from Australia, and then you need some machine tool from Germany or Switzerland. It's much, much more complicated. So, all of this kind of made in America, made this and made that, it slows it down. The political reality, though, is that some of that is inevitable.

And the other overlay is that there are real security issues. I mean, they really are, and we can't just pretend there aren't. so, the issue of having, you know, Chinese software monitoring and able to switch off our entire electricity grid has to be we cannot have that situation. Now, there may be different ways of dealing with that rather than banning things. but, there are real issues. >> maybe I'm just seeing it cuz I live in the US now and seeing it through the US lens. I mean, it's everywhere. Every conference we go to about batteries or renewables, it's just constantly on the psyche about made in made in America.

And maybe I'm projecting that because that's my experience now. >> Well, but there's something else going on. So, we want in one Yeah, there's real there's there are real issues, right? But, there are also fake issues because all the people who are banging on about made in America and they're on their Apple phone and they've got their Apple, you know, tablet and they've got that everything, their shoes, their clothes, everything. so, there's an element of using issues because you don't like clean energy, so you say, "Well, it's got to be made in America." But, you know, the the I come back closer to the real issues.

If you look at the supply chain, some of those critical minerals, the critical minerals that you need to build a

wind turbine or, you know, to to for the chips that are in the inverters and so on. Those are the same critical minerals that the military needs for all of its hardware. So, it feels it feels like a I mean, it is it is a real issue, but it's much broader it's much much broader than just clean energy, just renewables or or EVs.

And we will muddle through. We will muddle through though the answer is we will not have a single solution that will move on from. We will as we always have in trade. We look at look at what's going on now with the the attacks on Ukraine. Five fifth year of the war and the Russian missiles are still full of components made in the west. They still can't make a missile without western industry and we can't stop them getting our components. So, that should tell you how how easy it's going to be to unravel and to say made in America and that's it and close the door to the it's not going to happen.

>> Okay. All right. round of applause for my call. Warm round of applause, please. >> >> Thank you very much. Thank you.