Nate Hagens (00:00:02):

You're listening to the 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, and 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.

Nate Hagens (00:00:33):

This week, we welcome Sebastian Heitmann from Berlin, Germany to the podcast. Sebastian is a venture capitalist focusing on tech inventions, that if successful could result in large scale reductions in the CO2 emissions for global society. Sebastian and I talk about some of those ideas, in particular, the challenges and opportunities with deep geothermal technology. But we also unpack the energy situation unfolding in his country, and the broader backdrop we find ourselves in with respect to energy, technology, and growth. This was a very informative conversation, please welcome Sebastian Heitmann. Guten Abend, Sebastian.

Sebastian Heitmann (00:01:35):

Guten Abend, Nate.

Nate Hagens (00:01:36):

For 25 years I've been saying, "Guten Naben." Because my dad had one semester of German in college, and I've learned 20 German words, but they're all wrong. So thank you for correcting me in our email thread, that it's Abend.

Sebastian Heitmann (00:01:49):

Guten Naben is the slang version of it, so it's totally fine.

Nate Hagens (00:01:57):

Oh, is it? Okay, I didn't know that.

Sebastian Heitmann (00:01:58):

Yeah, it'll fly by, people will understand you.

Nate Hagens (00:02:03):

So great to see you last month, we spent three or four hours talking about some of the things we're going to talk about today, and that probably could have gone 10 hours. So briefly, if you could just introduce yourself, what is your main work, what is your worldview, given that we're alive in the early 21st century, and can you share your path of how you landed here working on the things you are?

Sebastian Heitmann (00:02:32):

A pleasure. Yeah, first of all, thanks for having me. I remember our conversation very vividly, and it left a lot of thoughts in my mind. And I guess this is how we connected, and we've exchanged some materials in the meantime, it was very interesting, it's stuff actually that is very close to what I do. So I'm Sebastian, I'm co-founder of Extantia Capital, we are a climate first venture, basically investing into decarbonization. To get here was not a very straight journey, and I always say the last thing I wanted to do in my life was create a financial product, but here we go, I ended up doing one. My original background was an economist, and I've worked in software as an entrepreneur, and I've also worked in other fields. But I've had since a long time sort of a keen interest in the energy space, and I've also been investing into this space for quite a while.

Sebastian Heitmann (00:03:23):

Quite a while, goes back to 2006 roughly, when some of you might remember there was a big solar boom, all of a sudden we thought that solar become scalable, solar will become affordable, and a lot of the solar companies popped out and IPO'd, in the US as well as in Germany. Until we all learned that yes, solar scales, but not in the western hemisphere, and mostly in China. And all these companies ended up going bust, because the value-add wasn't as significant, and we simply ended up being a commodity as it is today. So those are the early days that sort of sparked my interest, and ever since I've remained interested in the topic. And following 2015 Paris Climate Agreement, I thought, hey, look at this, we finally have a very interesting macroeconomic model that should bring out innovation in climate, and started to look for some companies that I thought would be winners, in very different technologies, not just one. Picked some companies, invested some own money as well.

Sebastian Heitmann (00:04:33):

So there was a high level of conviction, that this will be something. We are now in the year 2016, 17, 18 roughly, but the conviction was soon met by frustration, by frustration that there actually isn't much capital for innovators in this space, at least wasn't back then. So the mixture of conviction, frustration led to the fact something's going to do something about it, we can't just all sit and complain. The things we can do on individual level have very minuscule effects, so let's see if we can change something.

Sebastian Heitmann (00:05:06):

And the one thing that we saw that we could change, lacking a better idea I always say, to actually be a founder myself in the space, I created with two other partners, Joern-Carlos Kuntze and Yair Reem, we created Extantia as a European focused venture firm focusing on decarbonization. We set out initially with one pilot fund, which we have done investing by now, and investing now out of fund number two, which is a larger 10 plus two fund, so that was the journey. In the meantime now the wave has broken, it's now called climate tech, no longer clean tech, it's a bit broader as well. And still early, but we see some capital flowing into this space, and this was probably our hope, that pioneering in this space, we paved the way to mobilize institutional or private capital into climate, because we thought this is the only way we'll stand a chance of making a significant dent. So that's sort of the journey.

Nate Hagens (00:06:10):

In your materials you mentioned the word gigacorn, can you explain what you mean by that?

Sebastian Heitmann (00:06:16):

Yeah. Obviously we asked ourselves, "What is significant reduction in CO2?" And we broke it down to CO2, we know that there's more than just CO2 to the world, but it's a significant measure that most people can relate to today. And trying to make it also simple for potential investors, we try to be fairly transparent and measurable, that's why we are breaking it down to CO2 mostly.

Sebastian Heitmann (00:06:39):

So gigacorn is just a term that signifies two things. A, that climate can be... I mean, we need scale. And gigacorn for us are companies that are solving a gigaton CO2 problem. So we made roughly 50 something gigatons of CO2 per year so any space that contributes at least one gigaton is worth investing in, as an industry, as a sector, as a subsector, whatever. And we then go, "We can't assume that one company would have a hundred percent market share, but 10% market share is a realistic goal for a company solving a gigaton problem." So that's our scale, that we say, "Minimum threshold is a hundred megatons of CO2." That's a lot, this equals the emission of many smaller European countries like Switzerland, it's a lot.

Nate Hagens (00:07:30):

How many gigatons does the whole world use now, emit?

Sebastian Heitmann (00:07:35):

50 something, depends on whose measurement you want to trust. 51, 55, depends, some different numbers, but I think roughly 50, increasing year by year as well. We're not there yet, where we decrease. So we are currently about 50, the US is roughly three, to put that into perspective. So even out of US emissions, it's still a significant share, where you can say, "Does this move the needle?" And yes, we are not investing to one company, we're investing into a portfolio of 30 companies. If each of them would be doing a hundred megaton, we would equalize the US emissions. And a lot of the companies that we invest in have a much, much larger potential.

Sebastian Heitmann (00:08:18):

Some of them can do several gigatons of potentially CO2 reduction, we can talk about that a bit later in more detail, about what type of technologies are most promising. But this is the general thesis on scale, so we need scale, and the other part is all about speed. We call it concept of time value of carbon, lending it from a classic economic principle.

Sebastian Heitmann (00:08:40):

And our thesis goes that a ton removed today has a lot higher value than if this happens in the year 2040 or 50. So this leads you straight away into investing into near term gains, or near term effects, which leads you straight away also to investing mostly into some type of assets, or existing infrastructure that don't require long buildup. Something where you can change something that's

already existing, and decarbonize it. Most of the time if you're looking into building up entire new industries, or entire new skill sets, it tends to take a lot more time, classic example would be fusion reactors. I think very efficient, but just takes a very long time to build up, and from a climate perspective too late. I think we should still work on it, it's an important topic for the future in general, but we don't have time to see the first reactor come online in the year 2040, or 30, whenever it is, for one to come online. This does not provide enough speed.

Nate Hagens (00:09:50):

You're talking about nuclear fusion?

Sebastian Heitmann (00:09:52):

Yeah, nuclear fusion. For example, there's many other technologies too, but it's one that most of us would agree is not going to be available in the next two years, or next five, 10 years at scale. I mean, you might see first sort of smaller reactors coming out, and test reactors, but where we can actually produce gigawatts of energy with nuclear fusion, I think it's still a while away.

Nate Hagens (00:10:17):

So that's the giga part?

Sebastian Heitmann (00:10:19):

Yeah, that's the giga part, the corn part is the pure logic behind it. Unicorns are a common term, and we say any company that's able to reduce a hundred megatons of CO2, just by the logic of the carbon price alone, but also by any other logics that we'll see in the market of dynamics, is going to be a extremely valuable company. Or you could say the CO2 reduction potential of a company serves as a pretty good proxy for future evaluations.

Sebastian Heitmann (00:10:46):

And that's why we say these companies will be extremely valuable, that's why we always say also climate can be a really good business, it doesn't have to be only for philanthropy, or concerned environmentalists or something. We see a trillion dollar opportunity most likely to be significantly larger than the digitalization that we've experienced over the last two, three decades. And companies such as Apple or Amazon, there's a very good likelihood that we'll see a lot of those companies coming out of climate, extremely valuable companies. So we actually see that there is a definitely economic opportunity as well.

Nate Hagens (00:11:28):

But unicorns are also make believe.

Sebastian Heitmann (00:11:32):

Good question. Yeah, absolutely. I mean, they're often make believe, and also you see sometimes so-called climate tech companies who are not fulfilling the promise, that's always out there. Tesla is an example, extremely high value, for sure a pioneer and a great company, paving a way to electrification of transportation. But itself, the company's footprint will not be very large. We could probably attribute some significant enabling factors to them, but the CO2 reduction is not the main driver of value here. So that's to show an example that it often comes up. So this was very important for us when we started out, we wanted to make sure that what we do actually has significant impact, and that we avoid greenwashing. We're fully aware that the road to hell is paved with great intentions, and we did a lot of work on ensuring that at least we avoid it as good as we can, using the science that we know today.

Sebastian Heitmann (00:12:36):

We've hired Professor Pomponi, who's an international renowned expert in so-called life cycle assessments, completely new methodology that suits a venture firm. Currently LCAs are mostly using lag data, so we have project a lot into the future, as we sort of looked at future technology. So we have a methodology it's called EPIC, which we share openly, you can download it on our website, the full methodology and how we try to predict impact in the future, and make sure that we do something that has a significant impact.

Sebastian Heitmann (00:13:12):

You'll be surprised, especially in the beginning, how many deals that we thought would be amazing for climate ended up being killed. Because when you do the math, you find out actually the impact is a lot smaller than you thought it would be. We also initially thought there might be more digital solutions for example, that would really help us to decarbonize. The simple truth is hardware's polluting the planet, and that's why we need to fix it. As unsexy as it often is for markets, this is what it is, CO2 is a molecule, you can't blockchain it away. So we'll have to find ways to deal with it in old engineering, and chemical, and physics based solutions.

Nate Hagens (00:13:57):

So we're going to get to that, and we're going to get to a couple of the more interesting projects you're involved in. But let's start kind of where we left off when we met in Berlin, What's your worldview? Just take off your pedigree of your history and your current job, how do you see the world in our society right now, with respect to our economy, and energy, and climate, and population, and growth, and everything?

Sebastian Heitmann (00:14:31):

That's a big, big question. I think it's obvious that we are in a time where strong shifts are occurring, we've been in a fairly sort of comfortable zone for the last 60, 70 years, since the end of World War II. More or less we've seen a steady period of peace, at least for the majority of the planet, we've seen a steady rise in wealth and income, and lifting people out of poverty for the last many years. And now all of a sudden things are changing again, we're looking at a darker picture, we're looking at a potentially long-term change. Not just be a short-term downturn, and you might see a long-term change. This is a

lot to do with what I think we both commonly believe, that we're waking up from a grand bonanza, and are facing a major hangover.

Sebastian Heitmann (00:15:25):

That we've over consumed for many decades, we've created quite the mess in our fiesta, and now it's time to see that we've hit and overstepped many planetary boundaries, we are close to reaching many tipping points. And this is a realization we've long tried to ignore, and science has been telling us for a very long time, and if we would've acted when we were told we would've potentially be today in a very different situation. But we didn't, we tend to ignore it, and now we're, not just because of climate, also politically and security wise, in a completely different world. All of a sudden threats from the past are coming back out, and these political struggles that we're seeing right now, and the situation here in Europe, has a lot to do with energy. At the end of the day it's about resources, it's about power, and those two are exactly connected as well. So we are in times of significant change, significant shifts, we'll see where it takes us, I can't predict the future also. But for sure, there's a lot more uncertainty than there's been before.

Nate Hagens (00:16:37):

So when we met six weeks ago, we remarked that even with everything going on with Ukraine and Russia, and the European energy situation, that it seemed like people in Berlin, people in Germany were still startlingly energy blind, that they'd really hadn't set in. Has that changed in the last six weeks? We're recording this on September 15th, are people coming to understand this?

Sebastian Heitmann (00:17:07):

I think slowly, because most of us are currently receiving letters from your local utility company, showing us that for sure, let's assume we have a supply, this winter it will be becoming extremely expensive. And the news are full of bakeries and other business owners that say, "Oh, we can no longer afford to bake our bread, because it's insanely expensive. Our gas bills went from 10X to heat the ovens." So these are effects, and of course on the other end you also have now on the news, that companies are starting to lay off, because of energy costs being simply too high. So I think this is something that has changed in the last six week, we met in a slightly rainy but still summery day, now it's starting to get colder, people are starting to heat. Actually this morning I was reading a interview with the head of the German Energy Network Agency, saying that he was actually surprised to see that the households now in the first couple days of slightly cooler temperatures have demanded significantly more energy than he would've expected.

Sebastian Heitmann (00:18:16):

So there's still some energy blindness as it seems, I don't know whose it is, is it the estate owners or the private individual houses? But I guess we will all feel it in our pockets this year, that it'll be just an extremely expensive winter. And there's also the question, will we see actual situations of scarcity, where there will not be enough supply?

Sebastian Heitmann (00:18:38):

I think nobody can predict this, because it depends on the lot of factors including the weather. And also the weather, not only in Germany, but also in the neighbor state, and they potentially can supply, but depends on their own sort of consumption. There's a lot of factors coming into play, that we can't fully predict today, but it's totally on the map that we might see actually situations where we selectively have to shut off certain regions from gas supply. Electricity seems a bit more stable, although that also depends. Again, we are in Europe, we have a connected grid, it depends to a good extent on the situation in France, will it rain, will the nuclear power stations come back on? There's some uncertainty still left, but I think slowly people are starting to realize it's actually real, and it's actually very uncomfortable.

Nate Hagens (00:19:30):

So I have a lot of questions on this, Sebastian, but before I forget, you mentioned the baker is starting to get worried, because it costs 10 times more to heat the oven. I'm not really a bread person, but when I was in Berlin I had the best pastries and bread in my life. And the person there, my friend who took me there said, "It's because the way they mill the flour." They grind it smaller or something. But the breakfast pastries there, you cannot buy that in the United States anywhere, it was unbelievable, just FYI. You're probably used to it or something, do you know what I'm talking about?

Sebastian Heitmann (00:20:07):

Yeah, there's a huge culture around bread here. Obviously this is a bread country, for sure. And it's also one of the basic nutrition for pretty much anyone over here, and there's possibility that it will rise to €10 a bread, $11 for a bread, it's just insane.

Nate Hagens (00:20:31):

So in the UK and in other countries, they're introducing energy caps, that households have to pay a lot for energy, but it's capped, and above the cap the government will pay for above that. Is that also happening in Germany or not?

Sebastian Heitmann (00:20:48):

Not yet, I think it's going to come, because I think otherwise we'll be overloading the system pretty madly. They recently announced a 65 billion recovery act, but that's sort of more of a one time payment towards your energy bills or something, and not for every household. It's for students, and elderlies, and some others, there's a bit of different system. The very underprivileged, or very low income households, they anyhow have subsidies for the energy built, even today.

Sebastian Heitmann (00:21:21):

So that's just going to anyhow land on the pockets of the state, everybody living on social welfare, or some type of subsidies, they typically have some type of scheme already in place. But even middle income families will face a tough time, all of a sudden you're seeing a thousand bucks more per month going towards energy, it's going to be significant. It's not just a 10, 50 bucks, it could be significant, it all

depends how the gas price evolves. And of course the markets could also turn completely different once we see that there is a chance that we make the winter, that actually the solutions are coming in place, the markets might completely relax as well, God knows. I mean, the storages are quite well filled, better than they predicted, and also I think the imports from neighbors such as Norway and the Netherlands are also working better than they expected. So maybe the market turn completely.

Nate Hagens (00:22:16):

As of last week, obviously the imports of Russian gas are substantially down, but the imports of overall gas are only down 5% or something like that.

Sebastian Heitmann (00:22:24):

Exactly. Russian gas at the moment, I think zero, we haven't had any imports for the last couple days.

Nate Hagens (00:22:31):

Yeah. So broadly, do you think what's happening now is kind of a indictment of the 'Windenergie' strategy pursued by Germany over the last 15, 20 years? What are your thoughts on that?

Sebastian Heitmann (00:22:47):

Unfortunately, yes it is. And this is the term that you sort of brought to me, and I've been using it actually myself quite a bit. We've been definitely blind to these certain aspects of energy over here, although also to be fair a lot of people warned us, that these so-called energy transitions that we're planning here has significant dangers. And I think the guiding principle behind our energy transition, has been ecologically motivated. And we're seeing now that we should have considered economic and security factors a lot more, countries like the US have a very clear strategic agenda when it comes to energy. The US has invested a significant amount of subsidies or also private capital over the past decades to become completely energy independent, through Shell Gas, but also traditional oil and gas, and renewables.

Nate Hagens (00:23:50):

85%, not a hundred, but 85% energy independent.

Sebastian Heitmann (00:23:54):

Yeah. Well, to a large degree energy independent, exactly. So this is strategic, even though neighbors to be honest have had this on their agenda much more, countries like the UK have had laws for maximum imports for many years, so we cannot import more than 30 or 40, whatever the number is. What percent of our energy, the rest we need to source locally. That's strategic thinking, which we lack completely. On top of it, that ecologic priority came in combination with the liberalized energy market, led to the market looking for the cheapest solution to find an alternative to the ecologically no longer wanted solutions, which were primarily coal and nuclear, but both have important baseload properties.

Sebastian Heitmann (00:24:48):

We ended up building a lot of wind and solars, the so-called renewable energy act that was end of nineties, the beginning of two thousands by the red green coalition back then, is the second largest economic undertaking this country has done since the other one would be the German reunification.

Sebastian Heitmann (00:25:11):

Very large economic undertaking and we build out a lot of intermittent sources, but that also meant in turn that the base load moved more and more towards gas.

Nate Hagens (00:25:24):

Right.

Sebastian Heitmann (00:25:25):

And this gas, the only way to source such gas at a decent cost from our neighbor, Russia, they for sure have the largest reserves on the planet. The pipelines were partially there, were quite easy to build short and that was the simple solution the market went for, the liberal market looks for the best solution. I've been criticizing it for a while, polemically saying that behind every windmill there's a gas turbine, but that picture is not too far off reality. I think we were warned, also by the US, by the way. Your previous government was putting sanctions on Germany for... We're an ally and they're putting sanctions on us for Nord Stream 2, but still we decided to put the majority of our energy imports into the mercy of non ally, which kind of is bizarre to be honest.

Sebastian Heitmann (00:26:26):

Sounds not very thought through, you have an ally on one side, or several, and then you decide to put the fate of your country into the hands of a non ally who has a pretty shady track record. And you could almost say... I'm pretty sure that this was long term planned from Russians, the whole conflict there and they're using energy clearly as a weapon. There's no doubt about it, that energy is a weapon and that Germany or the whole Western Europe is a clear target of the weapon.

Nate Hagens (00:27:01):

This is what you and I talked about when we had dinner is that, if 20 years ago people were less energy blind and they looked at energy as the fundamental building block of our economic engines instead of dollars and technological combinations, maybe these decisions wouldn't have been made. I think what's happening with Ukraine and Russia and Germany is a big biophysical wake up call for people to see that we need energy at every part of our economies to create and vent, maintain, run, deliver, dispose of... There's nothing that happens without energy.

Nate Hagens (00:27:43):

I wonder, and here's the other thought I had, Sebastian, I think the German spirit of doing the right thing, ecologically, is where my heart and spirit is at. But I think given what the world faces, I fear that the right thing, ecologically, is going to lose out in the short term to the urgent thing economically. So I ask you getting back to your work...

Sebastian Heitmann (00:28:12):

It has to.

Nate Hagens (00:28:14):

…yeah, just getting back to your work for a second, what do you think about the world's now moving towards energy security as what they optimize as opposed to low carbon as what they optimize?

Sebastian Heitmann (00:28:30):

Currently all the measures that we can see are from a climate perspective, a disaster. Keeping nuclear power running, I wouldn't label as a disaster. That's actually smart thing to do, it's already sunk cost and sunk carbon as well. You build it all, it's there, you should utilize it.

Sebastian Heitmann (00:28:49):

Building new, as I mentioned earlier on, I think it's too late, would take too long time, but the consequence of course we are firing up coal again, what else can we do? In the end of the day, you said it, or you hinted to it, we're talking about that six weeks ago, quite a bit that what people have not understand fully enough is that our growth and our wealth depends to a very large degree on the amount of carbon we consume, through energy. Energy is 75% of our carbon budget and that's where the problem is.

Sebastian Heitmann (00:29:23):

What we try to do with our firm to come to the solutions part now is to do exactly this. We want to unlink or uncouple, carbon and growth that we come to a green growth because that's actually the only way forward. If we don't find that way, then we have to go completely different way and you've also been showing how that way could look like, but that's a completely different way, this is a way in which our society fundamentally will change.

Sebastian Heitmann (00:29:52):

If we want to have any chance of continuing growing… This is not so much about only growth in the Western world where we already have a very comfortable life. It's also about growth in other areas of the globe where people are living in and are still been very different circumstances and rightfully so demand that they also have access to energy and access to resources. If we don't find that solution, we will also see socioeconomic very complicated situations. Again, Germany, we were worried about a migration crisis in 2015 with the war in Syria, that will look small to compare what could come.

Nate Hagens (00:30:31):

I agree. I'm very skeptical, highly, highly skeptical of a green growth outcome and yet, I sympathize with people advocating for green growth because many of them understand that the alternative which is negative growth and the social and economic and political and geopolitical response to that is very dangerous. So I sympathize with, we have to somehow figure out a way forward without… The way I

refer to it is we have to bend, not break, because break would be bad. I'm going to talk to you a little bit of some of the technologies you have in mind, but let's just keep on the German situation... Well you live there, so I'm sure you're aware the last few days it's been discussed that your largest energy company Uniper might be nationalized by the government.

Nate Hagens (00:31:29):

Given the centrality of energy to our economies, I've long thought that the eventual path was we're going to have to nationalize energy companies because they're so central to how things work, but do you have any opinions on that? On what's going on, or...

Sebastian Heitmann (00:31:45):

It is an interesting question, of course. I'm generally a person who prefers capitalistic structures, but energy is a specific sector where... It's hard to draw the line in energy. It's not just energy. Energy comes so many forms and shapes and so many things are directly related to energy. Where do you draw this lines? Just the supply of energy, but generally, energy is something extremely strategic for sure. And it actually has always been, strategic. Of course, how do we create energy? A lot of it's from natural resources, which belong to the people and not necessarily to a single corporational person. I'm generally a friend of the system like that some countries like Norway where, you get dividends from the energy that's been sold to other countries. The energy belongs in many ways to the people and therefore there might be a point for looking at least this more strategically.

Sebastian Heitmann (00:32:35):

I think the way we've trying to do this at the moment is yes, they're privatized companies, but also they work highly regulated space. They can't just do whatever they want. The space is already extremely regulated and they're fairly small boundaries or actually very high protection walls. The other way around, to be honest, from creating too much competition in the market, that goes also a bit too far into the design of the market, but it's not a market where you can just do whatever you want. There's a lot of requirements that you have to meet and I'm not sure if the nationalization is then the only way. My experience with nationalized companies also, isn't great. Typically, they're highly inefficient and also prone to corruption, of course. I'm not sure that this is the way forward, but open for discussion. Generally I am with you, energy is extremely strategic, but US is actually an example as well, with enough subsidies for fracking, you've been able to create largely energy independence. It's also a way to...

Nate Hagens (00:33:38):

Short term independence, because that fracking is depleted at 80% in the 18 months.

Sebastian Heitmann (00:33:47):

No, it's extremely short term. It's only bridge technology too, but I think even that's realized.

Sebastian Heitmann (00:33:53):

Actually just recently the Inflation Reduction Act that you have put together in the US is pretty impressive, a piece of legislation for renewables now. Depends on who's in, who's governing as well in Washington or also in the state levels. But in general, I feel there's a very strategic thinking about energy in the US, and this is still a wake up call, definitely for Germany, but also true really for the most of Europe. This goes further, we were trying to now become a hydrogen economy because again for ecologic reasons, hydrogen, but it's also clear that Europe will never be able to produce its own hydrogen. We simply don't have enough energy to do this green energy. We will always depend on imports. I think Germany estimates that at a best case scenario with current planning, we would have to still import 70% of a hydrogen, it's the same mistake. You might be not Russia, but still.

Nate Hagens (00:34:53):

I'll say the quiet part out loud, my friend. The biggest gigacorn is using less resources and less indirectly and directly less carbon. But of course we can't vote for such an outcome and it will never happen voluntarily. Do you have any thoughts on that?

Sebastian Heitmann (00:35:14):

For sure if we would be able... There's many angles to that as well. Where do you really start? But for sure, the ultimate problem is over consumption. I think that's... Fully with you, and if we are able to consume less, that would help a lot. The issue is we are growing population and not a decreasing population. We're strongly growing population, so that's something we should really start digging into the fact that...and here education comes in, we are now a CO2 play fund, but we fully consent and fully see that's not the only solution just decarbonizing. We also need to work holistically on the problem, and holistically has many factors. We're not blind in just a carbon direction. We do understand, but now with investment fund and we need to speaks of the language of the markets a bit, and let's say education is not necessarily something that suits itself well for capitalistic system right now, investing into this, but however needs to be done.

Sebastian Heitmann (00:36:15):

I think it's clear that educated women get significantly less children as uneducated women. And that's for example, one charity I support and I think they're doing great works called Educating Girls. And they're working exactly on that in India specifically, but also elsewhere, I think they're expanding, but working on giving education to females, and it's amazing the impact they're able to achieve with little tools.

Sebastian Heitmann (00:36:44):

It of course requires lot of local community work, but in the end, it's simple work, going to the family, speaking about the importance of sending their daughters to school, paying the farmers for letting them go to school and the effect is amazing. It's also interesting, once you break that cycle, once you send one generation to school, the likelihood that the next generation will also be educated is significantly higher. Basically, you break the cycle once and you break it for good.

Sebastian Heitmann (00:37:19):

There's many angles to it. That's for sure topic we need to deal with and the overall population is mostly topic in developing countries. I think in the Europe and US it's anyhow... We're not growing by birth rates, but mostly by immigration at the moment, I think. In Germany, the birth rate is 1.3 or something like this per couple. It's quite negative,

Nate Hagens (00:37:41):

But one American consumes the same as 10 or 15 Filipinos though There's two population problems, population of people and population of refrigerators and cars and everything else.

Sebastian Heitmann (00:37:55):

Of course, there might be things that we simply will do less in the future. The hard part is of course going this sort of half earth of movement. There's so many problems with that on a level where decisions become almost theological and at least morally very complicated. I wouldn't know how to really do this. This feels a bit like being in a Batman movie, trying to...

Nate Hagens (00:38:27):

Everything is morally complicated. If you understand what's going on in the planet, everything is morally complicated because there are no easy answers. Let's get back to your work and your focus. You want to develop low-carbon technologies that replace or invent new ones that allow us to get our same brain services of our lives using technology and materials and stuff, but using far less carbon than we currently do. You understand that we can't decouple GDP from energy or not by much anyways, but we could decouple energy from carbon energy. Yes?

Sebastian Heitmann (00:39:14):

Absolutely. We are on this track already. We are building out renewable energies. We've invested, I think roughly 3 trillion as a planet into the build out of wind and solar over the last many decades. That's a significant amount of money for not that great of an outcome so far. I think we have 5% roughly globally wind and solar supplied, but still, we are inventing in this space and what we think is we should simply look at the areas with most potential in general. We have certain finite resources on the planet, finite resources of coal, all our fossil fuels and uranium. Basically those are finite resources and we have a whole bunch of renewable resources, sun being one, wind being one, waste, tidal, geothermal, biomass and a few others of minor concern. But I think those are the ones we need to look at and need to understand, is there more potential in these now than we're currently developing? And of course with wind and solar, we are only good track.

Sebastian Heitmann (00:40:10):

The problem with wind and solar is that there actually are not an energy transition, but an addition. We're adding electrons to the grid, but they're not transitioning us away from the other ones because the other ones are the ones supplying the base load, which we now, through thanks to Germany, maybe understand finally how important it is. Thanks for learning the lesson. But this is the issue. This is an

energy addition. We need a transition. We need to find an energy source that has the similar or same properties than we have from our finite resources. There are, hydro is an example, today clearly, hydro is widely used, but also pretty much at the end of its capacity, we hydro has been used already.

Sebastian Heitmann (00:40:51):

There will be modern hydro that has certain benefits, some pumped hydro. There's certainly some potential still there. And I'd say, if somebody can find a way how to very efficiently use, slow moving water, be it rivers, be it ocean currents and so on, there will be huge potential hydro. There would be terrawatts of hydro in that energy source, but currently technically we're not able to, but that's then again, that's potential, that's what we should look into. Do we find ways how to enable hydro for example, and same counts for all the other renewable energy sources. Biomass, can we be more efficient? Harvesting out biomass or geothermal is one that we also quite keen on because that's obviously has the biggest potential. We are sitting on the giant battery, it's called earth. We have some type of nuclear reaction at the core of the earth.

Sebastian Heitmann (00:41:44):

It's also renewable sorts of energy. It's not that we deplete it and then cools out. It's actually continuously renewing its heat and that is just a gigantic amount of heat below. Here we go to cosmic scales now for billions of years, I think there's studies showing that 0% of geothermal energy would power humanity for 2 million years. 0.1%. That's the amount of energy we have. There's studies done actually by some US folks at Cornell University quantifying this energy resource below our feet and the numbers are just purely gigantic in terms of exajoules. I'm talking there's potential, the questions now, how do we make use of this potential? And by the way, uranium, just to at least be fair to it, I think there could be other generations of nuclear, generation 3, 4, 5, whatever, which would make a very efficient use of uranium and therefore expand a lifetime of this finite resource to a very, very long time.

Sebastian Heitmann (00:42:49):

And I think that's the argument that a lot of pronuclear people argue, let us use this uranium to transition us to nuclear fusion and not fully against this. My only problem again with that is time, time to impact for nuclear is way too slow now, but there's potential. And this's what we're looking at as a venture capitalist, we are looking at potential. We see a lot of potential geothermal. We see a lot of potential in biomass. We do see potential hydro as well. Those are the areas we're looking at and see what can be technologically enabled.

Nate Hagens (00:43:21):

If we get more efficient in biomass, if we add more energy to the system, that's a low, but that's low carbon variety. Ultimately that has to be coupled with a new governance or a new cultural aspiration other than what we currently have because our current system is optimizing monetary profits that doesn't have any scale or destination other than to grow. If we were to use our materials more efficiently, there's a rebound effect that the money that we save here will just be spent on some other

things that have indirect carbon on them at the store. I just want to set that aside to see if you agree or disagree with that before we get into the technical possibilities.

Sebastian Heitmann (00:44:08):

I do agree. We need to find... Humans have always been... And there's the law, I forgot the name of the law, but..

Nate Hagens (00:44:15):

Jevon's paradox.

Sebastian Heitmann (00:44:16):

Exactly. That's Jevon's paradox. That's exactly what it is. The more energy you give to system, the more it will consume. Meaning that if you would give it unlimited energy, it will also be consuming unlimited energy. I guess you're also familiar with Kardashev scale on civilizations. Of course, on a grand scheme of things comes into mind. We are still a stage one civilization. We are probably at the brink of becoming a stage two because we also now slightly being forced to become a stage two.

Nate Hagens (00:44:48):

What is stage two?

Sebastian Heitmann (00:44:49):

Stage two is a society that's able to harvest energy from the galaxy, let's say, beyond. Solar would be one. We're able to harvest from a galaxy or actually from a solar system. I think the entire galaxy that's the stage three then, but from our closed solar system we're able to harvest energy.

Nate Hagens (00:45:11):

Well, we've been using energy from the sun for a long time, but you mean something more than that?

Sebastian Heitmann (00:45:16):

Yeah. Energy independence as well. We're completely energy independent. That would be stage two. Stage one is still dependent on finite resources, but stage two is completely energy independent.

Nate Hagens (00:45:27):

And you think we're approaching that point? Possibly?

Sebastian Heitmann (00:45:31):

Not yet. For sure not yet. I think the initial... You can read articles and articles about that. Estimations are widely different, but some people will say we are sort of on track to reach it in the next 100 to 200 years, also long term. Some people say it's probably a couple 1000 years away. I think stage three is believed to be extremely far away. Millions of years now.

Sebastian Heitmann (00:45:54):

At the moment we're at stage one, for the foreseeable future for our lives, will remain stage one.

Nate Hagens (00:46:00):

Yeah.

Sebastian Heitmann (00:46:02):

And we have a problem have with climate change, we need to solve before we become stage two, let me very clear about this. We cannot think in cosmic scales here, climate change, and then this direction of a natural habitat is something that we cannot think and use the long term scales.

Sebastian Heitmann (00:46:18):

By the way, sometimes I am put off by these people who are trying to push all the problems, which is really, really long term. That's not the luxury that we have right now.

Nate Hagens (00:46:27):

I agree with you. I'm glad you said that, because there's been a lot of that in the news, Nick Bostrom and MacAskill, others lately.

Sebastian Heitmann (00:46:34):

Exactly.

Nate Hagens (00:46:35):

To me, all that stuff is ecocidal because our challenges right now, we're headed for an earth truck future and we need to save the biosphere and have some sort of runway to get society through the next 30 years.

Nate Hagens (00:46:51):

Okay, with that very long introduction, one of the things that you and I spoke a lot about in Germany that I would like you to unpack a little bit is you and not only you I've met many other people that are very excited about the possibility, not only of geothermal, but of deep geothermal. Can you describe what that is and how it might work and how that might be a game changer and go from there?

Sebastian Heitmann (00:47:23):

Absolutely. As mentioned earlier on, the Earth's the largest battery that we currently sit on, there is estimations from... This about US only now that the US has a potential of so-called crystalline hard rock geothermal, which is geothermal sitting in fairly deep, let's say anywhere between three and 10 kilometers, depends on where you are. I think rough numbers, roughly 13 million exajoules, that's an insane amount of energy. This is more than all other sources that we know today. Wind solar, uranium, coal and everything combined, by far more. Yeah. So, that's again, a very large potential.

Nate Hagens (00:48:07):

Let me stop you right there because is that the same analogy to measuring that there is uranium in seawater? Which is true, there is uranium in seawater. There's also gold in seawater. But it takes a lot of energy and materials to get that out. So, is that a fair analogy, or and the technology would be more targeted in this case?

Sebastian Heitmann (00:48:27):

That's what we've done, looked at. And we actually fine, of course, it requires technological shifts. But, the big but, when we started wind and solar, there was actually very little existing technology that we could use. There was very little industry experience that we could use. And still, we've been able to scale it extremely well. And now, see a really interesting cost curve on those technologies. The interesting part about geothermal, the question about geothermal, the only question is how to get deep?

Sebastian Heitmann (00:48:55):

How do you access this depth? Energy at this depth. And this is all about the technologies for drilling. So, we happen to have, and most of it is actually centered out in Houston, in the US, right, again, a global drilling industry that has been drilling roughly, well, has a capacity of somewhere around 100,000 wells per year that are being drilled. And they've been extremely efficient with bringing down costs for all of these technologies over the last many decades. Yeah.

Sebastian Heitmann (00:49:25):

Previously, a well in Texas somewhere would require a couple hundred people and a few months of work. Today, it's done in 10 days with four people. And you see the extreme cost curve coming down once people are starting to take it seriously. And they typically take it seriously when it's an economic great opportunity. So, that's very different to all the other energy sources that we have actually. A massive industry, which has a lot of experience.

Sebastian Heitmann (00:49:55):

And I'd say actually probably 80 to 90% of the tools already that are required to utilize this energy resource. Plus, they have know-how. They have assets. They have skilled labor too. So, this is actually poised to scale in an extremely interesting way. And that's different to all other energy sources, which cannot scale as fast as they could potentially scale. So, that's for me, one of the key points where we believe it can really have a major breakthrough.

Sebastian Heitmann (00:50:24):

Of course, like I said, we need new technology. It's also quite simple. I mean, today this global drilling industry is searching pretty much for hydrocarbons. Hydrocarbons are found in so-called sediment rocks. The one thing you do not find in crystalline hard rocks is oil or gas, or any sort of hydrocarbons. So, there was never a need to develop a tool that would actually satisfy this need. There was some geothermal always. But the geothermal also so far has been only used in sediment rocks.

Sebastian Heitmann (00:50:58):

We don't drill geothermal hard rocks. Again, because there's no tools for it. So, we use geothermal today, wherever it's easily available at low depths. So, next to a volcano, next to a fault. San Francisco, San Andreas fault, the geyser is one of the largest geothermal areas in the world, is several hundred megawatts coming out of there powering the city of San Francisco.

Nate Hagens (00:51:21):

And how deep do they have to drill for that?

Sebastian Heitmann (00:51:24):

Not deep at all. Not too deep. No, no, because it's a very active tectonically active area.

Nate Hagens (00:51:29):

And what about Iceland?

Sebastian Heitmann (00:51:30):

Iceland is the El Dorado of geothermal energy. It's a country that uses a significant part of its energy mix is geothermal. The other part is hydro. So, they are completely energy independent country using no fossils or finite resources of any kind. And they also still have a lot more potential geothermal. They can build this out. Of course, it's a tiny nation. But it's an interesting country to visit, to be honest, because you see how a society can look that lives in energy abundance.

Sebastian Heitmann (00:51:56):

They live with energy abundance. When you come to Iceland, they ask you, " Can you bring me a project that consumes energy?" Yeah. I have a lot of energy. Why don't you have an idea? Look, we know investors and other stuff like e-fuels. And they thinking, "Can we build an e-fuels factory here? Now, we have heat. We have plenty of power. That's what you guys need is input."

Sebastian Heitmann (00:52:17):

Interestingly enough for e-fuels, we also need carbon, what the society there does not have is carbon. They have, other than cars, they have basically no carbon consumption. Interesting enough. And then cars also electrifying also there. So, soon they'll be a society without any carbon. The airport, still one of the main consumers of carbon.

Nate Hagens (00:52:35):

Right.

Sebastian Heitmann (00:52:36):

But yeah, it's interesting that they're pretty much a carbon free society. And so, the problem for building an e-fuels plant there is how the hell to get the carbon? Where do you get the carbon from? And the

answer would be direct capturing in this particular case, but that's the technology which is also still quite in its infancy.

Nate Hagens (00:52:50):

Right.

Sebastian Heitmann (00:52:50):

But yeah, it's interesting to see how that works.

Nate Hagens (00:52:54):

So, what's the main difference between geothermal as we know it today, and it's in many places around the world as you mentioned, and deep geothermal?

Sebastian Heitmann (00:53:02):

Well, the name implies it. It's depth. Yeah, and but the other part is that it's-

Nate Hagens (00:53:07):

How deep?

Sebastian Heitmann (00:53:08):

So, between 3 and 10 kilometers is a realistic assumption. It depends on really where you are. And in certain parts of the globe, you will hit the hard rock after 3 kilometers, yeah. In another place like Turkey or Finland, even earlier. And in other places you could be drilling through sediment rock for 5, 6, 7 kilometers. I think Canada has some areas where it's really deep sediments. Yeah. It really depends. But in the end of the day, the earth has so-called temperature gradients all over the place.

Sebastian Heitmann (00:53:36):

And they vary from place to place. Iceland has a temperature gradient of roughly 120, meaning that for each kilometer you go, it gets 120 degrees warmer. Most of the US is probably in the 30s to 50s. That's sort of a normal temperature gradient, except for the hot zones like San Andreas fault, or some other areas yeah, where it's warmer. San Mateo I think is one. So, then we have a higher gradient. So, that depends.

Sebastian Heitmann (00:54:03):

So, in certain area. And I think the entire west of the US is pretty interesting for geothermal. The east is quite a bit cooler. It means you have to go deeper. At some stage you will always hit the temperature. Now, there's no area in the world where you will not get to the temperature you need. And that's the issue today. Geothermal is pretty much in most areas. The high heat, above 250 degrees, is typically too deep. So, we're using it for fairly shallow users. And hence, also mostly for heating, less for electricity production.

Nate Hagens (00:54:35):

So, what are the main technological pathways for a potential breakthrough for deep geothermal up to 10 kilometers, like you said, through igneous and metamorphic rock? What are the big pathways and challenges technologically?

Sebastian Heitmann (00:54:51):

Technological challenges are mostly in drilling. Yeah. The drilling equipment, the current PBC rock drill bits that we use are not made for drilling efficiency in hard rock. That's simply not made for it. So, the technologies that are being researched today, there's different approaches. That we are investors in one of those. But they're either plasma based or millimeter wave based. So, anything that's worked with the extreme amount of heat that eventually disintegrates the rock or weakens the rock, and allows you to therefore drill efficiently.

Sebastian Heitmann (00:55:25):

Yeah. The millimeter wave actually vaporize the rock. And you suck up dust more or less. Those type of technologies that allow you to drill linear. Today's drilling cost is exponential. The deeper you go, the more expensive it gets. And once you hit hard rock, it gets insanely exponential. Your drill bits sometime, what does it mean exponential? It simply means your drill bit lasts nothing. The amount of energy you put up at top, by the time it goes down there, there's almost nothing left. And your drilling is extremely slow.

Sebastian Heitmann (00:55:59):

And you have to constantly change the bits, which requires you to do so-called tripping. You need to take out all the pipes, put them all back in again, put in new, take them out, put a new bit in, take it down again. This takes a long time, and also consumes a lot of resources. And that's where the exponentiality comes from. That sometimes a bit in hard rock can last only for a couple of meters before you have to exchange it again. And that at four or five kilometer depth, this is extremely slow.

Sebastian Heitmann (00:56:25):

We have drilled very deep. We have drilled several projects, which are extremely deep and also reach I think 12 kilometers. The deepest in Russia, called a super deep. But those were not drilled for energy reasons. They were drilled for scientific purposes. And they also didn't have economic or time as a measure in there, yeah. This was completely different research. So, that's something we need to find. Drilling technologies that allow us to A) drill efficient hard rock, and basically B) drill close to linear.

Sebastian Heitmann (00:56:59):

That we have a very predictive cost in our geothermal project. But it's not the only thing. It's not drilling. It's also you then need to make sure that you have efficient heat transfer. Yeah, you need to build systems that allow the fluid that you pump, and it eventually works like a big heating, a big heater, right. You basically take a cold fluid, it goes through a radiator, and comes up as a warm fluid, yeah. More or less, to simplify it.

Nate Hagens (00:57:23):

You put fluid all the way down, up to 10 kilometers, and it comes up another drilled hole as heat?

Sebastian Heitmann (00:57:31):

Exactly. That's how it works. So, you typically have a geothermal. You have so-called injections and production wells. You have typically it's a so-called triplet you drill. So, two injection wells and one production well. And the production well puts in cold fluid. Yeah, typically water. And it comes up as warm water, or ideally as super critical water. Super critical is the fourth state that water can take. And that's a very specific state, very interesting.

Nate Hagens (00:57:59):

So, hotter than steam?

Sebastian Heitmann (00:58:01):

Yeah. A lot hotter, but also under pressure. It only works in a combination of steam and pressure. Super critical, we have at 374 degrees Celsius and 200 bars of pressure. And this is for water now. For other fluids, it's different. I think for example, CO2 becomes super critical at somewhere in the low 30s, 30 Celsius, yeah. So, you can also put in other fluids. But let's say we use water. That's how it gets super critical. The beauty about super critical, why is it important? Why does it matter?

Sebastian Heitmann (00:58:32):

Because its able to transport roughly 10 times the amount of energy than non-super critical water can transport. Meaning it gets extremely efficient to produce energy with super critical conditions. So, but in order to become super critical, you need to make sure that the fluid you pump down there also heats up. So, there's work to be done on the well itself to make sure that you have an efficient heat exchange below the ground. So, it's one part is drilling. The other part is the heat exchange that we need to solve.

Nate Hagens (00:58:58):

Well, I'm probably not the best person to grill you on this because I'm not an engineer. And I don't understand all this. So, I'm just going to ask you naive, general citizen questions about this process. But you're going to drill an injection well for water, or some other substance. And then you have a producing well where the super critical heat comes. How do you get the water from the injection well to the producing well? And if you're so many kilometers under the earth, doesn't it just dissipate down there? Or, how does it get from one place to the next?

Sebastian Heitmann (00:59:36):

Actually, once you are in these crystalline hard rocks, you're pretty much in a stable formation of rock. Yeah. It's one single type of rock. And it actually also doesn't have a lot of cracks around it. There's not much instability in this type of rock. You have these cracks and instability in the sediment rocks. That's

what you typically do in geothermal today. That's the part you case. Yeah. You have some type of cementing, or put on a pipe, or something. Yeah.

Sebastian Heitmann (01:00:01):

And once you're in hard rock, you TBD, to be honest, we'll see after the first project if you need to pipe it or not. But it's likely that you don't. The way to do it is you actually have to build some type of heat exchange mechanism. There's different technologies without going into too much detail. But there's so-called closed-loop technologies, and there's so-called open-loop technologies. There are different approaches. All of them might work ensuring that we have an efficient heat transfer from the rock to the fluid. Basically, a lot of technology from fracking can be applied here. That's how fracking in many ways works.

Nate Hagens (01:00:32):

But wouldn't fractures that deep just automatically be closed tight because of the pressure at that level?

Sebastian Heitmann (01:00:40):

You would think so, but not necessarily, no. I mean, you have to work on it. Also, what they do today in fracking, they are using some type of ceramics to keep these fractures open. But again, this is pretty much technology that we derive from today's processes. There's not much new innovation needed.

Sebastian Heitmann (01:00:59):

It depends on which technology you're looking at, but the fracking is one technology. Other companies actually do a close-looped system, basically laying pipes down there, which are super conductive pipes. Yeah. So, it depends which technological approach you will use. But all of these technologies actually are derived from fracking today.

Nate Hagens (01:01:19):

And when we met, you told me that there's the fracking, the drilling, the millimeter wave, or the plasma, et cetera. But there's also, you said they're applying proprietary things from the nuclear safety industry to protect the equipment at such heat and pressure, yes?

Sebastian Heitmann (01:01:38):

That's one of the engineering challenges that needs to be solved. I mean, these separate drilling technologies often require electronics for sensoring, which means you need to take electronics down haul. And electronics obviously, when it gets very hard, need to be shielded. And there is basically military or nuclear technologies that are able to withhold these type of four or five hundred degrees temperatures. It's not completely unheard of. But that's something that oil and gas, for example, that's a typical challenge they haven't had so far. They never went so hot. So here, we cannot rely on today's technology. Same with the drill heads. That we need different type of drill heads.

Sebastian Heitmann (01:02:11):

But on the shielding electronics from heats, there is work to be done on that front. But again, this is something we've used diligence with, of course, when we looked at the technologies and we spoke to experts in other industries that are dealing with these type of conditions. That it's mostly military and nuclear, or actually also, fusion reactors. So, there is material science available today, or there are materials in the market today that are able to handle this. They haven't been tested yet for this type of purpose. But that's something that's a challenge that we need to solve. But again, an engineering challenge, not a scientific challenge.

Nate Hagens (01:02:46):

So, today the US Department of Energy released a plan to lower geothermal costs with big R&D and sub-service research, et cetera. I'll send you the link.

Sebastian Heitmann (01:02:59):

I saw it. I saw it. I saw it.

Nate Hagens (01:03:00):

Oh, you saw it. Okay. So, all of a sudden, I'm hearing about this everywhere. How many firms are working on this? And what is the next milestone in seeing if this is going to actually work or not?

Sebastian Heitmann (01:03:13):

How many companies are working on? There's a few. Not a crazy amount. But there will be globally, I don't know, 20, 30 geothermal tech companies actually innovating in the space. On different angles of it. There's for example, I just mentioned it. There's companies working specifically on the electronics issues. Yeah, there's a Houston based company doing that. There's companies that work specifically on the drilling challenge in the US. There's a company called Quaise in Europe. There's a company called GA Drilling. There are companies also, US.

Sebastian Heitmann (01:03:44):

I mean, most of my US, to be honest, like Sage, or GreenFire, or Geothermal Solutions, that are all working with some elements of solving this problem. Eavor is another one out of Canada, which is quite advanced. Fervo is a bit of a different game, but also working on enhancing geothermal, has just also been able to attract a large amount of investment, which was a little bit in the news for a geothermal company.

Sebastian Heitmann (01:04:08):

That's a large amount of investment, and three years ago would've been unthinkable. But they did 100 something million round just the other day. So, there's companies working on it. There's capital flowing into it. That's the most important question. Is there capital flowing into it? Is somebody funding this? And that's the interesting part now that certainly Houston is waking up. And certainly Houston is now

starting to take this serious, and is starting to invest into as well. All of the major Houston players have a pretty much clear geothermal agenda today.

Nate Hagens (01:04:37):

So, what's the next milestone that we'll know whether this is going to work, might work, not going to work, et cetera? Are there pilots that are happening now that we can expect results from? Or, is it all still in the R&D stage? Or, where are we at?

Sebastian Heitmann (01:04:53):

Depends on again, I mean, as I just said, there's 20 or 30 companies and they're all in different stages, of course. Fervo, the one I just mentioned, is definitely in a piloting stage, yeah. And their EGS systems also will enable a very large amount of geothermal already. Yeah. They're definitely in a stage where they're becoming commercial projects now. Others, I think Sage, was just doing some field tests. And it depends on what technology. Some are earlier, some are later. But, yeah. They're in all stages.

Sebastian Heitmann (01:05:21):

And some are definitely have near-term applications where we say in the next 12 to 18 months, we'll be seeing first commercial projects coming out of it. And some things like the millimeter wave technology, probably has a few more years of work to be done before it can be commercialized. But like I mentioned earlier, we're a climate investor. We don't invest in stuff that comes alive in the year 2040. So, all of the things we look at, and geothermal, generally, all of the companies we see is stuff that by the end of the decade are in implementation modes for all of these technologies. Yeah. Otherwise, it has no climate impact.

Nate Hagens (01:05:58):

Let's for the moment assume that deep geothermal works to some small to intermediate extent at a minimum. What problems does that solve for us, and how? Our global economic system.

Sebastian Heitmann (01:06:13):

First of all, it's a real energy transition. I mentioned early on. This is actually a way, and you can actually even go in and retrofit existing fossil fire, mainly coal plants. They use the same turbine eventually, steam turbine. You could go in and so-called retrofit a coal-fired power plant. And you could drill a well next to it, and simply exchange the way the heat is being created in this power plant. That's a real transition yeah, where we say, "Okay, we can take offline coal and replace it with geothermal."

Sebastian Heitmann (01:06:47):

Now, it's not an addition. It's in a real transition. And of course, then once you've done that, and there's also the case for heat to be made. This for electricity, of course. And that for sure, the first case will be heat yeah, where we use district heating systems, which are available plenty of all over the world. Also, actually by the way, district cooling systems, which are also becoming a thing now, specifically in hotter regions. And replace the current fossil heat source with geothermal heat source.

Sebastian Heitmann (01:07:16):

For that, you don't even have to go that deep. We don't need 400 degrees in a district heating node. 150 is totally sufficient. So, that's where it can very simply use existing resources, a heating grid, and replace this with the geothermal resource. And this already exists, by the way, today. I mean, for example, the city of Munich in Germany is completely geothermal heated with the district heating system. They have low resources and where they can easily tap into some geothermal.

Sebastian Heitmann (01:07:47):

And they've been using it for decades. So, this is not a crazy future. The question is just why can't I do this in Chicago today? Yeah, because I simply haven't found a way to - I'm not in Munich, I need to drill deeper. I can't access that heat yet. So, what I'm saying is there's a lot of infrastructure that can be utilized and can be leveraged in order to roll it out. So, that's where it would take us. And it's that it's a real transition of existing hydrocarbon based energy.

Nate Hagens (01:08:18):

So, the other point you mentioned is if this works, you could pretty much drill anywhere, in Kenya, in Indonesia, in Japan, in Syria, in Russia, in the United States, in Europe. So, the Global South has access to affordable energy in this way that currently they don't. There's that side of the story, yes?

Sebastian Heitmann (01:08:45):

Absolutely. We call it a very democratic, fair, distributed energy. Everybody has more or less the same access, specifically when we talk about having a linear cost in drilling. When drilling is no longer a prohibition, cost prohibition, for realizing a project, yes. Then it's very distributed. Everybody has access to it. That is pretty much similar price because the cost difference will be marginal. It doesn't matter if you go 8 or 10 kilometers. It's not going to be a make or break.

Nate Hagens (01:09:15):

But we don't have any idea about the cost yet because there's not even viable pilots. Or, do we have some ideas? Obviously, you wouldn't be investing in it if you didn't think it was too-

Sebastian Heitmann (01:09:26):

Exactly. No, no. We clearly do. We can understand the basic economics of it today already. I mean, we know the inputs. We know what these inputs cost. All of these drilling technologies today are called contactless drilling technologies, meaning they actually have no wear-and-tear on the equipment itself because they're not in direct contact with the rock at all.

Sebastian Heitmann (01:09:45):

So, they're spitting some type of flame, or wave, or whatever the technology is, out. Actually, there's no friction with the rock, right. So therefore, we can very easily understand what the inputs are. So, we have costs on obviously creating the tools. We have costs of powering these tools. But it's actually, they don't

require a lot of energy, with some typically mobile 500 kilowatt generator can drill a well for 10 kilometers.

Sebastian Heitmann (01:10:10):

So, the energy consumption for drilling is negligible. And then you have cost for removing the fluids in the muds. Yeah, which are pumps essentially that you need to install. And there are certain costs for that involved as well. But it sounds like 10 kilometers is so crazy and long. But any of these technologies that are being developed today, it'll take roughly 10 days, 15 days to drill such a well.

Sebastian Heitmann (01:10:35):

It's not that it's a major undertaking. And the cost of this will be in the two digit millions. For each well, yeah. Then of course, you have the sub-surface cost, and you have on-surface cost. And that depends. Am I feeding into an existing node for district heating? Am I doing a greenfield operation, building a new power station? That could completely vary, right, depending on what you're doing on surface.

Nate Hagens (01:11:01):

So, let me understand this just from let's assume the technology works. And I've looked at enough alternative energy things in the last 20 years to know that there are always complex things that we don't imagine ahead of time. But for now, I'm just going to assume that this is going to work.

Sebastian Heitmann (01:11:20):

Yeah.

Nate Hagens (01:11:21):

Doesn't this also, especially if it's inexpensive, allow us to create low carbon precursors to what we've previously used fossil hydrocarbons for, plastics, petrochemicals, all those things, because we could use the excess energy and apply it via hydrolysis or other things to create lots of chemical precursors, yes?

Sebastian Heitmann (01:11:48):

Yeah, absolutely. I mean, we are already investors in technologies for this. There are existing technologies as one of the companies we invested in is called Ineratec, that basically recreates on-surface Fischer-Tropsch synthesis, which means creating out of hydrogen and carbon, hydrocarbons, but instead of sinking slowly to the ground with heat and pressure, create hydrocarbons, because it's the same thing that happened naturally, a little deeper. They're able to do this on surface in a containerized solution reactor. And this is an old process Fischer-Tropsch, it was invented and the name you can hear it's very German was invented by in the German cesarean time. So a long time ago in the beginning of the 20th century. So the technology's not new. It's been employed as well in the oil gas industry for a long time. Typically very large scale projects.

Sebastian Heitmann (01:12:39):

But anyway, so there is technology and with that you create hydrocarbons and you can create any hydrocarbon from it. You can create a fuel and they're working right now on jet fuels because that's sort of a logical market. But you can also create waxes. I think as a matter today, I saw the news early on, they put online today a plant in Hamburg, which is creating waxes, specialized waxes, but carbon free. I mean, not carbon free, they have carbon obviously, but circular carbon only. So they're using, in this case, they're using CO2 from the chimney and green hydrogen.

Nate Hagens (01:13:12):

So we have the technology to create low carbon hydrocarbons, as it were right now, the issues that-

Sebastian Heitmann (01:13:19):

Circular hydrocarbons I would call them.

Nate Hagens (01:13:21):

Circular hydrocarbons. Right. The reason we don't do it, and we don't do it at scale, is because our real hydrocarbons that we're extracting from the ground are much cheaper than the multi-step process to create the circular hydrocarbons. But if we either had a society that had a different pricing system or we had depleted hydrocarbons that we didn't have as much access to, then all of a sudden these higher cost circular hydrocarbons would make more sense for society. Society might be smaller, might be less complex, but the technology exists to create all these things that we use today without accessing the bounty that we've got from the carbon pulse so far. Yes?

Sebastian Heitmann (01:14:11):

Yes. The technology exists already today and the reason why it's economically complex still today is because the inputs are complex to get by, we need to get carbon in a circular manner, meaning we have to take it from a chimney or from dark air capturing, which is extremely expensive still, and we need to have green hydrogen. It only matters with green hydrogen, with gray hydrogen, there's no point doing it. So green hydrogens also scares to come by.

Nate Hagens (01:14:38):

Can you explain to our listeners what is green hydrogen?

Sebastian Heitmann (01:14:41):

Green hydrogen is referred to hydrogen that comes from a renewable source. Hydrogen is generally created with electricity, electrolysis. We split in water H2O into O and H2. Oxygen we typically use it where we can or it just goes in the atmosphere, and the H2 we try to separate and then use for whatever industrial process, and that's how we create hydrogen today. The input for this electrolysis is energy, electricity, essentially. And of course if the source of this electricity is fossil, then it's not, doesn't really make sense to create. That's what we should do today. I mean most of the hydrogen we use today, so called gray hydrogen we use from fossil. There's all different shades of hydrogen nowadays, turquoise and whatever, where there's sort of intermediate solutions.

Sebastian Heitmann (01:15:32):

Green hydrogen is A) quite scarce, there's not that many projects able to produce green hydrogen and B) quite a few times more expensive up to an order of magnitude more expensive than gray hydrogen today. But yeah, from gray hydrogen, it wouldn't have a circular effect. Yeah, it's even negative, hydrogen in generally is a negative energy source, for each jewel of hydrogen I'm producing, I actually need to put whatever 1.1 jewels of any other energy source into it. And hydrogen also often is confused. People think it's an energy source, it's not, it's just a carrier of energy. So we create hydrogen as a carrier.

Nate Hagens (01:16:12):

Yeah. And there's an energy penalty from doing that. But if you had lots of very inexpensive energy, like example getting the heat from under the earth at a low cost, then you could do that. Right. So what is the main advantage?

Sebastian Heitmann (01:16:28):

It's something we didn't touch about, Nate, also yet and the cost of it as well. I mean cost is a very important factor and wherever we look into investing into something, we want to make sure that the potential for the company is there to what we call the green premium gets reduced or well, it's got to come below the fossil price eventually. Anything that will be at fossil prices or above fossil prices is subsidies business forever and unlikely to really scale, so unlikely to become a gigacorn because the scale is so huge. So any technology that we look at must have the potential to come significantly below the price of the fossil version for geothermal, there's a very clear pathway to that happening. Geothermal is already in some parts of the world significantly below, Iceland we just mentioned early on. And super critical geothermal would take it to the extreme. Yeah, it'd be extremely price competitive.

Nate Hagens (01:17:24):

So other than the potential cost savings, which is pretty compelling on its own, if that manifests, what are the other main advantages of deep geothermal relative to solar and wind for example?

Sebastian Heitmann (01:17:41):

Usually once, it's a fact that it's so called base load, it's 24/7, there is no night for geothermal and no windless time for geothermal. So it works 24/7. It's very dense energy source as well. The amount of square meters you need to extract it compared to solar, which needs a lot of space is minimal. The wells that you drill are whatever, nine inch or something or 10 inch, very small and provide quite a lot of power, so it's extremely dense. Nuclear is also extremely dense to be fair. But so is geothermal, it's stable. It's also so-called distributed. You can have it in many different places. You don't have to have central large scale plants that produce it. You can have a lot of small distributed plants. Today, I would add another point to it, it's very secure form of energy. It cannot be easily taken out by a bomb or something else like it. Our nuclear power stations are as we learn right now in Russia, targets in the war, it's basically not possible. Or I think more interesting was the vulnerability of the Saudi infrastructure. We saw these couple cheap drones that destroyed a refinery in Saudi Arabia a few years ago. That's a

really vulnerable structure. Obviously very low cost tools can create large damage and supply problems. So that's also an element that today I would add to the mix. It's a very secure infrastructure.

Nate Hagens (01:19:15):

So Sebastian, you're the first person advocating a particular technology or investing in a particular technology that I've had on this show. It's not that I am advocating deep geothermal or that even I'm a believer in it. I'm trying to be agnostic on what I want to see happening and I'm trying to describe what is happening and in your description of what deep geothermal could do for us, I think it highlights kind of our opportunities and constraints. And additionally, I kind of like you as a human being and you're very smart and articulate. So I'm keen to learn about this. So just as an aside, I'm not advocating this, but it just seems like this potentially could be the next can to kick technologically. I don't know if it's going to work or not, but if it does work, what new problems would it create? I assume you've thought about that.

Sebastian Heitmann (01:20:22):

We have thought about that and it's also a question that comes quite often when we speak to politicians or others about it. So what other problems can we create? Honestly, it's a bit of the staggering part. We haven't found any major problems. I mean the issue of earthquakes or instability comes up quite often. But actually when you look a little bit into deeper, you find that that's a minor issue. Earthquakes happen today in geothermal areas, mainly because we drill in generally tectonically active areas, volcanoes faults and so on that are instable already before we drill in there and drilling enhances this instability. When we are looking into deep geothermal and to new drilling technologies, we no longer need to drill in tectonically sensitive areas. We would actually drill in the middle of the plate and hence you significantly reduce those type of risks. Other question that's being asked quite often, don't we cool off the earth? Yeah. Are we going to deplete that resource as well? Here the answer is also, I mean, I mentioned earlier it's large battery, it's gigantic, it's continuously renewable, it's renewable source of energy. So that risk is also not given sort of on a... So those are the two main concerns that we are hearing quite often and we think they're quite well mitigated with the current technologies.

Nate Hagens (01:21:41):

From an ecological perspective though, climate change is not our problem. It's a symptom of overshoot as a species. So this will not solve overshoot, but I don't know what will, and this seems to be the way that clever homonates will try to kick the can again. And I can see some benefits from it, but I can also see that if this were to work globally, it would fuel another round of human consumption and other species and other non-climate limiters and the planetary boundaries would potentially suffer.

Sebastian Heitmann (01:22:20):

Potentially, yes. I mean, that's for sure, that's a certain, on a meta level, same would happen to fusion to nuclear or whatever, whenever we sort of start supplying a lot of energy. There's also maybe on the contrary side I believe that if we are able to provide energy and energy brings prosperity, prosperity

brings education, we might also solve the problem another way, smarter people will take care more of their habitat and understand the global issues better.

Nate Hagens (01:22:48):

I mean, this is where I'm trying to be a facilitator here, in that people say, "Oh, we have to solve everything with this one thing." But I think there are multiple things that need to be solved. We talked about it earlier, there needs to be better governance, better education, a change in consciousness of who we are, where we came from, what we're doing, how to use energy to get healthy, better lives that aren't addicted and polarized and entitled, but that's not your job. Your job is to look at the technologies of what might happen. So I wish you well on this and-

Sebastian Heitmann (01:23:29):

I mean, Nate, this was the really interesting part of meeting you and having the conversation with you that you obviously having this all encompassing view, and you're taking care of the big picture. And it's really important that we do not take the big picture out of sight. Like I mentioned, we cannot have a tunnel view on certain only one technology or there is no silver bullet. We got to be very clear about this and we need to do a lot of things in parallel. And this is just one step of decarbonizing and decarbonizing is one of our largest problems. And by the way, we were not only doing geothermal in our fund as well, we also really in other technologies, like I mentioned hydro's interesting. We're looking at many hydro cases. We are investors in biomass as well. So biomass has more potential than we currently see. So there's not just one solution.

Sebastian Heitmann (01:24:12):

And again, climate is a large puzzle and not all pieces are the same size, but in order to finish the puzzle or to get a chance at doing something, we need to find all the pieces and put them together. So it's really not about the silver bullet or anything like that. And I mentioned earlier on biodiversity is something we haven't touched on, but biodiversity is insanely important and is not measured only, at least in CO2. And education, I think we mentioned that earlier on as well. But you mentioned also governance. I mean there's a lot of things that we need to process in time and I'm glad that somebody's out there's thinking about it because as you said, we're not proposing that we've have the ultimate solution. We're adding one piece to the puzzle technology to decarbonize.

Nate Hagens (01:24:59):

If you don't mind, I will close with some questions that I ask all my guests, a little bit more on the personal nature. So do you have suggestions on how people living in advanced economies, perhaps in Germany can take all this on board and prepare themselves and their communities and their cities for this economic energy transition that I call The Great Simplification? How do we meet the future halfway? Do you have any ideas on what to recommend to people?

Sebastian Heitmann (01:25:30):

That's a good question and not an easy one. I mean, first of all, I think again from energy blind become energy aware. Become aware that it's a scarce resource, become aware that it's not just a given thing and that there's a huge cost to it as well, an external cost. So I think that's something everybody in his personal mindset can do. It costs you nothing. Actually I would recommend the videos on your website to be honest, to watch them, they very easy to understand and everybody can invest those 20 minutes or something to understand the problem. So that's the really one thing. And then if we are living in a democracy, then of course that's the power you have, you have a power to vote for the people to make changes and use that power. Go vote and vote for people who you believe at least represent the best interest.

Sebastian Heitmann (01:26:22):

And of course you also have a choice with - if you have any capital - you have a choice with your capital. How do you allocate your capital? Where do you allocate your capital? Make sure it has some type of long term use and is part of the solution and not part of the problem. So that's actually for those who have significant capital, and often it's a combination too, you think, I don't have any capital, but you are probably going to be part of some pension fund that has a lot of capital. So you can also use your influence there maybe as an individual, it's tough, but you can get organized. And we've seen many great initiatives, how simple citizens took actions on exactly those type of institutional players. So there is ways to take action, political action, capital action, and on your own awareness. And once you start becoming aware, you will also start rethinking many things that you do.

Nate Hagens (01:27:17):

And what about recommendations for young people, young humans who are becoming aware of climate change during their lives and that were midway through the carbon pulse and some of these biophysical constraints? You were a few minutes late for this call because you were reading a story to your four year old daughter. What do we tell our teenage, college age or younger kids about the future that's going to be different than the last 50 years?

Sebastian Heitmann (01:27:45):

I mean, first of all, what I would recommend everybody to do is also to understand the problem, to work on solution for the problem. And part of the solutions are, I mean, in order to become part of the solution, it's good to understand your science. So if you can go in the direction and be part of the solution, understanding the science, study the right type of subjects, so interested. Not everybody has to become a scientist either, but you can also become a teacher frankly. It's also extremely important, or an early educator in any sense. But yeah, create awareness and try to be part of the solution. So many, you can also become a content producer and create awareness. So there's many ways for young people to engage in this. That's the thing that makes me slightly hopeful. And also now in our capitalistic world or what I often get asked, so why now?

Sebastian Heitmann (01:28:39):

Why is climate change now an issue? We known this for 30 years. Why is it actually becoming now actionable? Why are people investing into this now? The simple answer here is the people who are now the asset managers and the decision makers and policy makers are of a generation that has actually grown up with the problem and then slowly starts to understand it. And the previous generation kind of denied it a little bit. Now this generation, it's now allocating the assets, making the policies. They've grown up with sort of an annual COP conference it's starting in Rio '92 or something and sort of heard that climate change is a fact. We had to take 20 years to stop the people denying it, that's kind of over now. Most people understand that it's actually real. And now we start seeing people allocating assets in this direction.

Nate Hagens (01:29:30):

It's partially that and it's partially we see what's happening in Pakistan and in Europe and in Australia, and these things are kind of hard to deny.

Sebastian Heitmann (01:29:38):

Yeah. Yeah. Exactly, we're starting to see effects much earlier than we thought we would as well. But yeah, we also are starting to see real effects that are undeniable. Yeah, fully.

Nate Hagens (01:29:47):

So what do you care most about in the world, Sebastian?

Sebastian Heitmann (01:29:52):

Of course, I mean, I care about... What I would really like to achieve is to leave the next generation a place which is not a lot worse than what we founded, and that's a hard thing at the moment. It doesn't look good. It doesn't look good from our wealth perspective, from our environmental perspective, from our political perspective, it seems we're on our way to leave a mess behind. So if I can play a role in slightly improving the situation a little bit, that would satisfy my sort of personal side of it quite well.

Nate Hagens (01:30:25):

So we've talked about climate and CO2, but of all the issues in the world, what are you personally most concerned about in the next 10 years or so?

Sebastian Heitmann (01:30:35):

That we reach tipping points, that we can no longer, that it's just not reversible tipping points, and at that stage we will have to move from mitigation to serious adaptation.

Nate Hagens (01:30:44):

And in contrast, are there things that you've experienced or things that you're seeing that give you a lot of hope about the next 10 years and what would those be?

Sebastian Heitmann (01:30:54):

Clearly, I'm in this privileged position right now that every day I'm being confronted with solutions. I have a wealth of people that come to us every day with great solutions and great ideas and minds thinking about it, and this completely makes me hopeful. Otherwise I couldn't be doing the job. I mean it's quite frankly, you have to be slightly looking through the world with an optimistic lens in order to appreciate the innovativeness of the people, and it is amazing. People are super inventive and not all of them will pan out all of these ideas. But we also just need to be realistic. We'll need to see a ton of companies fail in this space too, in order to make sure that a few could survive. So from that point of view, of course I'm very privileged to see a lot of people, very smart people working on solutions. And we are now technology investors, but we see also so many non-tech solutions on a daily basis, we confronted with that are also fantastic. And so yeah, the human ingenuity is something beautiful and that's what makes us stand out as species.

Nate Hagens (01:32:00):

So in contrast to an investor perspective, this final question might be a little bit odd, but if you, Sebastian were benevolent dictator and there was no personal recourse to your actions, what one thing would you do or implement to improve human and planetary futures?

Sebastian Heitmann (01:32:22):

One thing?

Nate Hagens (01:32:23):

Or two things or three.

Sebastian Heitmann (01:32:25):

Yeah. One thing is hard to grasp, but it would be really on a dictatorship, I would probably actually go for education, ensuring that everybody on this planet goes to school. The processing power that can come from there is amazing.

Nate Hagens (01:32:41):

And that we teach ecology in the school.

Sebastian Heitmann (01:32:44):

Obviously I should have qualified that not just to any school, clearly. And yes, obviously a school where we teach ecology and ethics and then other important subjects. But yes, of course, but even basic education goes a long way already. Of course we'll have our in the westernized world we'll go further maybe, but basic school in certain areas would really help. And I guess if we could force that to happen, we would solve a lot of these overshoot problems that you mentioned earlier. And it's a symptom. If we can change the root problem, the symptoms will also get less. That's why I think probably the main leverages on education. There's also very complicated, but I'm a dictator now and I'm just going to tell everybody to do it.

Nate Hagens (01:33:32):

This has been great. Thank you for taking, you had a full day at work and then you took care of your daughter and now it's past 10 o'clock German time, and thank you. This has been a wide ranging, informative conversation. I am sure that we will stay in touch and to be continued. Are there any other closing thoughts, advice, wisdom for people listening today?

Sebastian Heitmann (01:33:55):

No, I'd like to thank you for the very sort of comprehensive way that you put together this stuff that you do and bringing the message across, thinking with this sort of holistic lens. Keep on doing that and I hope that people start listening more and more. I think you have some audience already, but more and more to you and let's stay in touch and discuss the progress. We're still at the beginning.

Nate Hagens (01:34:20):

Danke sehr, Sebastian, guten abend my friend.

Sebastian Heitmann (01:34:24):

Guten abend.

Nate Hagens (01:34:26):

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