Nate Hagens (00:00:02):

You are listening to The Great Simplification with Nate Hagens. That's me. On this show, we try to explore and simplify what's happening with energy, the economy, the environment in our society, together with scientists, experts, and leaders. This show is about understanding the bird's eye view of how everything fits together, where we go from here, and what we can do about it as a society and as individuals.

(00:00:36):

Amigos y amigas, bienvenidos a la Great Simplification. Today's guest is Antonio Turiel, who is a physicist at the Institute of Marine Science in Barcelona, Spain, specializing in remote sensing, turbulence, sea surface salinity, water cycle, sea surface temperature, sea surface currents, and chlorophyll concentration. He is also truly a polymath and a renaissance man. Most times when you see the word polymath, it's someone self-describing themselves on LinkedIn. I am describing Antonio Turiel as a polymath. We talk about oceans, how they are important in regulating Earth's climate, yet they receive very little attention as to what's going on with the ocean temperatures, the AMOC, et cetera. Antonio also runs a popular blog in Europe called The Oil Crash. He truly is working 60 to 80 hour weeks on the human predicament. Very active in Spain, on trying to get Spain to do things more sustainably. This conversation covers a wide spectrum of content.

(00:01:55):

Antonio and I have known of each other's work for 15 years, but this was the first time we've ever spoken together. It was a great conversation. For those of you who are listening to this on the podcast apps, I might suggest that you watch this on YouTube where there are full captions available because Antonio, even though it's his third language, he speaks very, very fast. This was a great episode and I hope to have Antonio back. Please welcome Antonio Turiel.

(00:02:25):

Saludos amigo

Antonio Turiel (00:02:42):

Good morning

Nate Hagens (00:02:44):

Antonio, I have known of your work for a very long time and you've probably known of mine, and we are finally having a conversation. So thank you for taking time out of your busy schedule today.

Antonio Turiel (00:02:57):

Well, I am very glad to be here with you actually. And yes, I have being following you for a very long now.

Nate Hagens (00:03:04):

We had to wait until the crisis was upon us to have a conversation, the irony. So you are among many other things. You're a physicist specializing in remote sensing, turbulence, sea surface salinity, water cycle, sea surface temperatures, sea surface currents, chlorophyll concentrations, and other marine ocean issues. You also run a popular blog on oil and you're very active in Spain, in the sustainability discussions. And you have a family and a full-time job. So my first question is, how in the heck do you do all this?

Antonio Turiel (00:03:47):

The secret is not sleeping. It's quite easy actually. For instance, today I slept for just four hours. This is not my usual schedule, but sometimes it happens. Now I think it's a question of having a good organization of time. And also when you are commited to something, when you think that something must be done, I think that you find the energies to do it.

Nate Hagens (00:04:12):

Yeah. I feel the same way, but I still need eight or nine hours of sleep. And you and I on these prep calls with our technology, you were up at 10, 10:30 PM doing these tech checks. So, carry on with your important work. So I think we could talk for three or 12 hours, but we have a 90-minute hard stop because of your train. What should we talk about?

Antonio Turiel (00:04:40):

I think that we can start talking about the situation with the climate in general, in particular ocean climate, which is my specialty. And then we can go ahead discussing our natural resources, and the conundrum that we have for energy and for economy at the global scale. I think this will be more or less the things that we could tackle.

Nate Hagens (00:05:01):

Excellent. That was my idea as well. So I've had a lot of ocean experts on this podcast, one on peak fish, another on prior mass extinctions with hydrogen sulfide, and DJ White who's a cetacean activist, but no guest so far has unpacked specifically how burning fossil fuels leads to acidifying oceans. Can you just for starters, in a basic primer way, explain the mechanisms and the risks and implications of ocean acidification?

Antonio Turiel (00:05:45):

Well, something that happens in the oceans is that the oceans are continually being mixed by the action of wind, because wind generate waves. So the question at the end is that because of this mechanism, oceans are continuously capturing small bubbles of air inside it. The question is that if you are increasing the concentration of CO2, this is contributing to the dissolution of this CO2 inside of the ocean. This is what we call inorganic and dissolved CO2. There is another mechanism for the dissolution CO2 inside water, which is caused by the action of living organisms. So in particular, in algae, because when they die, all the carbonates, all the chemical substances they have assimilated CO2 from... from

these bubbles I mentioned before. And when they die, they go to the bottom of the ocean. And then because several mechanisms, the CO2 is also released and also dissolved.

(00:06:41):

And this contributes to the acidification of the ocean in the deeper layers of the ocean. So we have a mechanism for the upper layers, we have mechanism for the lower layers. And anyway, all of them are contributing to have more dissolved CO2. The CO2, when it is dissolved on water, because it is carbon oxidant, it becomes then carbonic acid. And the carbonic acid, as the name implies, it's an acid. So this contributes to the acidification. Why is acidification is important? Because there are a lot of marine organisms that needs the pH, the concentration of ions, the acidity, the say of the water, to be in a particular specific margin, otherwise they die. This affects fishes and this affects, for instance, corals, because corals have a problem to integrate carbonate in order to form their skeleton, the exoskeleton. So this becomes dissolved, they tend to segregate and disappear.

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This affects also the skeletons of algae. At the end, it's affecting all marine life because in one way or the other, they are depending on having unstable, let's say, acidic level in the ocean. So yes, this is one of the conundrums that we have. Because also we know that from all the emissions, the manmade emissions of CO2, because of the burning of fossil fuels, we know that a few of them finish into the ocean. So this is the reason why the ocean is acidification at this very rapid rate.

Nate Hagens (00:08:20):

Okay. I have multiple follow up questions to that. Let's start with your last one. So most of the heat and emissions from fossil fuels have been absorbed by the oceans, right? Something like 90%. Why is that?

Antonio Turiel (00:08:40):

Yeah. 80% of the case of the heat. Well, the main reason is because the ocean has more capacity to store heat than air. So this is what is called the heat capacity, which is let's say the amount of energy, the amount of heat that you need to accumulate in order to increase the temperature by one degree. And when you compare the heat capacity of the water against the heat capacity of the air, it's about one million times more. In the case of water, it's much, much more larger. So water is the large storage of heat of the Earth. So anytime that you're putting into contact the warm air with the ocean in a continuous basin, the water is assimilating this heat, it's getting rid of this heat from the air and accumulating it to the water because it has a huge capability to storing heat.

(00:09:36):

The problem is that it has a huge capability, but not an infinite capability. So the problem at the end is we continue to do this, we are going to alter also, and we are altering actually, the structure of all the water column. We are affecting the ecosystems where the fishes live. We are affecting the many, many things and this is what is happening. And what is more worrisome even is that all this heat that the ocean is accumulating could be released suddenly if specific physical processes take place. And this may happen. So one part, a significant part of this accumulated heat could be suddenly released causing a massive disruption. And this something that we-

Nate Hagens (00:10:15):

How would that happen and has that happened in the past?

Antonio Turiel (00:10:21):

It seems that there are several cycles that favor this release of heat from the ocean. It has mainly to do with the movements, the vertical movements of water in the ocean, and also the difference between the air temperature and the water temperature. So what happens is that as we are accumulating heat on the oceans, if the warm water finally upwells at a place at which the air is colder than the water, the water will be transferring heat to the air. And this is the main mechanism of transfer. And it seems that this happens with more intensity because this happens always. But the question, at which times this mechanism intensifies, it seems to happens following several cycles. We don't know all of them, but it seems that we have a 20-year cycle that in fact we are now going to the bad part of the cycle, in which the ocean is releasing a significant greater amount of heat to the air.

(00:11:22):

And there are other cycles, other periodicities, other times at which these releases even increase more. But we don't know exactly why this happens with this periodicity. We don't know the mechanisms. At the end, take into account as in any other branch of science, we know some phenomena, but we don't know all the answers that why these things take place. At least we know it takes place, but we don't know all the mechanisms being involved.

Nate Hagens (00:11:48):

So it's safe to say that most people don't really think much about the ocean unless you live on the coast. But the oceans have been acting as a huge buffer for the heat that we've been emitting over the last hundred years, and we just take it for granted. Yes?

Antonio Turiel (00:12:06):

Yes. Now something which is important is when you are running climate simulations with large computers, it is very clear that what is driving the behavior of Earth climate on the long run, is the ocean. The ocean is the main driver because it's the main system in terms of accumulating heat and energy in general. So the effect of the ocean is felt all over the world. And many of the important perturbations, for instance El Nino, which is something that is been discussed this year because this year seems that it's probably to be one El Nino year. And this is associated to droughts and floods, and it's associated also to heat waves and so on, depending on the place you're living on. These are mainly ocean phenomenon. It starts in the ocean and it finish on the ocean actually. So yes, the dominant part of all the climate machine is the ocean.

Nate Hagens (00:13:05):

So compared to the rest of earth systems, is the ocean fast or slow to change? And what if oceanic changes begin to speed up?

Antonio Turiel (00:13:15):

The ocean, because of this huge capacity that it has to store warm heat, let's say, and energy, is the slowest part of the climate system. Well, probably not the slowest because maybe the cryosphere, the ice is even as slower. But because perhaps less size and impact. So the most active parts is the slowest one with difference. And the fact that some processes are speeding up actually right now in the ocean is quite worrisome actually, because it is indicating that all the processes around what we typically call climate, which is what is happening on the air, the weather and so on, probably are going to accelerate as well and much more. So this is the reason why any accelerating in ocean is very important, because normally it should be slow, and actually it is accelerating.

Nate Hagens (00:14:11):

Okay. So getting back to your comment on coral, there are some scientific reports that suggest coral reefs will be 75% gone by 2050 or nearly gone this century. So this I think affects like 25 to 30% of ocean species because they depend on them for their life cycles. But this is probably do mostly to sea surface temperatures. Acidification will play a role going forward depending on latitude, currents, et cetera. But what are your thoughts on the implications of a loss of coral, and what a loss of coral this century in turn kick off a collapse of trophic food webs in the ocean?

Antonio Turiel (00:14:59):

Well, this is clear because coral offers the habitat for many species of fishes in particular. So the question is that if coral is collapsing, many species, and especially species of fishes, are collapsing as well because they are going to lose the place at which they live. So this is implying that all this part of the trophic chain disappears. Something that people doesn't take into account is that, and when you are considering the living beings on Earth and the different places on Earth, they're all connected. This is the cycle of life. So at the end, you have first the algae, which is the same as plants in the ocean. There are other animals that eat those plants, animals those which eat those or fishes, or fishes that eat those and so on, up to arrive to the greatest perpetrator. But at the end, everything dies. And in dying, all the organic and inorganic matter that they have gets dissolved, and this is the basis for the new generation of algae to bloom.

Nate Hagens (00:16:06):

And 10 million years from now, it will be oil.

Antonio Turiel (00:16:11):

Well, the millions years, I don't know, but several tens of millions of years, yes, of course. Once they accumulate and if the geological conditions are the appropriate ones, for sure this will be turning to oil. Yeah. Of course. But the problem is that we cannot wait for so long. But the key point here is that if you have one part of this trophic chain... Trophic means eating. So the way in which one eats from the other, and the other eats this one and so on and so on. At the end, everything is reduced, is composed and serves as food for the algae. Everything restarts.

(00:16:48):

The problem with this is that if one part of this chain collapses, at the end, all the chain collapses. And this is something that for instance, we have observed in several parts here in the Mediterranean Sea, that we have what is called barren seas. So on the barring bottoms of the Mediterranean Sea, we have lost the Posidonia, which is a kind of grass that lives there. We have lost also corals, we have lost lot of things. But we have no fishes. So the only thing that we have there is urchins, this small animal. And on top of it, on the surface of water, you have jellyfish. And this is all the thing that you have. Every other thing has disappeared. So this-

Nate Hagens (00:17:28):

Is that just in some areas of the Mediterranean or a lot of areas?

Antonio Turiel (00:17:34):

It is happening maybe in some coastal areas across Spain, across Italy and across Greece.

Nate Hagens (00:17:42):

So are you chained to your office doing papers and presentations and science, or have you actually gone, been able to scuba dive and go in to look at some of these reefs and actually in the ocean?

Antonio Turiel (00:17:58):

No, because I have too many things already to be done. No, my problem is that I specialized a lot in remote sensing. And remote sensing, you see the ocean, but from a distance. And even if I travel a lot because I'm forced to, because I have a lot of meetings, for instance with the European Space Agency for this kind of things. I am not doing campaigns. I am not performing campaigns myself. My colleagues here are performing. Sometimes they have invited me. But the problem is that you cannot arrive to everything because it's very hard. It's very hard to do everything.

Nate Hagens (00:18:36):

Yeah. No, I understand that. So acidification, it's going to affect aragonite and calcifying organisms, but it's another hit against coral. But also, as you say, not only coral but other calcifying, plankton and organisms. So I assume because of the heat and maybe the oxygen, I'm not sure, I assume that this will initially be in the shallow waters. But how fast will ocean mixing make this a full ocean thing?

Antonio Turiel (00:19:10):

This is hard to say because we're observing that we have experienced changes in the way the ocean is mixed. Because something which is quite interesting, actually it has to do also with the problem of taking profit of wind energy, is that winds are becoming more intense in open ocean and less intense on the continents and on coastal areas. And some places, these change has been traumatic.

Nate Hagens (00:19:33):

Why is that?

Antonio Turiel (00:19:36):

We are not completely sure. We think that it has to do with the most rapid pace of ocean in order to absorb and release heat. But anyway, there is something that we are measuring, so we know for sure this is happening. And as I said, in some places, this is quite dramatic. So the question is that the wind is the main force for mixing in the ocean. It's not the only one, but it's the main one for the mixing of waters. So we are changing the way in which waters are mixing, but again, this is not homogenous. There are some places at the ocean at which the mixing rate is increased and the mixing rates at other places has decreased. So you are commenting on water temperature. And this is true that this is affecting in general all the life, because, well, temperature affects in many different ways. One important way is that as you increase the temperature, you are reducing the solvability of oxygen.

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So it means that the amount of oxygen that is contained inside the water is diminished. So for organisms, the rely on having this oxygen to live, for instance fishes, because they have taken the oxygen dissolved water, they have less and less. And even at a point that combined with the presence of some algae, there are dead zones in the ocean, in which there is no oxygen at all. So no living species lives there. And this is one of the efforts. But for sure, the increase in temperature, also what is increasing is the solvability of the carbonates in water. And this is also one of the reasons why the coral reefs are suffering and other organisms are struggling, because the carbonates, the substance at the end... The carbonate to be understood, it's the concrete from which the organisms are done. So at the end, you are dead. So at the end, you have this thing dissolved in water, you have a problem because anything is being ruined, has been destroyed.

Nate Hagens (00:21:41):

So last year, I had a podcast with British Columbia scientist, Daniel Pauly, who's studying something called the Gill Oxygen Limit Theory, that fish are actually moving towards the poles because they can't breathe. They have to go to where the water's cooler and there's more oxygen. So fish don't care about the climate debate in the world, they're already moving towards the poles.

Antonio Turiel (00:22:06):

They're moving actually. But the question is that at this point, trying to deny that there is a change on the climate of the Earth is completely absurd because it's something that we can measure from many, many different ways. I will explain you something that if you don't know, probably you're going to find amazing actually. Some years ago, one friend of mine went to Antarctica, and he commented me that he was actually impressed because he has been a lot of times there. And there a lot of amount of blue icebergs that he saw. Why blue iceberg is so special? Because the ice becomes blue only when it is very, very, very compressed. So typically, when you have blue ice, it means that it has been really very deep inside a thick layer of ice, probably for thousands and thousands and thousands of years. So this iceberg made of blue ice that he saw probably represented the ice that was there since, I don't know, maybe 20,000 years ago, a 100,000 years ago, something like that.

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And now the problem is that everything gets, this is the ice that's there, they're running into the sea. And this is not normal. Prior to that, 30 years ago, you almost never saw one of these blue ice icebergs. But this is one among many, many other evidences of the things that are taking place. And in particular regarding fishes, we are measuring this, we are observing that as decades pass, several species are moving, going away from equator. So again, to the North Pole or South Pole, because otherwise they cannot live there. And some species simply cannot resist some temperatures. And also for breeding, they need a specific conditions. Not only that, but there are some specific species of fishes in which the rate of the gender changes depending on temperatures.

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So we are observing that because of these changes in temperature, they have for instance, an excess of female specimens in front of male specimens. And these sometimes may cause some problems. So as I said, there are many evidences, and not only on the sea, we have also be observing the displacement of some insects. For instance, in Spain it is quite evident right now, we have some species of insect that used to live in the tropics that are arriving now to Spain just because the conditions are allowing it.

Nate Hagens (00:24:34):

You also have those dedicated plantations that show there are trees in Spain, but they're basically dead monocultures that don't have a lot of biodiversity and insects and life the way that they used to do. There's that. So let me ask you this. I don't know if you know much about this, but since we're talking about the oceans and wind, there has been news that the AMOC, the Atlantic Meridional Ocean Current has slowed something like 15%, which is a massive amount, in the last 30 or 40 years. And living in Spain and Northwest Europe, that has implications for future climate. And in fact, if you look at the climate models worldwide, that area doesn't look to be heating up that much relative to the rest of the world. Is that because of this AMOC? And what can you say about your research, and what the AMOC is, and the implications?

Antonio Turiel (00:25:37):

Yes. So the AMOC is what you call Gulf Stream. So it is the, let's say, surface arm of AMOC. AMOC is a part of the global circulation of water that is essentially transferring heat and moisture from the equator to the poles. So there is one of these arms that goes on the surface, what is called the Gulf Stream. It is running from North Brazil, enter the Gulf of

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Mexico, then turning around Florida Peninsula and then following all the east coast of the United States, and then turning more or less a bit below Cape Hatteras; it's very close to New York. It is turning down to east. And this is arriving, it follows more or less a constant latitude. So it's horizontal when you're seing a map. And this is arriving Europe and this is supposed to be one of the main reasons for which the climate in Europe is warmer and moister. We have more humidity thanks to that. And this also helps in order to have a better harvest here and so on. So it's very important from the agricultural point of view. So what you say is right.

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One of the implications of the slowing down of AMOC is that the climate in Europe is going to be, by comparison, not as warm as the rest of the world. I will not say cooler because it got cooler because the driver for increasing temperatures is also present in Europe. But here the temperature and in Central Europe is different in the case of Spain; doesn't increase at the same pace as in the rest of the world because of that, because the lack of this, but also it becomes drier. And this drying partisan, worrisome. Right now, for instance, we have a problem: important droughts in Europe that were unseen since 500 years ago, it may be a coincidence or maybe it's an effect of the cumulative effect of the climate change, for sure.

Nate Hagens (00:27:41):

Okay, three more questions on oceans and then we can move on. Number one on AMOC: why is it slowing and how much further slowing is already built in because of the inertia of the climate system?

Antonio Turiel (00:28:00):

As I have said, AMOC is part of this thermohaline circulation. So it is mainly driving by the difference and temperature and salinity. Precisely the thing I am working around this because now we are able to measure sea surface salinity. We are able to measure sea surface temperatures since some years ago and also sea surface currents. With combining all together, we can identify at which rate water subsides downwards at a specific places. So the question with AMOC is that you need to close the loop associated to the thermohaline current because at the end, it must make a circulation. So what is coming alat surface, but at the end it needs to go down in the ocean running by the bottom of the ocean, then coming up in Antarctica or in the Pacific Ocean and then coming back from several ways and then finally arriving again to Gulf of Mexico and at the end, completing the circuit.

(00:28:59):

The problem that is probably one of the causes of this slowing down of AMOC is the problem that we are observing in the south of Greenland. That was one of the specific places at which this current subsiding is downwelling. Probably is associated to different things: lack of wind, for one thing; also the accumulation of fresh water because of the melting of water from Greenland and also from continental Canada. This is for instance something that was observed in past times in the geological history; it's a story that the fact that if you have great amounts of fresh water coming; fresh water is harder to sink.

(00:29:44):

So the problem at the end is that this water, what happens normally, south of Greenland is the combination of wind and other factors makes that some salt is released and this water is getting saltier, cooler, and then it starts to sink and this is the way it completes.

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But now because of the presence of this fresh water and surface, this warming surface, it tends to be buoyant. It tends to be this surface is very hard to sink and it is one of the reasons it is slowing down. We have other two points at which the AMOC goes down, which are south of Iceland. Probably there are also some efforts there; maybe not as intense as in the case of Greenland. So this is the reason. The

main reason is this one, because the changes associated to the melting, especially coming from Greenland and from Canada.

Nate Hagens (00:30:35):

And how much more of that is already built in?

Antonio Turiel (00:30:39):

Well, as this is a very slow current, when you make a change on it, it takes a lot of time to reinitiate it. So for rebooting it, it's very hard. The main concern right now is if this current will be completely stopped because of this, or diverted more to the south. That could also happen.

Nate Hagens (00:31:04):

There was a Hollywood movie about that. I think it was called The Day After Tomorrow-

Antonio Turiel (00:31:08):

Well, that's a bit exaggerated. Yeah, I know, I know. But it's very exaggerated actually, because of things are much slower in reality now that... Let's say that the things that happen several days there typically will happen in several thousand years actually. Anyway, the question is that it could arrive to a complete stop. If it stops, it means that Europe will become very dry. Naturally, this is what happens, and probably will imply that the east coast of United States will become much hotter and warmer even at latitude like New York, let's say.

Nate Hagens (00:31:44):

And among other things it would eventually then lead to stratified oceans and lots of very bad effects for oceans. What are-

Antonio Turiel (00:31:54):

For some lightning particular and for hurricanes.

Nate Hagens (00:31:55):

Why?

Antonio Turiel (00:31:59):

And for hurricanes, because you have a warm, yes. Because the main fuel for hurricanes is the temperature of sea surface system. Yes. So as you know that above 28 degrees Celsius of sea surface temperature, you have energy to fuel the hurricane, and this will imply that hurricanes could go farther north with all the implications that has.

Nate Hagens (00:32:25):

Okay, here's a hard question for you, maybe: some people, especially with what's going on, not too many countries too far to the east of you, humans are afraid that we're headed for a thermonuclear strategic exchange between NATO and Russia. What would the effect of a multi-year nuclear winter have on the oceans and their ecosystems? Have you looked into that?

Antonio Turiel (00:33:03):

The problem is that if we do this, well, apart from the direct implications from radiation and all the fallout from the nuclear weapons and so on, that is absolutely devastating. You take into account that now the conditions, let's say astrophysical conditions of the Earth, astrophysical cycles associated to the slow changes in the mutation and eccentricity of the orbit of the of Earth around the sun, Earth is now in a situation in which if it was not for climate change, it would be favored to go frozen. To become in a glacial state.

(00:33:42):

Because normally what has happened the last millions of years with this configuration of continental masses, with this configuration of chemical composition of the atmosphere and so on, we typically have periods of, let's say, 110,000 years in which the Earth is frozen, it's in glacial state. And we have some that are stable states that show longer of interglacial, which is temperate, which is the period in which we are right now. That typically last around 10,000 years.

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So the truth is that climate warming and climate change, the fact that we have high CO2 concentrations in the atmosphere, now it is making impossible that the Earth to be frozen. So this is the only good effect associated to the release of CO2, the fact that we have gone too far away in this direction. But in case you make a nuclear winter, you are forcing the Earth on this glacial state because it is what is favored because the current configuration of the orbit of the Earth. So for sure the Earth, well, more probably the Earth would enter in, let's say, hundred thousand years of glacial state.

Nate Hagens (00:34:54):

And also the blocking out of the sun would kill a lot of the plankton.

Antonio Turiel (00:35:01):

Yeah, it will kill everything. No, no, this is clear. You have had, let's say, amount of aerosols and another particles with dispersion atmosphere that typically last for five years in the case of a total nuclear war. I hope we're not coming to this scenario actually, but in this case, yes, the time for all the dust to really start allowing, having the light from the sun to come to the surface, will be last typically five years. So in five years, almost everything will be lost. Not everything, but almost everything will be lost. So this will spell total disaster for plants and for algae, for sure. No, the mass majority of the life on Earth will be exterminated, this is clear. And then we'll fall in this time, hundred and thousand years of glaciation.

Nate Hagens (00:35:56):

Jellyfish and urchins?

Antonio Turiel (00:36:00):

Yes, some cockroaches maybe.

Nate Hagens (00:36:03):

Okay, so segueing into your other specialty. And by the way, let me pause here. You are truly a polymath. I know that because I've followed your writing for a long time and you have a strong Spanish accent and I just want to call out and respect you that you are able to articulate these incredibly complex scientific topics in Spanish obviously, but also in English, which is not your language and it's just deep gratitude for people like you that are just so multi-talented and care about these things. So, mucho gracias.

Antonio Turiel (00:36:47):

Thanks a lot. Also in French, if you're interested.

Nate Hagens (00:36:52):

Zut Alors. Okay, so segueing into energy, you understand peak oil and other limits to growth; given that we are now or close to peaking and that oil is the master resource, how worried are you then, about the future of life in Earth's oceans given that the amount of emissions are likely to go down in the not too distant future? They're not going to go away. They're still going to be a lot, but they're going to be not increasing. So that's question part one, and then part two, of all the ocean risks, given your knowledge about energy depletion, what is the biggest ocean risk that you're worried about?

Antonio Turiel (00:37:38):

Well, these two are complicated questions convoluted once, actually. So regarding the first one, is that you should take into account that even if we are forced to reduce our oil consumption because the production of oil starts decreasing, that is a process that is starting by now; the rate of descent, the rate at which the production of oil decays is not fast enough in order to, let's say, spell out the possibility of catastrophic climate change. If we wanted to avoid the worst scenarios of climate change, we should be reducing our consumption of fossil fuels in general, not only oil, by let's say 5% per year. Excuseme, 7-8 % per year. And this is not the way at which the production of oil is going to decay. Not to say, for instance, coal. Coal is not going to fall so fast. So the question is that-

Nate Hagens (00:38:41):

The overall decline rate of legacy wells might be 7%, but we're going to still drill and that new drilling is going to offset that.

Antonio Turiel (00:38:50):

Yeah, exactly. Exactly. The question is, if we were to stop completely or it will be more or less around the rate that we need, but have is still coal and you have still gas, so this is not enough. This is quite clear.

Nate Hagens (00:39:04):

Plus you can see that if what happened in Germany the last six months, that's one of the greenest political environments in the world and they're rebooting old coal towns because of the Russia situation.

Antonio Turiel (00:39:19):

I suspected. This is another question. So what happens in a situation of energy crisis is that you may resort to resources that are worse from the point of view of CO2 emissions. So even it may be in terms of energy, you are reducing your energy consumption because you're using something which is worse, which is not giving you as much energy as you had before. Probably in terms of CO2 you could have a worsening of the situation. So you will have the worst of the worlds: to have less energy and more CO2. Probably this is a thing we're going to do.

Nate Hagens (00:39:55):

I sadly I agree with you and one part that that's not talked about... By the way, there is not a single integrated assessment model in the IPCC that specifically projects a decline in growth.

Antonio Turiel (00:40:09):

Absolutely-

Nate Hagens (00:40:09):

Not only that, there's none that do the nuclear winter scenario in the climate models and there's also none that include deforestation as a response to negative economic growth; because the burning of the trees wouldn't be as bad as coal maybe, but we are losing the sink. What if we lose half of our forests sink capacity?

Antonio Turiel (00:40:33):

Yes. That question at the end is talking into account that in the forest biomass, so you have CO2 that has been stored there with some changes, some renewal, but has been stored there for centuries. So at the end, you are releasing CO2 that was accumulated there. This is clear.

(00:40:50):

But that is not only that, it's also fracking, it's also tar sands. This is the kind of resources that are so bad that they've released a lot of CO2 to obtain a meager amount of energy. And the question at the end is that most likely we're going to follow this path. And as you have said, this is exactly what Germany has done. While this situation has become dire enough, they have started burning more coal. Something which is quite paradoxical the past summer, is that in the situation in which we have heat waves in Europe, in Central Europe and in Germany, France and so on, we have droughts. They have problems to carry the coal across the Green River just because the river was so low that the boat couldn't pass and they just wanted the coal to pass in order to burn it to aggravate the situation.

(00:41:41):

But unfortunately we are so blinded to the energy question, we're so blinded to the climate question that we are trying to do our best as a society, as a community, as whatever civilization in order to burn more and more disregarding the long term effect. So regarding this first question, my intuition is that even if CO2 emissions are going probably down in the next years to decades case just because of depletion, something that we cannot avoid, probably the rate of decay is not going to be enough in order to really avoid a very sharp climate change. Even a catastrophic climate change. This is for one. Regarding to your second question, can you remind me because I have forgot-

Nate Hagens (00:42:28):

Second question is, you're an ocean marine expert; of all the possible ocean risks, given what you just said about climate, what is the biggest risk that you are worried about in the oceans in the next hundred years?

Antonio Turiel (00:42:45):

It depends if you are thinking about marine life or you are thinking about the importance of oceans for humans.

Nate Hagens (00:42:53):

Both.

Antonio Turiel (00:42:53):

There are many things that are very massive risk. This is the problem. There are very many things that are massive risk in both senses. So we have the problem with the depletion of fish, for sure. This is important because 500 million persons depend on the protein they can get from fishes and we have a lot of our fisheries, this is a problem. We have the very serious plan with the accumulation of plastics, which is entering all the traffic chains and plastics, the main problem that they represent is that when they arrive to our fish or to our dish is that they are what is called endocrine disruptors.

Nate Hagens (00:43:35):

Endocrine disruptors.

Antonio Turiel (00:43:36):

Excuse me, endocrine disruptors. So it's altering all your hormonal functions and this is not very good, actually.

Nate Hagens (00:43:43):

So there's two plastic problems: there's the big chunks of plastic and then there's the minuscule ones we can't see that are in the ocean food chain.

Antonio Turiel (00:43:51):

Yeah, this is the problem. Even some algae are able to assimilate. So this assimilates in fishes and it's more and more assimilated in greater predators and so on. So we have the problem with plastics, we have the problem with heavy metals, which are very intense in some ocean for instance in San Francisco, of course in the Mediterranean, the presence of heavy metals is quite important. We have in general the releases of dioxins and other chemicals, organic chemicals that have a lot of dangers. Present a lot of dangers for life in general because they are very toxic.

(00:44:29):

We have the problem of salification. One of the problems that we have, for instance, very close to the coast all over the Earth, but for instance in the Mediterranean is that as our expanses have been drought and all the water table is getting down because also we are over exploiting it, then the sea enters from below the ground. You don't see it, but the sea is entering and it salification, this part. So it is ruining this water table, this is not ever going to be able to be used because the content of salt, the presence of the water sea salt-

Nate Hagens (00:44:58):

That's happening in Bangladesh.

Antonio Turiel (00:45:00):

So many things. Yes. So there are so many, many things that for me will be hard to say which is the greatest risk. For me, one of the important risks that for sure the ocean is going to have, at least for the following I hope a few years, is the pressure for exploiting natural resources in the sea in order to compensate for the lack of resources on Earth or land.

Nate Hagens (00:45:27):

You mean the undersea mining of nodules of copper and things like that.

Antonio Turiel (00:45:31):

Exactly.

Nate Hagens (00:45:33):

I knew that this conversation would go six hours, so we're going to keep it to 90 minutes per our agreement. So let's switch to energy. Again, you know a lot about this topic. Let's just start here: can you explain what the second law of thermodynamics tells us about what types of energy we should be using and what types of tasks and how it relates to the ability and the desirability of electrification of our economy?

Antonio Turiel (00:46:02):

Yeah, well it's also very complicated question actually. Well, let's start by the beginning, the laws of thermodynamics. Everyone knows about the first law of thermodynamics: the energy is never destroyed, it's only transformed. So you cannot win energy nor lose energy, it's only transformed all the time along.

This is why I understand that for many people, this is very strange because what you know is that you are putting gas in your car and at the end of the day you have less gas, so you need to refill, so you are losing energy.

(00:46:36):

But the question that this energy which is concentrated, organized energy, is getting disordered; it's been converted into heat. Because something that most people don't know is that heat is actually energy, the kinetic energy associated to the movement of the molecules of any body. So what you are doing at the end is you have this orderly movement of your car that by friction, by the fact that it is passing by other surfaces, by the air and so on, you are losing, you're converting it in the disordered movement that has the molecules in any substance. I explaining this because it has a lot to do with the second principle of thermodynamics.

(00:47:21):

The second principle of thermodynamics, says that when you are doing any transformation regarding energy, no matter what, you are going to lose a part of the energy in the transformation because it is going to be converted in this disordered movement of the things. And this is what typically we call entropy. So when you are for instance converting the energy from your gas in the engine in your car, even in the process that is taking place in your engine, this process is not a hundred percent efficient. It couldn't be. And one part of the thing is just being dispersed as heat, and you cannot avoid that.

(00:47:57):

So the question is that when you are transforming energy from one type to the other, you are going always to pay a toll, an energy toll. You are going to lose some part of the energy. The amount of energy you're going to lose is larger as the types of energy, the original type of energy and the final type of energy, are more different. For instance, you have a water wheel and what you want is to convert the mechanical energy of the flow of the river and you want to convert this linear movement in a circular movement of the wheel. So this is mechanical to mechanical, this is very efficient and typically you are going to lose very low amounts of energy because of this. So from all this, you have some energy coming to the wheel. Probably are going to take in profit of 90% of even more. Which is the most inefficient way, the kind of transformation for which you pay the largest amount of energy in the transformation?

(00:48:58):

For instance, photovoltaics because you are converting let's say solar energy, which is the energy of the photons coming from the sun that's a light, which is a kind of very ordered but also very dispersed energy. Because of this specific quantum effect on the atoms, you are able to convert these to electricity. They are very different. The two very different types of energy you are taking essentially one of the most disordered types of energy, more dispersed, which is light, and converting it to one of the most ordered ones, which is electricity; the efficiency is typically quite low. So for typically PV panels installed today, the commercial ones, the efficiency is around 20, 21%. On the lab on specific conditions, very good devices, PV panels with very expensive materials and so on, maybe you can at obtain 30, 40%. I think the largest possible amount theoretically is about 56, but under very, very, very controlled situations, which is not going to happen ever in reality.

(00:50:09):

So this question regarding efficiency is quite important because sometimes when you are making plans for all the transformations of the different types of energy, as we're passing through several steps of transformation, every step implies a loss of energy. So we are getting energy from the sun, which is light on electricity on the PV panel. So we are losing around, let's say, 80% in a commercial panel. Then you're taking this electricity. And for instance you want to convert this to hydrogen because hydrogen is more convenient, let's say, to be stored. I think it's quite bad actually, but anyway. So, you are going to lose another 50% of this 20% that you have gotten. So you are going to have just 10% remaining.

(00:50:59):

Maybe this hydrogen, you want to use it in a car or in that truck. And then you need to do other many processes in between: you need to compress the hydrogen, you need to first reduce the temperature because otherwise it's going to get very warm, very hot and it could explode. And then you are going to take advantage of this in a fuel cell. So you are going to lose incredibles amount of energy because any one of these transformations. So all the idea regarding the energy transition, the way in which we are going to apply these different steps, are relying on the fact that at some time we are going to increase the efficiencies so that everything is going to run smooth and we are not going to lose incredibly huge amounts of energy-

Nate Hagens (00:51:49):

If the sun is so ubiquitous and huge and the photons hitting the Earth are abundant, then who cares if it's only 20% efficient on the solar panels, right?

Antonio Turiel (00:52:04):

Well, this is a good point because typically, this is the kind of argument that was used for a long amount of years sometime ago. So they say, "Okay, the amount of energy coming every year from the sun equals, let's say, 8,000, 9,000 times the amount of energy being consumed on the Earth, using all the different sources of energy. So it is so large that who cares?"

(00:52:28):

The problem with this is that first of all, let's recall that this energy arrives, disperses over all the Earth surface, which is huge and 3/4 of these surfaces is the ocean. It is not easy to gather the energy there. Other parts are desert, other parts are mountains. It's not that easy to capture it. But the question also is that since some time ago, we know that at the end, the Earth is already using the energy from the sun for doing things which are important.

Nate Hagens (00:52:59):

Right.

Antonio Turiel (00:52:59):

For instance, to create winds, rain, to make the plants grow, these kind of things that are important at the end for the functioning, the normal functioning of the earth. So at this point, this has been analyzed

by the Zurich Technology Institute, and they arrived to the conclusion that in the best of the cases, the amount of energy that we can intercept from the sun without altering all the normal functioning of the earth in a catastrophic way, even worse than the climate change, will be to gather around 0., I don't remember the percentage, but it will be key equivalent to four times all the energy that we are consuming right now, which is a huge amount actually, right? But it is not 8-9,000 times. It's just four times.

(00:53:45):

So this first implies that okay, it is not as abundant as many think. It is abundant, but it is not incredibly, not luxuriously abundant. This is not true. Then if it is a large amount but it's not so large, then the way in which you are using it is very important, and the efficiency of all the transformations are crucial if you want to make something which is functional. This is just one of the many problems that we have with all the systems devoted to gathering renewable energy. When I'm making my talks, I typically explain why this model of renewable energy is not necessarily the best one, the best fitted one. This is just one of the four main problems that we have with it.

(00:54:39):

So the first one is this one. The second one is that it relies on materials that are not so abundant on Earth because the systems for harnessing this energy, maybe the kind of energy they're harnessing is renewable but they are done from non-renewable materials. The point is that some of these materials are actually scarce on earth and they have also, their own depletion curves, so you can obtain a given rate. So it's not that easy to make a substitution.

Nate Hagens (00:55:05):

Even the non-rare ones, if we were to scale them two orders of magnitude like copper will have their own depletion curves, and it will take more energy to get them.

Antonio Turiel (00:55:17):

Exactly. Well in fact, in the case of copper you see what is happening in Chile right now. It is quite clear that we are arriving very close to the peak of copper production. In principle, was intended to be around 2035. But that's probably why we're going to accelerate it.

Nate Hagens (00:55:34):

Then if we do mine all that additional copper, then we have another shortage which is water in Chile because you need-

Antonio Turiel (00:55:40):

Yes.

Nate Hagens (00:55:41):

... a lot of water to mine the copper. Okay, keep going. What are the third and fourth?

Antonio Turiel (00:55:45):

Let me say something about this because it's interesting because some months ago, I was contacted by a mining industry in Chile because they wanted assistance to predict the presence of jellyfishes because they have also lot of jellyfishes there coincidentally. The problem that they have is in order to operate the desalination plant, they need to keep the main duct taking the sea water free from jellyfish because it blocks. Every time it blocks it, it makes a breakdown for several million dollars. They wanted to have assistance to predict this. So everything at the end is connected in a way.

Nate Hagens (00:56:28):

Yeah, it is. The late Albert Bartlett said that the greatest inability of humans was to understand the exponential function. I would append that by the ability of humans to think in systems, to think "and then what," because we're so reductionist looking at one thing. But now we know that jellyfish impact copper, impact solar, impact energy. Okay. What are the third and fourth challenges?

Antonio Turiel (00:57:02):

Yes. So the third, and this one is quite crucial right now, is so far when you consider all the steps on the life cycle of any renewable gathering system, it depends on fossil fuels. So for each one of the steps on the life cycle from the extraction of the materials that you need in order to make the different pieces, the different components of the systems, the energy devoted for the making of these components, all the phases of transportation, all the phases regarding the deployment, installation and the maintenance of the systems and at the end the decommission because sometimes they are not decommissioned, in all those phases you're using fossil fuels. It's very hard to avoid using fossil fuels. Up to date, nobody has ever managed to be able to do all the steps on the lifecycle of our renewal system in which fossil fuels were not appearing.

(00:58:14):

So for instance, this makes people like Gail Barrett to say that in fact, renewable systems are fossil fuel standards, something that you can get around. You have some fossil fuels by the hands. Otherwise, you cannot because they need fossil fuels to operate. I think this is a quite serious concern right now because something that we are observing is in the current situation in which for instance, we're struggling to keep on the level of diesel production because diesel is the thing that is decreasing the fastest regarding all the fuels derived from oil. We are observing that in general, oil mining on the Earth, transportation on the Earth, has become much more expensive during the last years. This is affecting for instance, companies that are working manufacturing windmills and manufacturing wind power, turbines and systems and so on, to the point that they have incredible losses.

(00:59:10):

I was getting information quite recently from the losses accumulated during the last year, just last year. I see that for instance, the three greatest wind manufacturers on Earth, they have very incredible losses. For instance, Vestas has losses for $1.5 billion dollars past year, just 2022. Gamesa, which is now part of Siemens, it was a former Spanish company and it's now part of Siemens, they have $2 billion losses per year. General Electric, the wind power division, they have $2.2 billion losses. So it's absolutely amazing.

Nate Hagens (00:59:51):

Yeah, I'm much more sanguine about solar than wind as a potential resource. But keep going on because I have 19 more questions for you. So what is the number?

Antonio Turiel (01:00:03):

Okay, okay.

Nate Hagens (01:00:03):

By the way, real quickly on this, I totally agree with you that all the renewable advocates in government and industry neglect the fact that … They think that we just keep everything the way it is and we build out all this other stuff, without understanding that this huge subsidy of fossil helpers, 500 billion strong in terms of human labor equivalent, are going to be retiring and declining. That is what is supporting the build out of renewables right now. But keep going, Antonio. What is your fourth?

Antonio Turiel (01:00:39):

My fourth question is something that I find also quite interesting that nobody wants to discuss about this. It's the fact that those systems are by design, designed to produce electricity. Electricity is something which is cool. I think it's something that's very nice. It's a high value kind of energy. It's a source of energy you need to produce consumer energy. But at the end of the day, in the context of the world, it represents 20-21% of all the fine energy consumed in the world. In advanced economies it's more, but you are always typically moving on the range of 20-something percent.

(01:01:20):

The question at the end is you have a 70-something percent of the energy, which is not electricity currently. We are assuming that it's going to be easy to convert this to electricity usage, and it is not clear because some of the things that we know that are hard to become electric. Even more important, interesting than that is that when you analyze the consumption curves of electricity, for instance in Spain in the European Union and in the sample of all advanced economies, we observe this stagnation or decrease of the electricity consumption since the year 2008.

(01:01:58):

So we have 15 years in a row with oscillations. It's not a simple decline, but you have a clear trend of decrease in electricity consumption when the previous years we have a very steep increase of electricity consumption. So it seems that it is very hard to increase the amount of electricity they are consuming. This is normal because electricity is not the preferred way to consume energy. It's still the preferred way to consume energy because of the flexibility, all the possibilities that it gives. It's from fossils derived from oil. This is the main source of final energy in the world.

(01:02:35):

When you say when for instance, in the case of Spain, that now they are pushing very strongly on Europe that we made this substitution because it's going to be simple in some sense. I say okay, but at the end, the consumption of electricity is been reduced from 15 years. It is not something which is

accidental the last year and in the COVID pandemic. No, no, no, no, no, no. It's something that actually is happening for 15 years in a row. So something is happening here. Of course, it has a lot to do with the loss of industries in general.

(01:03:09):

Industrial reduction is something that in Europe now is getting very intense because of the situation in Europe. It's not easy to say that this is going to change. So why do you want to increase the amount of systems able to produce electricity when you have no actual market for it? This is interesting question.

Nate Hagens (01:03:28):

Well, you and I have never actually spoken about that, but your four categories there are exactly what I say in my presentation. So either we're reading each other's work or-

Antonio Turiel (01:03:40):

For sure.

Nate Hagens (01:03:40):

... this is a robust finding. So you've said before, Antonio, that based on analysis of various studies, that the world would likely be able to sustain around 40% of the current energy that we consume in the intermediate to longish term. You've also said that if planned four and managed well, that this doesn't have to result in a drop of standards of living for most people but rather, a change in lifestyle. Can you unpack what you mean by this? What is the difference between standard of living and lifestyle in your opinion?

Antonio Turiel (01:04:19):

I think this is seen quite differently in Europe than United States because here, we have not those superabundance problems, and it is easier because we need less, let's say, private transportation systems. So for instance, in my case, I live in a town outside of Barcelona and I commute by train to my work here in Barcelona and back. Well, for me this is not quite complicated not to have a car. But for the United States, quite complicated. So the question for instance, the discussions here is in Europe, as you know. The European Commission has said that in principle, the selling of cars working on gas or diesel could be forbidden starting in 2035. This is because they start to realize that it's going to be very hard to keep all the amount of cars that we have here.

(01:05:20):

So how you can manage to make these changes in the energy consumption without affecting your life standard? So maybe not owning a car but sharing the car with other people that are going the same direction of you. Probably this is much easier to be done in places like Spain or in places like in Europe in general than in United States because you live in a quite different way. Okay? We know also that 30% of all the food produced globally is wasted even without anyone touching it. So that when we are talking about the problem that we have in the food system, that we have a problem, a serious problem in the global food system.

(01:06:03):

But this problem is mainly a distribution problem. It's not a production problem. We have also production problem for sure, but the main contributor right now is a distribution problem. We have a huge waste of, for instance, clothing. I don't know that in Atacama desert, in Chile, there is a vast extensive terrain at which there are a lot of clothing is been dropped there, some of them still wrapped in the plastic they were produced, because nobody has better touched them just because now are out of fashion and they are not interested on them. This of course, is a very huge waste of energy, resources, whatever you want.

(01:06:48):

In general, these methods of car sharing, something that, for instance in Spain is quite common that you have a washing machine inside your house. This is not typical in the United States, but here, it's quite common in the blocks of apartments. People has washing machine for its own each apartment. So you can share them, for instance, as is done in a lot of the United States. You can share other electric appliances. At the end, it's a question of reorganizing the way in which things are done. In the case of Spain for instance, it will be relatively easy to reduce our energy consumption by two-thirds, but also-

Nate Hagens (01:07:34):

By two-thirds?

Antonio Turiel (01:07:36):

Yes, relatively easy.

Nate Hagens (01:07:38):

Really?

Antonio Turiel (01:07:39):

Yeah. But the problem is that this will have a huge economical impact.

Nate Hagens (01:07:44):

Right.

Antonio Turiel (01:07:44):

A huge impact.

Nate Hagens (01:07:45):

And financial on stocks and bonds and things.

Antonio Turiel (01:07:48):

For sure. Yeah. So the question is, I am just discussing here the technical part. The problem is that of course, what it implies in terms of economics and financial is devastating because you are really cutting up, a lot of industrial activities for sure. The problem at the end is that maybe, probably this is going to happen anyway. Also, if you want the people to live, they need to have jobs. They need to do something for a living. So at the end, they need to work in something. So it's not as easy as okay, we are going to shut up all the factories. It's not as easy as that.

(01:08:27):

But from the technical point of view, what we need to live, it's not as much as it puts in. The problem is how we pass from this oversized economic system, oversized production systems to something that can be encompassed with the limits of the planet. This for sure is the hardest part, but it's something that I usually insist in my talks, that typically the problem for energy is posed as a question, which is a technical question. This is the reason why a physicist like myself is asking, "Well, how we can solve this?" I didn't say anything from the technical point of view, this is not a real problem. The main problem is a society problem. It's a cultural problem.

(01:09:08):

We need to change the way in which we consume and we make relations between each other and with the planet. It's a cultural thing mainly. It's not really a technical question, but I'm pretty sure making such a huge transformation of the economic system is not an easy task. I understand that many people will despair when you see that because they say okay, this is probably more difficult to do, that they're looking for a magic energy source to cap off everything.

Nate Hagens (01:09:40):

But at least we're now talking about it. I think the Ukraine situation has at least made the words that you just said sound somewhat plausible. So moving on to another topic related to what you just said that I know you have researched and thought about, why is the idea of rationing something that is generally associated with scarcity? Something that economics and economic theory, which is supposedly the science of scarcity, is not good at thinking about or handling. How have the minimal and temporary rationing systems in Europe because of the Russia/Ukraine situation been received so far?

Antonio Turiel (01:10:28):

This is interesting also for many avenues actually. So first of all, something that should be said about rationing, of course rationing implies that you have not enough resources in order to keep the things the same way you were doing previously. So this meaning that in some sense, you have scarcity. But the question is that economic theory of course is not able to cope with rationing by a simple fact is because in a standard economic theory, you have a principle which is called the infinite substitutability principle, let's say. Any factor, any production factor can be substituted by another one. The market will be finding the invisible hand of the market finances.

Nate Hagens (01:11:08):

Except for energy. They get that totally wrong.

Antonio Turiel (01:11:10):

Well, I think it is not the only case, but it is probably the main case right now. At the end, this is just a hypothesis. It's not a law of nature. It's something that, it is hypothesized to be like that, but it's not true. This is what happened. It's not true. The idea is that in principle if you put a price tag large enough, the market is going to find a substitute. Well, at the end it will be okay, provided the physical reality allows it. That sometimes is not the case because for instance, in the case of energy, you have energy that you have. But even in the case of materials, it happens that you have not really appropriate substitutes. If it is something that is essential as energy is, then you have a problem for sure.

(01:11:52):

So this is the reason why a standard economic theory does not contemplate rationing. Rationing always is seen as a failure of the market because the market should be able by definition to provide a substitute. So if it is not doing this well because someone is interfering with the market and creating this situation, and this is not true. That's because the physical reality, what's interfering is physics at the end. Okay? So at the end the question is well, how do you deal with rationing?

(01:12:19):

Rationing, at the end, implies okay, you have not enough for what you were, your expectations because at the end is that. You are expecting to spend as much in all the things you're doing, but you have not enough. So you need to decide how do you assign this? In the case of rationing, you cannot use the typical market laws because what is going to happen is that the one who is able to pay the most is the one who is going to get the largest portion.

(01:12:50):

But sometimes you have some essential activities. Let's say, for instance, agriculture, food production, food distribution, all the things are related to water, bringing water to have clean water, drinkable water. All these things imply a lot of energy and other things. And well... in general the putting all the essential goods to the reach of all the citizens. So those things for sure should have a priority in the use of energy. So at the end, the question is that when you are thinking of rationing, the way in which you are rationing is a political decision.

(01:13:29):

I'm pretty sure that it is going to be presented, as it has happened in the case of Europe, as a technical issue. But it is not. It is always a political issue because it is the idea that you have a how of society should work, that makes you to decide, okay, how I am going to assign? For instance, you're going to say, "Okay, we are you giving to everyone the proportional amount of things." So you have, let's say, 10% less. So everyone has 10% less. Okay? But this is a way of saying that everything is equally important to you, but it is not. Or you say, "Okay, these activities are more important than others." But then the others that are going to be reduced the most, you are taking a decision on that. This has to do with your own ideas, principles, ideology, whatever. It's a political thing.

(01:14:16):

In the case of Europe, what has happened is that of course, we have not enough gas for all the things that we wanted to do. So we have passed by several rounds of rationing in Europe, even maybe, well,

you are not probably aware, but it's something that even people in Europe has not been aware of this. But first we have a rationing of gas. So we were told in the past summer that we should reduce our gas consumption by 15% - in the case of Spain, because it was a bit different, it was just 7%.

(01:14:47):

But later in September, October, we were told that we would have to reduce electricity consumption by 10%, which is a significant amount. At the end, we have been able to cope with this. We have been able. We have met the goals. The two reasons for which we have met the goals, first in the case of this particular winter is because the winter in Europe this year has not been really cold. It's amazing because for instance, in Central Europe, we have observed temperatures that were 15 Celsius above the average. I don't know how many Fahrenheit, but just multiply by 1.48. But it is really very warm. So this has favored that the typical needs for energy for heating have been much more reduced during this year.

(01:15:41):

The other thing is that we are experiencing a massive closure of factories, enterprises, and industries in Europe at a really massive, massive rate. So I think that people don't want to speak out loud, but it is exactly what is happening. For instance, Germany is taking a great hit with this. So altogether, has allowed us to significantly reduce, to ration. But what is interesting is that it has been done almost not taking any specific measure because the state of measurements were quite weak, quite unconcrete. But at the end taking account what have happened, that the winter was mild, that the gas stations are closing. So actually they have not need to implement anything on place.

(01:16:33):

Even so, the European Commission has announced that from here to year 2030, we should reduce our total consumption of energy another 12% our total consumption of energy, taking into account that we are starting from where we are starting, with this additional natural gas with this reduction of electricity. Not only that, but for instance, in the specific case of France, they have a real, very complicated situation, what they call the sovereignty plan, I mean, austerity plan for energy consumption. They say that they're going to reduce the total energy consumption by 10% from now to 2025, so in two years, and they are going to reduce the total energy consumption by 40% from now to 2050, which is a huge amount.

(01:17:31):

This for sure is going to invite a huge economic transformation. At the end, the problem is how are they going to do that. You have, for instance, the situation in France right now, it is quite heated. They have massive strikes. They have outrage.

Nate Hagens (01:17:48):

No, I just can't imagine. Given your knowledge that the linkage between energy and GDP, if you reduce your energy by 40%, your GDP is going to go down, which what about all the debt, the trillions of dollars of debt by the European Central Bank? How is that going to be paid back? That spells the end of the Euro and all kinds of other issues. A comment and a question: first of all, the fact that European

governments are actually stating these things, it is hard for me to imagine the same statements being made in my country. I just cannot imagine it, even though you're at least facing reality.

Antonio Turiel (01:18:29):

Well, but we are facing a different reality than yours.

Nate Hagens (01:18:33):

That's true.

Antonio Turiel (01:18:33):

Because the question-

Nate Hagens (01:18:34):

Because we still have 80% of our own energy. Yeah.

Antonio Turiel (01:18:42):

Yes, this is the key point. You have resources we have not.

Nate Hagens (01:18:42):

Yeah.

Antonio Turiel (01:18:42):

This is a wrong timing

Nate Hagens (01:18:42):

So do you think in the near future, in the next decade, that we, Europe and the US, or anywhere globally, as part of this rationing discussion, are we going to nationalize essential industries such as energy to ensure that everyone who needs access to resources gets them? Is that on the horizon?

Antonio Turiel (01:19:09):

Well, it is not on the horizon. It's already happening in the case of Europe. France has nationalized... they have a part which was non-nationalized, which is private,... the main electricity utility they have in the country, Électricité de France, 16% of this was in private hands and they decide to nationalize last year. But at the same time, Germany decided to nationalize the three largest distributors of natural gas in Germany. But at the same time, Belgium privatized the electricity utility of Brussels. At the same time, Austria privatized the main utility in Vienna. This is happening all over Europe, but it is being done in such a... I don't know how to qualify this, but let's say a silent way that nobody is actually talking about this.

(01:20:05):

For me, this is very funny because the European Union has specific regulations against doing exactly that. But as all the countries are doing, nobody's saying anything. It is quite funny. So it is already happening, but probably this is not enough because the key point for us is that we have not the resources. We have not the resources. So we need to get the resources from somewhere. In the case of United States, you have resources, you have plenty of resources. I mean, they're not infinite. You are going to run out of them. Before that, you are going to run low on them and the amount of resources is going to be depleted, and this is going to cause problems there. But it's not the same as in Europe. We have really nothing.

Nate Hagens (01:20:53):

So I wonder who's going to be better off: Spain, because we don't have the resources and you're going to be faced with a hardship now and figure out how to navigate it at a lower throughput, or the United States, which has another decade or two of resources and will continue living in an unsustainable way and not prepare.

Antonio Turiel (01:21:12):

Well, there is a sentence by John Michael Greer, which is quite good, "Collapse now and avoid the rush."

Nate Hagens (01:21:20):

Yeah.

Antonio Turiel (01:21:21):

I think maybe this is going to be good for us, even if it is going to be harder right now. We'll see. We'll see.

Nate Hagens (01:21:27):

Yeah. Many people, Antonio, moralize capitalism as either a savior of the world or the root of all our problems. What is your stance on this? And given energy depletion and climate and ocean risk, which you are fluent in, do you see capitalism as having a place in future societies?

Antonio Turiel (01:21:52):

Well, I think we need to go to the next step. Capitalism is just one step in the evolution of economical thinking. Before that, we have what is called... I don't know how to say it in English, sorry. I know the term in Spanish, but we have what is called [Speaking Spanish]. Well, another term that I know how to say it. So we have passed by several different economic systems. Capitalism, as we understand it now, typically when you look for a definition, for instance on the Wikipedia or whatever, it says capitalism is a system which is characterized by private property, free market and so on. And this isn't right. In capitalism, you have that, but in previous systems we have also private property and free market. This is not what makes the essence of capitalism.

(01:22:41):

What makes the essence of capitalism right now, at the beginning of 21st century, and the thing that in fact puts everything in compromise is the necessity of growth. This is the key point. So the question that the capital, the money has right to have an interest rate. This interest rate is what makes the need for this exponential increase on wealth, this exponential increase on production and consumption and everything. And for sure, this is completely incompatible with a finate planet. This is the key point of it.

(01:23:17):

We need to overcome the limitations of the current system and to go to a different system, which is just another one in the historical succession of systems in which you can have private property, you can have free market, but you cannot have infinite growth, because of course infinite growth is impossible in a finite planet. This is the key point.

(01:23:39):

When I am discussing these things, some people here in Europe, you know, in Europe, the political thing it is different than United States, but they like to pose themselves as anti-capitalism. I think that this is, from my point of view, it's a wrong way to pose the thing. It's not a question of going against, because capitalism, with its lights and shadows, for me, it's just a step in the evolution. So the question is not going to be anti-capitalistic but be post-capitalism, going to a system that is going to be created after this one. This is something which is natural. I mean, all living things, such as civilizations for instance, progress change along the time to adapt to the situation. So we need to adapt to the current situation, and these adaptations implies an evolution in our way in which we relate to each other and also with the planet.

(01:24:36):

Something that should have been obvious from several decades now, but now that's impossible to avoid it, is that we cannot grow forever in finite planet and it is so simple statement, very, very clear statement, all the statement, all the plans that we have is from one hand, we have run with the inputs because we cannot keep the pace, the rhythm at which inputs is are entering the system. We are not running out, we are running short, and we have a problem with the inputs and we have a problem with the outputs because all the ways we're generating are changing the climate but are contaminating ourselves. I mean, they poisoning ourselves at the end. So at the end and all these things, because we have had intent of growing forever in a finite planet and this for sure cannot work and this for sure should should break at some place. It is breaking at several places at the same time.

(01:25:28):

Okay, it doesn't matter. We have arrived to this point, as I used to say, that I am not looking for how you say, ah, sorry, I'm not interested in find the guilty persons. I'm interested in finding the solutions. So forget about how we have arrived here. For sure, some people have more responsibility than others, but for the time being let's start concentrating in the solutions, which is the thing that we need. And as you have said, we are going to run probably very different pathways. For instance, in Spain, in Europe, in United States, in China and Russia, the situation is going to be quite different for the different regions and so on. But in the long run we need all of us to become really sustainable in some sense. So Europe for me is already in the fast track to that and we need to figure out how to do this in the easiest way.

And the problem from now is that they're completely blind to the real depth of the problems that we have.

Nate Hagens (01:26:35):

Yes, I see. I want to be respectful of your time, I'm not getting to all the questions I want to ask you, so you might have to come back in six months or so. So in six months we may live in a totally different world. So Antonio, society and the planet as you're well aware, face many risks and challenges. What are you most worried about now, in the near term?

Antonio Turiel (01:27:03):

Well, for sure the risk of nuclear war cannot not be rule out, unfortunately don't for me, this is not the main scenario, but unfortunately it's a scenario that cannot be ruled out, and this for sure will be overwhelmingly the main risk. But putting this apart, for me, the main problem is that probably we're going to observe a proliferation of wars and revolts on the... It is already happening. The problem is that this is already happening. We have many countries that are becoming failed states. For instance, Sri Lanka is only keeping more or less in say because India is investing a lot because India is very worried about the situation of Sri Lanka, also because they have this Tamil minority there that can be influencing what's happen in Sri Lanka, and India is injecting a lot of resources on Sri Lanka just to keep it afloat. But Sri Lanka is completely collapsed. We have Pakistan, which is a country which is also in a very delicate situation and we are talking about a country having 220 million person and atomic bombs. So this...

Nate Hagens (01:28:09):

And they can't buy natural gas because Europeans are buying it.

Antonio Turiel (01:28:14):

Exact, exact. Absolutely, absolutely correct. We have a dire situation now in South Africa, which is in principle the richest country in all Africa, but this in terms of GDP for sure, and they have a very delicate situation right now, a lot of instability and so on. But we have many, many countries having quite dire situations in Africa, Latin America, I mean, Asia. At this moment, at this exact moment. So the main risk right now is that we can observe a real breakdown of a lot of conflicts inside the countries, among different countries, wars and all these kinds of stuff. We can go to a global destabilization process.

(01:28:59):

And this in turn could severely affect also United States because United States, some of the resources you are obtaining from other countries and if these countries get very destabilized, this is going to create problems also for you, even if you can run much more self-sufficient than us for sure. For me this is the main risk right now, I mean in the social terms, because this can be, the question for me is that the reason why I think this is the worst risk right now is because probably this is going to claim a toll in terms of human lives which is going to be unbearable.

Nate Hagens (01:29:36):

So do you have any personal advice to listeners who understand what you're talking about at this time of global economic crisis? Kind of the John Michael Greer variations, simplify first and beat the rush, or what do you tell people?

Antonio Turiel (01:29:52):

Yeah, again, it's different United States and in Europe. So in Europe-

Nate Hagens (01:30:00):

People listen to this podcast in all countries of the world, it's a global audience.

Antonio Turiel (01:30:04):

The problem is that probably the response depends on the place you are living in. For instance, you live in Latin America, now, but in this perspective because you are living this slight baby slow motion or not as a slow motion as you would like. So they already know the situation is becoming very dire in many parts in Latin America.

(01:30:21):

In the case of Europe, I think that, yes, so simplifying your lifestyle is something which is important, and also to gain something, which is important, very important is to gain psychological resilience. Because if you have a life expectation, you have all of expectations and how the things should work out, and now all your worldview is being shattered by the reality, this is very hard. This is really very, very hard.

(01:30:48):

So I think that it's quite important to gain this psychological resilience, to gain this adaptability that here in Europe you are not so used as in the United States, people tend to have a lifelong work here. This is the usual thing. So people work in the same thing for all their lives at the same place, everything, all the same. Probably now the scene, the thing is going to be quite different, so we need to adapt and we need to face this with the appropriate dose of optimism, understanding that we can improve, but we need to put the means to improve. This is completely different from the American mentality. I mean, this is a different, completely different way of thinking things. And in Europe I think these are things which are important. Also, trying not to get debt.

Nate Hagens (01:31:37):

In debt?

Antonio Turiel (01:31:38):

Because servicing debt is going... Yeah. I think this is going to be very hard. I am very happy because just yesterday I canceled the loan on my house. I am very happy right now. And yeah, I think that this other part is important, and also trying to work locally to gain resilience at community level, working community are things that are important.

(01:32:02):

So in the case of the States, I think that these prescriptions are useful in a way. The problem is that it's not going to be so evident in probably 10 years, during the next 10 years, probably you're going to be in a complete different situation because also you are going to lose our, let's say, dead weight, the dead weight of Europe because Europe is going to get in some sense disconnected. And this will allow you with all your own means probably to be more or less okay, more or less, in a world that has become smaller suddenly, for maybe 10 years more. It is going to depend on the factors that for me, it's very hard to evaluate precisely, for instance, how the situation with oil production is going to keep in United States. Because even if we know that fracking as it is going right now with this decrease of the drill and complete the wells and so on is probably going to get a severe drop in the next months.

(01:33:05):

But at the end it depends, if you restart a new cycle of investment, the involvement of the government, because you have the resources at the end. So even if they're expensive, you can exploit. So this will imply that maybe you are reducing social welfare in order to produce this thing. Okay, this is going to be hard to be sure how Saudi is going to be deployed in United States, but most likely you have for saying something 10 years more to adapt. So taking drastic measurements right now probably is going to be seen as a weirdness, something which is not fit for our normal social standards. But something that could be useful for you is to observe what happens in Europe and to try to learn the lessons from what is going to happen to us.

Nate Hagens (01:33:53):

Would you change your advice on what to do to young humans, teenagers or college-aged students? What do you tell them about the future, Antonio?

Antonio Turiel (01:34:03):

Well, I have my own teenagers at home, so.

Nate Hagens (01:34:09):

Do they understand all this, about the energy and climate?

Antonio Turiel (01:34:12):

Yes, yes, yes. My daughter usually says that we have screwed up the situation. She blames us. Well, in fact, I need to accept that it's true, actually. I mean, she's also participating in the same part right now, I mean, because you cannot avoid it. Okay, but yeah, this is true that we need to do more on that. My recommendation for the youngsters, well, I think that even United States, the life they're going to live is very different from the one that their parents have lived. This is clear. They need to understand that getting resilient to be adaptable, to not be very dependent on supply chains that need to arrive to isolated places, this is important. You need to avoid that. It is better to live in communities which are more or less self-sufficient, that can be supplied easily, this kind of stuff.

(01:35:16):

And also regarding the choices for career, for instance, if you are going to college or whatever, I think that it is better, I cannot avoid that because I am a physicist myself, but I think that in general STEMs are better choices than others, unfortunately, I mean taking into account the direness of the predicament that we have. So if you could go for a STEMs, I think it's preferable, taking into account. If you could, I mean, not anyone has the skills or the natural inclination to this, and also other skills are useful for sure, but STEMs are going to be massively needed.

Nate Hagens (01:35:58):

Yeah, no, I agree with that. What do you care most about in the world, Antonio?

Antonio Turiel (01:36:06):

My kids, no doubt. No, no, I mean, sometimes there are always people that, because as I make a lot of inconvenient statements, some people look for some hidden motivation in myself and looking for some, I don't know, economic motivation. But it's very hard. No, I've been sometimes blamed for working fossil fuel industry or industry nuclear, I don't know, whatever. And I always give the same answer when I ask my motivation. I have two motivations: my life, and well, one is 16 years old, the other is 12 years old. These are my real motivations, and this is the reason why I'm doing what I'm doing.

Nate Hagens (01:36:55):

If you could wave a magic wand and there was no personal recourse to your decision, what is one thing you would do to improve human and planetary futures? And since you are a polymath, I will give you up to three things with the magic wand.

Antonio Turiel (01:37:12):

I actually will just need one.

Nate Hagens (01:37:15):

Okay.

Antonio Turiel (01:37:15):

One, because the problem is, as I have said, as a culture we will need, how do you say, a collective attack of common sense. This is what we need the most. We need to have a lot of common sense that we are actually lacking of it. We are putting short term interest, completely skewed views of the world. And something that for me is quite annoying, actually it's disturbing, that many times you observe that people are giving up on their personal responsibility on the public affairs. So you need to get involved and this concerns you. And you cannot say the typical saying that is, "Okay, well someone is taking care. Someone is in charge." This is what kids say. Adults take care of their own business. Adults know that they need to take responsibility. We cannot act as children, we need to act as adults. So if we all act as adults, I think that it will be enough.

Nate Hagens (01:38:28):

With education though, to understand our biophysical reality as a key component.

Antonio Turiel (01:38:34):

Yeah, for sure.

Nate Hagens (01:38:34):

Are you active politically in Spain with sustainability issues and getting these ideas scaled so that common sense has a better chance of manifesting?

Antonio Turiel (01:38:47):

Well, when you say political, sometimes it is important, I don't know if the connotation is the same in the case of the United States, but it's different to distinguish between political and partisan. So of course everything what I do is political because by definition of political comes from the Greek word polis, which means city, and it's the things that are interesting for the citizens. So for sure what I am discussing is important for the citizenship. So something, first, by the way, if you don't know, the word idiot was applied in the, it's also Greek word, and it was applied for the people that were not aware about the affairs of the city. So the people that-

Nate Hagens (01:39:28):

Really?

Antonio Turiel (01:39:28):

... we didn't want- Yes. The word idiot is coming from that. It's a Greek word. So it's quite funny, actually.

Nate Hagens (01:39:33):

So should we title this episode Antonio Turiel: Common Sense Versus Idiots?

Antonio Turiel (01:39:39):

Exact. This is exactly this thing. But anyway, regarding my engagement with public authorities, administration and so on, I actively try to convince them. I am talking to them frequently. They are frequently asking me questions. It is very funny because they don't really trust everything what I say, but they feared I am right and for this reason they keep on coming and asking me even if they don't like what I say, because of course what I am saying is now totally likelihood.

Nate Hagens (01:40:14):

Excellent. So I want to keep my word to you so you can catch your train to get back to your children. Final question: this was an introductory overview of your expertise, your work, your worldview on the climate, ocean, a little bit on energy. If you were to come back on this podcast six months from now or something, what is one question, one topic that you feel passionate about that speaks loudly to you that you would like to take a deep dive in? Just speculate.

Antonio Turiel (01:40:45):

The real energy transition that we need to do. I mean, there are many things that we need to discuss on that, but something that probably we are going to be in urgent need, massive need, to be discussed in six months from now is about food because food is going to become a very big issue globally. So probably we could discuss again in six months from now. We are going to talk about food a lot.

Nate Hagens (01:41:10):

Okay, it's a deal. Muchas gracias amigo. Thank you so much for your time and your work and let's stay in touch and let me know if I can help you, Antonio.

Antonio Turiel (01:41:21):

Thanks a lot. No, you are doing enough. Thanks also for giving me voice.

Nate Hagens (01:41:26):

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