

Sguardi sul Futuro

***Un dialogo su economia e politiche
del clima***

***Sergio Vergalli
intervista
Richard Tol***

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SERGIO VERGALLI

We're here today for another interview, we have here Professor Richard Tol, thank you very much for being here for our interview. We start again with our topic which is related to Net Zero Emission. Do you think it is possible to reach the net zero emission target by 2050?

RICHARD TOL

Well, the word possible has many different meanings. Is it physically possible? Yes. Is it technically possible? Absolutely. Is it desirable? Probably not. Is it likely? Absolutely not. So I think it is the wrong question to ask. Is it possible? Yes, of course it's possible. If there were a pandemic that wipes out 99% of humanity. Then we would go to net zero by 2050. Right. If there were to be a nuclear war between India and China, we would get pretty close to net zero by 2050. So, yes, it's possible. Do I think it is possible within sort of the normal way in which we do environmental policy? No, absolutely not.

We will not get to net zero by 2050 and zero by 2050 is of course, defined as net zero for the world as a whole. And the reason that we won't get there is because at the moment, a large part of the world is simply not committed to climate policy. And you may say, well, 2050 is 27 years away. So that's a long way in the future to convince the government of Brazil and the governments in Africa and the government of India to start taking this seriously, which they do not at the moment. But we should not forget that most CO2 emissions come from the capital stock rather than from consumption. It's driven by the buildings in which we live and IN which we work. It is driven by the vehicles we use to transport ourselves and goods around the world. It's driven by power generating plants and so on and so forth. That is where the CO2 comes from.

And all of these things have lifetimes that are measured in decades. And therefore, net zero by 2050 essentially means that some of the power plants that have been built in recent years won't reach the end of their economic lifetime if they have to go to zero by 2050. And that means that we have to strand a lot of assets. We have to prematurely retire a lot of capital. It sounds nice and abstract as something that we can do, but of course, it also means that investors will lose their shirt and companies will go bankrupt. And the idea that democratic governments would do that is very unlikely. And countries like India are, of course, still nominally democratic.

The idea that Modi or one of his successors would ever willingly bankrupt so many companies in his country just simply won't happen. But also more autocratic countries like China. I just don't see it as that. I mean, they've done it by accident a couple of times that they bankrupted large parts of their economy, but I don't think they will repeat this. And the power plants are simply too young. If you look at a country like Indonesia, they're still building coal fired power plants today. Some of them are planned to come on stream in 2025 or 2030 and are planning to retire in 2070. That is if you use the optimistic timeline. Medical Fire Power Plant is a 40 year timeline, but we also know that some of them are still operating after 80 years.

So no, getting to net zero by 2050 worldwide is simply not politically or economically feasible. It is a little more feasible in Europe because our capital stock is generally older than what you would see in South and East Asia, and therefore we would have less premature retirement of capital. But still, we're still talking about a slow transition and a very conservative concern, not in the political sense, but in the simply preserved over time sense, a very conservative energy sector. And at the moment, we know we can generate a lot of electricity in a carbon free manner, but we haven't quite figured out how to do 100% restore. It's simply is not there or very expensive.

We're beginning to sort of see how we could electrify parts of transport, but not yet aviation and projections for making the building and making our houses and offices as carbon neutral a seem to me very optimistic. It is a much bigger problem than people think. It's perfectly possible to build a new house and make it carbon neutral. But converting the old building stock in the inner cities of Europe to carbon neutral is an exceedingly complicated problem. I mean it's possible. Yes, we could raise those cities to the ground and build them all new, but it is not something that we will ever do.

Now of our own, we will, of course, now maybe put in will help raise the safety sort of ground for us, but we will not do this to ourselves. Now I am talking about zero at the moment and the question was, of course, about net zero. And is it feasible to suck enough CO₂ out of the atmosphere to compensate for the unavoidable CO₂ emissions? Right. Know the stuff that we can't get rid of by 2050? And again, basically, yes, we know how to do this. We know how to capture carbon and store it safely. There's been demonstration projects that show how this is done.

We know how to suck CO₂ out of the atmosphere and direct air capture that has been demonstrated and the problem there is upscaling is which requires a fairly substantial investment. But another problem that people often overlook is the fiscal implications of this.

The market for CO₂ currently is saturated. There's nobody going to buy CO₂ off you if you produce it at scale because there's enough bubbles in there already. We don't need anymore. And that means that the only reason that you want to suck CO₂ out of the atmosphere or the only reason that you want to capture carbon from fuel gasses is because of climate policy.

That is the only reason to do it. And that means that this somehow has to be subsidized directly or it has to be financed through a carbon offset program. That is the only way to finance this particular industry.

Now, there was a piece in The Economist, I think last week, maybe the week before. It's talked about just how large this sector would be, how large this economic activity would be. And of course, there's also been plenty of model studies looking at this. And if you want to go for rapid emission reduction, say 95% or more by 2050, then we are talking about very substantial carbon capture or very substantial direct air capture of carbon.

And we believe these models, what the explicit or implicit carbon price would be around 2050, then you can multiply those two numbers and you can come up with a total subsidy that would be given to the carbon capture industry and and in some models and in some

other realms, that is relatively modest, a few percent of GDP. In other studies that actually goes up to 20% of GDP or more.

So that is at the very least a large restructuring of the economy. All of a sudden we have an economic activity that is now virtually non-existent. It would be 20% of economic activity in 27 years time. That is a fairly rapid growth. But if you look at it from a fiscal perspective, that the idea that we would be spending 20% of our income on carbon capture and storage strikes me as fairly implausible that that means that essentially this industry, this and it would then be part of the public sector or at least be financed through the public finance will be twice as large as health care and it is electorally feasible.

And that has been shown time and again that we want to spend money on health care because it affects people that we know. It affects our parents. If you have young children, you are grateful for the hospital that is there and so we see the point of health care. Most of us know people who work there, no doctors and nurses who make their money, and we think they deserve a good salary and so on and so forth.

So that is electorally feasible to defend 10% of our income going to health care. But large scale carbon capture and storage will not be done by your neighborhood nurse and it will not be to your direct benefit. And the only way to keep the costs down is we're going through bio plantations, is large scale monoculture, very heavily mechanized, so it won't create many jobs.

We will do it where the land is cheap, so that is far away from Europe and it will be done by large multinationals. So the idea that they are going to raise public funds and then give 20% of our income to these large multinationals to suck the CO₂ out of the air for somewhere in Brazil or in India is just like the idea that any politician would stand on such a platform and get elected is just it's just a pipedream, I think.

And so for those reasons, I have no technical or physical problems with carbon capture and storage. It's a direct air capture. But I just don't see how this would work politically or economically at the scale required. And for those reasons, I don't see net zero happening by 2050 because I don't really believe in carbon capture, at scale at any time.

I just don't see zero happening by 2050. If we're talking about the 2100s. Then I say, yes, we have a fair chance of hitting that particular target, maybe by 2070 if we're lucky. But 2050, because of the slow workings of the energy sector and because of the rapid upscaling of the energy sector and the transport sector in parts of Asia and parts of Africa and parts of South America, 2050 is essentially tomorrow. It's too early.

SERGIO VERGALLI

I totally agree. Thank you very much for this answer. So looking at the picture, the point is, we have to adapt and to move to adaptation in this case, to look at other solutions. I have two questions in this direction: which could be the solution in order to accelerate the process? You have stressed there are some problems related to politics and also the acceleration of the energy sector that is not ready so far and so, probably we should move in the adaptation strategy combined with mitigation. Is it more important to one or to the other strategy? or are they both important? Or in which kind of direction we can move?

RICHARD TOL

Both are important, right? We cannot let the world get warmer and warmer and warmer and warmer at some point. That will lead to severe problems where warm blooded animals. Right. We have to keep our inner core temperature at 37 degrees. Otherwise our organs will fail. And that means that the external temperature also has to be kept to a comfortable level.

So that is fairly simple. We cannot burn all the fossil fuels that we know are out there in the Earth's crust because that will lead to very, very substantial problems. So we have to mitigate, we have to bring carbon dioxide emissions to zero because essentially a part of CO2 emissions stay in the atmosphere, basically forever, based on a human timescale.

They stay in the atmosphere for a very long time. And that means that the only way to stop climate change is to bring emissions to zero, carbon dioxide emissions to zero. So there's no question that it has to be done. Given the problems I talked about with net zero, the issue there is a more one of timescale than of feasibility.

So does the emphasis really should be on technological progress and climate policy should really focus on making carbon neutral alternatives as cheap or cheaper, as abundant or more abundant and as convenient as fossil fuels are now. But fortunately we have seen happening mostly away from the political theater around climate policy that has been going on for 35 years now.

What we've seen is that people in business sort of smelled an opportunity and said, we can solve this and we can offer better products than the fossil fuel industry can, and we're going to make money out of this. And we've seen that and in power we've seen that with solar power. We now see that with electric vehicles. And I long for the day that motorbikes are becoming electric because I really hate the noise that they make.

And as people put better carbon neutral products in the market, that is how we're going to solve this. It has to be done in such a way that the average person would want these products, that it's not something that is forced upon us by some government mandate or that it's subsidized for a very long term. No, it has to be stuff that people want to buy and fortunately, we've seen - I've been in this business for 30 years now - we've seen remarkable progress there. First wave wind, then with solar and now with batteries. Electrification of transport is going much faster. It goes carbon into houses that are now building, the progress that they're making in steel and the progress that they're making in cement and related products. It's actually quite dramatic what we've seen over the last couple of decades in terms of technical progress.

And that is that is the way to go and that is what policy should mitigation policy should focus on the emissions of this year. Emissions of next year are not important. What is important is the products that we bring to the market in the next 10 and 20 years. And as long as it's stuff that people would want to buy, the problem will solve itself.

Right? And it's not just with carbon dioxide, but of course we have the other greenhouse gasses as well. And one of the things that really heartened me was the Hvsusiba 2 rice, where they took a gene from barley and stuck it in rice plants, which has three effects. Well,

it has one effect, but with two implications. It sends more of the energy of the plant to the grain and less to the leaves.

And that means that it's a higher yields for farmers. And that is, of course, what farmers want. But because there is less biomass in the leaves, there's also less leaves to fall in the water and to methane. So you have actually both a desirable effect. You have higher yields and lower methane emissions and that is, of course, what we want.

And so it's that sort of things that make me hopeful for mitigation. So that is and that question as I said before, we're not going to get to net zero by 2050. And that means that we're looking at fairly substantial climate change over a century and over the next and the centuries that follow. And that means that we also have to adapt.

There are no two ways about it. There is climate change at the moment, and there will be substantially more climate change in the future. And that means that we will have to learn how to live on a warmer planet and perhaps with heavy rainfall. We have to learn how to cope with rising sea levels and so on and so forth, rather.

A lot of these things we know already how to do and we have to make clever use of that knowledge and make sure that the people who need the knowledge actually have it, right? I mean, the Netherlands has faced rising sea levels for a thousand years already, so knows how to cope with this. And what we need is to export that technology, which is not just hard civil engineering, but actually also involves institutions and so on and so forth. And to the places that need it most.

SERGIO VERGALLI

Now the next question is related to the role of coordination, we have problems with coordination failure. At the beginning you said we have some problems related to coordination. In some cases it's possible to see that each time we have a Conference of the Parties it's very difficult to find some solutions because we have a typical coordination failure: different acceleration, different speed of the countries that are involved. On one end you have the European Union that has a zero emission target, on the other hand some other, and at the beginning you started to stress these problems.

Could we have some solutions from the political point of view, can we do something in this direction or is it an open problem?

RICHARD TOL

It is and it isn't. And you're absolutely right that climate change is a global problem and it won't be solved unless all or at least most countries are pulling roughly in the same direction. But there is of course, coordination and coordination. So from the first Conference of the Parties in Berlin in 1995 to the 2008 Conference of the Parties in Copenhagen, I forget its number at the moment, and the idea was that countries would agree on binding, legally binding targets and timetables for CO2 emissions.

And as economists, we of course know that this is the voluntary provision of a public good, and that doesn't work. And that is, of course, what has been shown in these negotiations,

that it doesn't work. But in 2014, in Lima, and then it was ratified in 2015, in Paris, we have seen the introduction of that ugly mouthful, intended, nationally determined contributions.

Right. And you need to be a diplomat to come up with such ugly words. Right. And but there's two key clauses. One, it's intended these are aspirations. These are not commitments. And the second is that they're nationally determined. That is, these are not set by the United Nations, by some international treaty, but they are set by the capitals of their respective countries.

According to whatever process they use to make decisions. And that, of course, means that these COPs essentially have no longer any say about what the targets are of countries. It's just countries deciding for themselves. Of course, the Paris Agreement also has that every new climate policy has to be more ambitious than the previous one.

But it doesn't specify how that would be. I never understood why Trump walked away from Paris because his only obligation in Paris was that he would have a better climate plan than Obama had. And of course, that is exactly what Trump likes to do, claiming that he does things better than other people, even if he doesn't.

And so he could have just stayed in and just come up with glossier paper or something and declare that he had a better climate plan or nicer words or better words, as he would say. So in that sense, the coordination problem about emission reduction targets has been taken off the table in Paris. The only obligation that the Paris Agreement places on countries is that they have a climate policy and that they make it in some way more ambitious over time.

And so in that sense, and that is how you would design such an international treaty, and that is how it has been designed. The remaining coordination problem. And there the trends are actually going entirely in the wrong direction, is technology sharing. Previously I talked about how the solution to climate policy, the solution to the climate change problem is to develop new technologies and bring them to the markets.

Of course, that isn't the whole story. It also needs to be taken up by the vast majority of households and companies. It's the diffusion of the technology and is actually more important than the research and development. It's the diffusion that matters most and what we see happening at the moment is essentially a breakdown of trust between China and the United States, where more and more technologies are deemed classified potentially of dual purpose.

And that is exactly the opposite of what we need. And Europe is being caught in this as well. Biden made a big mistake. It was the only way to get the Inflation Reduction Act through. The only way to get substantial climate action through Congress is to give out large subsidies, essentially to revert to industrial policy.

But that also implies that the US is now competing with Europe for these new technologies. Right? And what we are seeing is a fragmentation of a lot of markets between the US and China, but also in energy markets through the IRA and between Europe and North America. And I think that is exactly the wrong way to go, because we would want these new technologies to diffuse as quickly as possible across the world, not just across the parts of

the world with whom we are friendly. I mean, you can turn this around and say, well, this brings competition into the market because everybody is competing for the same thing. But I think a more likely result of the geopolitics here is fragmentation and reinventing of wheels and the waste of a lot of capital and a lot of brainpower. And so that, I think, is entirely wrong. Now, returning to what I expect from COP 28, not much. The main, the good thing about COP 27 was that it did not fail, that countries kept talking to each other.

I hope that the same will happen in COP 28. Although tensions have risen since, I think that would be the best outcome that we can expect from COP 28 that there will be a COP 29 which is not at all guaranteed. The main spectacle at COP 28 and perhaps COP 29 will be that at some point governments will have to admit that one and a half degrees is out of reach.

And of course, politicians do not like to admit failure and so they will try their hardest to avoid language that says that, yeah, we agreed this in Paris in 2015, but that was a bit of a silly promise to make and they will not say that, right? But at one point they will have to admit the latest projection by the Hatley center is that we will reach one and a half degrees within the next five years. We're not going to solve that. Not even a nuclear war would probably stop that. And we don't want to go there right? So that will be the thing to watch for in the next few COPs.

First, do the countries in the world continue to come and continue to be polite to each other and say, we're going to solve this together even if we don't? And the next big thing, at least in my mind, is when are we going to admit failure and how? But that will come relatively soon.

SERGIO VERGALLI

So there is a link between the US-China, they can also affect the process of decarbonization. Related to this, two questions: one is related to what happened in the last two years, so the war between Ukraine and Russia that stressed again this topic of energy security. Italy, Germany, Europe in general discovered again that we have some problems related to energy security.

We have to rethink our process in order to decarbonize, to change a little the steps in order to decarbonize, before the war we had the Green New Deal, so the idea to move in this direction. In other cases also COVID-19 accelerated the process of funding in the direction of green technologies, but at a certain point we had this problem related to the Ukraine war, at the moment it stills exist and the war changed especially Europe, I think less the US but also there probably for exportation of some type of oil. Which is your opinion about this and which could be the effect, also thinking to the future?

Also related to coordination, maybe if we're not able to coordinate with others, maybe we can impose a system or a model in order to trade and in this case we have the Carbon Border Adjustment Mechanism. In your opinion, could the Carbon Border Adjustment Mechanism work or not?

RICHARD TOL

Those were two questions, and big ones. Energy security has always been important. And occasionally we are reminded just how important this is. Right. And the second invasion of Ukraine by Russia was an important reminder just how important it is to have a secure energy supply and how important it is not to rely too much on a hostile or a potentially hostile trading partner.

And I think it is too early to say what are the long term consequences of this whole strategy. But what we have seen is that Europe got away relatively easy. That sort of goes against some of the things that I said before, that actually is very hard to change the energy sector rapidly, because we actually did so, and with some people take it as a lesson for climate policy, but I don't think it spills over.

I don't think that we are willing to make the same sort of sacrifices for climate as we are for the immediate threat of a Russian gas boycott. But essentially what we've seen is that pipe gas that came for pipelines have been replaced. That gas that came through ships, through LNG. And that's essentially what we've done. And we were helped by a particularly mild winter and that is how we got through so far.

In the longer run, energy security and climate policy are closely related. The big problem with energy security and the big problem with fossil fuels is that production and, to a lesser extent, transport is spatially concentrated. There's a few places that generate a lot of oil and therefore if something goes wrong in those places, then the whole world has a problem with supply.

And of course, because oil is so important, we have everybody meddling in these places which typically exacerbates the problem rather than solves the problem. So that is the problem with particularly the oil supply and the gas supply. And then, of course, we have these transport nodes, the Straits of Hormuz, the Straits of Malacca, where everything has to go through, the Suez Canal. And if something goes wrong there, then we have a big problem as well. The good thing about renewables is that they are not spatially concentrated. We have a lot of small sources. And that means that A, it is much harder to create a big problem all at once because they're just spread all over the place. And also technical problems. Like last year we saw this ship on a single ship go wrong in the Suez Canal and the whole world trade killed over. And that won't happen if a single turbine fails. So in that sense, because it is not spatially concentrated and instead of relying on a few big sources, we relied on many small sources, it becomes intrinsically safer.

So that is a good thing. Some people worry about the rare earths that are needed for the batteries and for the solar panels and to a lesser extent for the wind turbines. Some people worry about the capital that is needed for all these things and we should of course not forget who is doing the saving right. And a lot of capital is imported as well.

Whereas, fossil fuels are subject to price volatility in the oil market and in the gas markets, solar and wind are of course much more susceptible to volatility in the capital markets because it's simply that the fuel is free, but the capital is not right and they're much more capital intensive. But those things I actually worry about less than other people because these rare earths are not needed for the operation of the plants.

They're only needed in the construction. And that means that if China were to stop exporting its rare earths, what would happen is that we will no longer build new solar panels, but the old ones will continue to work. And so and that is completely different from an oil and gas boycott by Russia, where the power plants will simply stop.

So in that sense, renewables are inherently more secure. So that is all good. Which is not to say that there are potential risks in going back to China and also going to India and it is still the case that for these countries, their main domestic supply of energy is coal. And we hear and read a lot about the expansion of wind and solar in China.

What we hear less about is that China also has an advanced program in coal liquefaction to replace gasoline and diesel with oil derived products. And they also have a substantial program in coal gasification on the ground, coal gasification where they would replace imported gas with coal and and those processes are actually more carbon intensive because of the energy needed in the conversion and are actually more carbon intensive than using the coal directly.

And it could of course be that, God forbid, in a standoff between the United States and China over Taiwan, somebody could decide to block the Strait of Malacca, to make sure that China can no longer get oil from the Gulf. And in that case, they would probably very rapidly upscal their coal electrification and coal gasification programs. And that will be fairly bad for, fairly bad for the climate.

Now, I don't think that China wants to do this. I think they'd much rather go for renewables and then amongst rather friendly relationships with definitely the countries in the Gulf and definitely with Russia. But of course that possibility is there when actually the link is not so much from climate energy security, but rather it's geopolitical events that could prove energy security and concerns about being dependent on imported oil and gas and not being able to run your army.

And people don't often talk about just how energy inefficient armies are. Tanks use a lot of fuel because they are very, very heavy. And there have been studies that say the Chinese army would stop within a few weeks if they can't import oil because they will have burned it all. And that is a real concern for them.

And of course, what we see is similar tendencies in India, which is getting much more belligerent. India always has a streak of trying to be, at least since independence, a streak of trying to be independent. But they are very dependent on imported oil and gas. And at some point they may decide that that is not a good idea.

That is probably further in the future than China, although things can change very quickly. And so, yeah, there are links between energy security policy and climate policy. I think in the long run it will be mostly a good thing that climate policy will actually make energy supply more secure. But in the short run, all sorts of things can go wrong and perhaps very wrong there.

And now you also asked about the core of the carbon border adjustment mechanism of the European Union. I think it is a little bit too early to say what will happen there. It's a good

thing that it's there, and mostly from a European perspective, what we have seen started in 2005 with what we have seen in the last eight years in the EU.

Is that initially a lot of permits, emission permits for grandfather to grandparents, that is, they were given away for free to companies based on their past emissions. And the European Commission has always promised that this will be temporary and it would be replaced by auctions. And that makes a lot of sense because grandparenting permits essentially rewards bad behavior in the past and it distorts capital markets because it's essentially a capital subsidy that is given to companies.

So for those reasons, grandparenting should be abolished and should be abolished quickly. But the European Union has not been able to do that for the last 18 years. And the main reason and that is mostly a political reason, has to do with international trade. And it's the trade exposed sectors that have been getting these free permits for the last 18 years.

And the Cbam will end this, or at least that is the plan, right? You never quite know whether they're going to follow through here, but that is at least the plan. These companies and these sectors can no longer claim that they are at a trade disadvantage because of the EU ETS and because now they're protected through this border adjustment.

So that is a good thing and that is, I believe, the main effect of Cbam is mostly internal EU politics and it will win these sectors of their capital subsidies in the will that they will be painful. Right? What we've seen happening after Brexit is that British companies had to do without these subsidies fairly abruptly. Thanks to Mrs. May.

And this was actually one of the reasons that British Steel went bankrupt because they used to get £100 million from the European Commission for free every year. And all of a sudden that disappeared and that sort of tipped them into bankruptcy. And so we can expect some things happening there because the effects of Cbam are concentrated on energy intensive trades.

I don't think it will make that much of an impact on the rest of the world because energy intensive stuff tends to be heavy and therefore we don't transport it long distance. It will affect sort of the cement trade between Turkey and Greece. And there is some steel ships around, but I don't think it will have such a large effect on the relations or the trade relations with China or the United States, because we don't tend to trade in energy intensive goods that much anyway.

Ironically, it may actually have a fairly large effect on the United Kingdom, because what I've seen happening in the last two months is that the price of EU ETS permits has been roughly stable. But the price of UK ETS experiments has cratered and the price of carbon is now much lower in the UK than in the EU. So there would be a tax essentially exporting from the UK into the European Union.

And so that would be interesting. But again, mostly political dynamic because of course their main export products of the UK are finance and entertainment and that sort of thing. Rather than that we export lots of steel and to, to the continent and, but it will be the, the political fallout will be interesting to watch.

SERGIO VERGALLI

Than

Thank you very much for this very interesting answer. I have other questions if you have time. One is related to technology.

We have spoken about coal, fossil fuels and renewables in general. There are two technologies, which are hydrogen on one end and on the other end is nuclear in general, fission and fusion. Probably we have some hope for fusion in the future.

What are your opinions about these technologies?

RICHARD TOL

I prefer to stay out of the technology forecasting game. I, as I said, have been in this game for a while. I've been doing climate for a couple of decades now and you sort of see it come and go. One decade everybody's in favor of hydrogen and the next decade everybody's in favor of electricity as an energy carrier. And then it sits back to hydrogen and then it sets us back to electricity.

And I don't know which of the two will eventually be in at the moment. It seems that for personal transport, for the cars that ordinary people drive, electricity seems to be winning the day. And that may be for a structural reason. And that is, at the moment it has an advantage and at a key time.

But also hydrogen is actually dangerous. I mean, you need big tanks for hydrogen because the energy density is so low, which is very inconvenient, because then your kids won't fit in your car or you need to do it on their high pressure and then it becomes heavy and it becomes dangerous and explosive. And I don't think it would be safe for someone like me to fill up a hydrogen car, knowing how I deal with petrol, that may simply not be wise.

And at the same time, electricity has a problem with hauling heavy vehicles. So I think if it comes to trucks and therefore definitely heavy duty trucks as well as shipping, it actually makes sense to go to hydrogen because there you need the extra pull and that you can't do with an electric engine and you have professionals handling the fuel.

So for those reasons, I think the markets, the transport market may split there. The smaller vehicles will drive on electricity and the larger vehicles and boats and ships will use hydrogen. That strikes me as a plausible future. But yes, as I said, that goes for cars that we're going back and forth all the time.

And nuclear power, I don't know. If we're talking about fusion power and the big issues there... I mean, fission power is hard to predict how it will go. And for a long time we did not build these things in Europe and North America essentially because of the risks that were involved. We are now building a few power plants again, but they strike me as largely failures there. There's all sorts of technical problems with these things.

They're delayed and delayed again. And have to be rebuilt, some of it off pure silliness. At one point the French engineers that went in to build this plant in Finland, were so arrogant that they started pouring French concrete that did not make it through the first winter in Finland and they had to start all over again.

And some of it is silliness, but they had the power plants, the nuclear power plants that are currently being built in Europe are technically troubled, they are troubled in terms of the organization and they are exceedingly expensive compared to wind and solar. And really you wonder why would we want to build this stuff in the first place?

Because there are politicians who are committed to this and the other problem with nuclear is that nuclear is the ultimate base load and it just is not flexible. And of course, what you need in order to compensate for the unpredictability and the variability of invented solar is you need to have an alternative power source that you can scale up rapidly, scale down rapidly.

So gas is a much more natural combination with wind and solar than is nuclear. So and of course, you can solve this by putting lots of batteries on the system. That just drives up the cost. What people are talking about now is putting lots of electrolyzers on the system and making hydrogen to store things temporarily, but it just adds to the cost.

And so I, I just don't see a big future for nuclear because of those reasons. And at the same time that is something that I do not fully understand. The Chinese and the Koreans seem to be much better at building nuclear power plants than any European or North American company. But I do not fully understand why this is and how this works.

Going back to sort of the decoupling between China and the rest of the world, do we really want to trust the Chinese government with building our power plants? I am not convinced that we want that for political reasons. I have nothing against a nuclear vision in principle. I just don't see how it would work in practice.

Also, when people talk about small modular reactors where small means small relative to nuclear power plants, but it's still big relative to everything else, right? That may be small nuclear reactors. Small modular reactors are not small at all, actually. And the size of a fairly large gas fired power plant. Now, with fusion I am not fully abreast with the technology there.

And of course, there is the old joke that fusion will be commercially feasible in the next 50 years, and it has been so for the last hundred years. And it seems to be that the projection of when this will work is always shifting into the future. Although when I was younger, the joke was about 50 years.

Now the joke seems to be about 30 years. So there has been some progress. The most promising technologies, or rather the technologies that are furthest ahead in the technological developments. The ITR and things like that go back to the old system of large centralized power generation. And I've seen some projections that really what you want is a single plant that provides all the electricity for the United States and then it will work.

Now you then have the immediate problems where it's a natural monopoly and how do we regulate it? You immediately have problems with maintenance, right? What if the plant needs to go down to be clean? You need to build the second one next to it. And of course, it's an ideal target for terrorists. And so for those reasons, I don't think that this particular form of fusion is the way to go.

Now, I understand that in the lab people are working on smaller fusion reactors and that would take away those concerns. But at the moment they're only well, they're sort of working theory and there's been some small scale demonstrations that, yeah, it would work in principle, but that will take decades to bring to the market. And at the same time, we have these ready made solutions with wind and solar.

So as I said, I don't like forecasting technology, but it strikes me that nuclear simply has lost the race to solar and wind and they will never be able to compete because of that.

SERGIO VERGALLI

You told us about the finance rule of announcing this fund to reduce the effect of CO2 or to also increase decarbonization. In this direction we have the rising stock market related to ESG, what is your point of view related to the ESG stock market?

And another point is related to insurance: in some cases it's said that insurance could be one of the manners with which we can give an impulse to adaptation. Do you think that the financial market could help decarbonization or the fight against climate change?

RICHARD TOL

No, absolutely. If CO2 emissions are driven by the capital stock and future climate policy is driven by innovation then, finance is incredibly important. You can't do this without finance now.

And there's some good things going on there. Obviously, a lot of money has been made available for these new technologies, essentially because people smell a market opportunity. Right. So that is all good. The whole ESG movement seems to have at least as far as I can see, seems to have a lot of components of greenwashing there, that there's all sorts of things that are labeled as E or as S or as G that are really just nothing much.

But it is, of course, important that these things are financed. Another thing that bugs me about this whole thing is that some people are boycotting fossil fuel companies and that they're forcing pension funds and those sort of things to divest from these companies. That is, I think, entirely wrong. If a university like mine decides to divest from British Petroleum, for instance, the effect is essentially zero on British Petroleum.

Right? Because we are a small investor, we sell our stuff and we sell it at a market price and somebody else buys this. And as a result, my pension fund and my university assets, because we put this voluntary constraint in our portfolio, returns less. And at the same time, presumably these shares are bought by somebody else who is less green scruples and as a result has a higher return on their investment.

So this whole divestment program essentially transfers money from well-meaning people who are green and forward looking to more conservative people who do not care about the planet. And so I just don't understand this. Of course, if green people sell out their shares in fossil fuel companies at a large scale that will just suppress the price, right? So it actually makes the problem worse.

Then you sell your shares to somebody who doesn't share your preferences at a discounted rate and they make a higher return. You are making the bad people rates, essentially the divestment program. And of course, you lose your voting rights with these companies so you can't exert pressure internally on what they're doing. So I just think that the whole divestment movement is completely misguided. It's led by people who really don't understand how financial markets work.

Now, with regard to insurance, there's a lot of misunderstanding of what insurance is. So if you're talking about property insurance, say, against fire, then essentially what you do is you have an entire city or maybe an entire country, and everybody is insured against fire because you have to be, otherwise they won't give you a mortgage. Right. And it's a smart thing to do anyway. So let's assume that everybody is insured against fire. And I know only a handful of fires break out every year. Right. So essentially, what insurance does is it transfers the risk from the victims off, in this case, fire to all the potential victims.

And because the incidence is small relative to the large population, actually, we pay very little for our fire insurance compared to the devastating damage it may do to your house. So that is how insurance works. It transfers the risk of a few victims to a large number of potential victims.

Now insurance does not work if we have correlated risks, if, as we see in person at the moment, we have an entire city that is flooded because then everybody claims at the same time.

So natural disasters are not so much insured, but they're actually re-insured. So what happens is that on top of the insurance companies, state insurance companies for insurance companies, and what these reinsurance companies do is essentially the same thing. There's a potential of natural disasters all across the world, but they happen only in one city or in one country at a time, and they pool the risks globally.

That is what Munich Re and Swiss Re and all the reinsurance companies do. And that is a very useful thing for us as consumers to be able to reinsure, to insure ourselves. And is it useful for climate change? Not necessarily, because while climate change does is that it probably increases the risks of natural disasters everywhere, and that would create a greater demand for insurance.

But because everybody is affected, you cannot insure climate change itself because there is no distinction between the actual victims and the potential victims. That transfer is simply not there. And of course, insurance companies and reinsurance companies are not charities. They are not there to take the risk away from us. They're there to make money.

So if, say, flood risks are going up, and it's likely because of climate change that the flood risks will go up and then the response of insurance companies would be either to increase premiums or withdraw cover. And actually, what we've seen happening is both movements. So insurance does not really solve the problem. It just may smooth out the problem a little bit over time.

But it's not that because you are insured, all of a sudden you no longer have to worry about climate change. The best thing you could hope for is that your insurance premium goes up and you pay more. And the worst thing that can happen and has happened in certain places is that insurance companies withdraw. And then as an individual, you're left with the risk.

And so insurance does not solve the adaptation to climate change problem at all. It is one of the mechanisms that will change in the future, it will have to change in the future, but it will not take away our problems, not in the least.

SERGIO VERGALLI

So we'll probably need the role of public funds for rebuilding after a disaster?

RICHARD TOL

Well, so some people say that the State is, the insurer of last resort, and often even if that's in some cases that is explicit, but in other cases where this is not explicit, the political pressure on the government is such that they will act as an insurer of last resort and again, that does not solve the problem.

And because the government does not have money, the government spends taxpayers money. So it will be a risk transfer from there will be a transfer from the people who pay taxes to the people who suffer the consequences. So it helps smooth the problems. But it does not take the problem away.

SERGIO VERGALLI

I've seen that some municipalities here in Italy, especially after the flood disaster in northern Italy are thinking about creating a fund for the municipality to cover some risks related to disasters, so a climate fund, and there is a debate related to this right now, like having a tax to create this fund and the idea is that this fund could also be used for some other things, like mitigation.

RICHARD TOL

Oh, absolutely. But that is how things are financed, right?

You use some of your tax revenue to create a rainy day fund, and at least that is the hope that it would be a rainy day fund. And then you use it when it starts raining. And that makes perfect sense. That's the basic diversification over time, right? Of course, there is always a problem with these funds either in the public sector that they may be abused for other purposes.

And the beginning, of course, everybody's well behaved. But if this fund is sitting there unused for ten years and then the newly elected politician will put his or her eye on this. Right. So, yeah, it works in principle in some countries have made it work fairly

well. I mean, Japan has had similar schemes for a very long time now and without too much corruption and everything.

But in the end it is used to shift money around, right? You do not take away the problem.

SERGIO VERGALLI

The last question, thank you very much for all your time so far, about geopolitics. I would like to understand your opinion about this. Before you've spoken about rare earths or critical materials. At the moment it seems that the control of the supply is totally, or in majority, is China's. China seems to control directly or indirectly a very high percentage of the total supply of rare materials and it seems like the US is losing the run against China, but I don't know if it's true.

In some cases probably there are other mines of rare materials around the world that are not discovered. For example with shale oil and shale gas, when we think about the reservoir of shale oil, now we're using the US's but I think there are other part of the world that are not discovered. In Russia for example right now they don't need an unconventional reservoir of shale oil. I don't understand why in some cases it seems that the US is losing the run against China.

RICHARD TOL

Well, yes and no. And the problem is actually similar to the problem with shale oil. It's absolutely right that China at the moment dominates these markets, which is mostly for historical reasons rather than for geological reasons. And what people have begun to realize is that these things are important and that China dominates and that we cannot necessarily trust China to continue to export this in the future.

And since then, people have been prospecting for these materials and there's now discoveries in Sweden and in Chile and in parts of Africa and so on and so forth. So it's not that these rare earths are geologically restricted to China, it's just historically the case. Of course, it takes a while to develop the mines for these things.

So if China were to decide tomorrow to stop exporting rare earths, then we have a problem. But that problem will solve itself. Then over a decade or perhaps a little bit shorter. One of the reasons that China dominates this market is the same reason that the U.S. dominates the shale market. It's historical and it is low population density.

So rare earths are rare. That is, you need to move a large amount of earth, to find a little bit of material. So these are fairly environmentally devastating operations that you could only do in sparsely populated areas. Similarly, shale gas is also fairly disruptive, so you do not want to do this close to people. So even though the UK has substantial shale resources and even though Germany has substantial shale resources, they sit very close to where the people are, whereas in the West they sit far away from where the people are.

Therefore they can do all these. It's a fairly dirty and noisy, noisy process and if you do it somewhere out in the Midwest then nobody cares, but if you do it close to Dortmund or close to Aberdeen and or close to Edinburgh, then people get very upset. And the same is true for these rare earths. They are probably everywhere, but you need to go into the desert of Chile or in the north, far north of Sweden to do this without upsetting too many people.

But in principle that particular dependency on China is a transitional thing and within ten years I think dependence will be a lot less. And as I said before, this has to do with the expansion of the capital stock, not the operation of our current solar panels. They will just continue to work. And if China stops exporting, you just can't build any new ones. And so in that sense, it's not comparable to an oil or a gas boycott.

SERGIO VERGALLI

Thank you very much, your time is very important for us, I appreciate it a lot. Thank you very much professor Richard Tol and see you the next time.

RICHARD TOL

You're welcome. Okay, take care. Bye bye.