



**MACRO Voices**  
*with hedge fund manager Erik Townsend*

## Robert Friedland: Geopolitical outlook & Geothermal Energy Revisited

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**Erik:** Joining me now is Robert Friedland, who is probably best known as Chairman of [Ivanhoe Mines](#) and Ivanhoe Capital but he's also the chairman of a company you might not have heard of called [I-Pulse](#). We'll be talking more about that in today's interview. Robert, it's great to get you back on the show. Our listeners have heard from me in recent weeks that I'm convinced that an energy crisis, a global energy crisis is imminent. I think the fact that we are currently enjoying low crude oil prices is an illusion that won't last very long. But you've certainly been around energy markets longer than I have. What's your take?

**Robert:** Well, it's great to be back with you Erik. It's amazing how much the world has turned. We went around the sun once and everything we talked about a year ago has come to be real. The energy crisis you're referring to is not a future phenomenon. It's here now! It has arrived. It's arrived because suddenly the world is at war and war has changed everything. We have such high electricity prices in Europe that smelters that produce metal can't afford to operate. They're shutting down. And that's only an \$80-\$90 crude oil, but astronomically high electricity prices in Europe. That's an amazing story of how we got there from here. But the energy crisis is already upon us and Russia is a giant crude oil producer arguably the largest, if not the second largest. And now that we've placed sanctions on Russian energy, just the marginal reduction in production has put the world on a knife's edge for energy. We thought that the price of coal was gonna go down, we don't need it anymore. But Glencore made \$16 billion mining coal last year, coal prices have skyrocketed. The Germans are burning coal to get through the winter. Angela Merkel had closed about 16 nuclear power plants in Germany. She was reliant on Nord Stream one and two, Russian natural gas. What a silly thing to do now that that natural gas is no longer available. The minute it got cold in Europe and the wind stops blowing all of Europe is short of electricity. We haven't seen electrical prices this high ever. It's already for Europe, an existential crisis. We haven't seen a major European population be bombed into the stone age. So they freeze in the dark. That's a moral obscenity. But that's what's happening to 40 million people in Ukraine this winter. And the implications are apparent, we are extremely vulnerable to a global energy crisis. Europe itself has only a few remaining natural gas pipelines. There's a natural gas pipeline from Norway to Europe. And there's some natural gas coming from Algeria to Spain and to Italy. But we now know that those ocean bottom pipelines are vulnerable to sabotage, as are all the Internet backbone that goes across the ocean and fiber optic cables. And so all of this fundamental infrastructure is now known to be vulnerable. And every major society is worrying about securing its own supply chain.

So Erik, if we go back to what we were talking about a year ago, in about 2008, we had an integrated world economy. It was just-in-time, everybody loved everybody. If you went to Walmart, everything said made in China. Today we have a just-in-case economy. Every society wants to secure their energy supply chain, their food supply chain, their basic raw material supply chain. The Japanese are rebuilding an army it was just announced last week that Japan's gonna spend 2% of GDP to build an army. They haven't done that since World War Two. Ditto, the Germans haven't had an army worthy of their name since World War Two. The Koreans want their own supply chain, they don't trust the Japanese. The Chinese want their own supply chain. India wants its own supply chain. Europe wants its own supply chain. Of course, America now has its partnership with the five eyes. So as we've balkanized the world economy, it's an insanely inflationary phenomenon. And each group plays to its own strengths and the people that are long energy, want to drive the price up. Vladimir Putin benefits from high energy prices. And now we have a situation where cheap Iranian drones are being bought by Russia and used on Ukrainian civilians. Obscene, obscene destruction of the energy backbone in Ukraine, which incidentally, feeds electricity to Europe. So here comes 1000 cheap drones a you, you might shoot down 950 of them, the other 50 get you. If those Iranian drones were turned on Saudi Arabia, for example, we could have \$200-\$300 crude oil forever. So I think the first point we need to make is that we should thank God every day, for the energy security the Western world enjoys from Saudi Arabia. Saudi Arabia, as a reliable supplier of energy to the world is literally keeping the lights on. They don't want the price to be so low, that you have less energy production. And they don't want it to be so high that you destroy the Western world economy. But without their responsible role in conventional energy, there would be no hope of making an energy transition. And so, you know, if you take 10 dogs in a room, I think you will observe that those 10 dogs all smell both ends of every dog. And so every nation now is worried about its own energy security and food supply. And that means that we already today in an energy crisis.

**Erik:** You mentioned the war cycle and this is something that I don't understand why people don't seem to see or maybe I'm worried about the wrong thing. But it seems to me, Russia exports about 8 million barrels of oil equivalent. And if they were to weaponize oil prices, you know, Saudi Arabia as you said, has been the swing producer that has stabilized markets, which is wonderful, but they've publicly admitted that they have at most 1 million barrels of spare capacity left, if Russia were to withhold half of its exports from the market, that would take 4 million barrels per day off of the market. Saudi Arabia and the United Arab Emirates and the rest of OPEC together don't have anything close to enough spare capacity to make up for that. And people tell me, I'm crazy to suggest it because Russia would never tolerate that loss of revenue. I say wait a minute, if they did that, it would double the price. They wouldn't lose any revenue. What am I missing Robert?

**Robert:** Oh boy, what you what you said is not only correct, it's only the opening note in a symphony. Russia is a country with a declining population and no fundamental domestic industry that the world needs save energy. So Russia is like Exxon run by like Cosa Nostra. And they benefit from higher energy prices. And so it's easy to throw matches in a flammable world.

If Iran were to turn those drones on Saudi Arabia and go after the Jubail complex, and you've seen Houthi missiles backed by Iran already hitting Saudi Arabia. If they do that at scale, you could have \$200 or \$300 crude oil overnight. My vote was in Jetta for Formula One and a Houthi missile came over our head and hit a big oil tank in Jeddah and the whole night sky lit up. It was just a couple of Houthi shooting missiles at Saudi Arabia. It only merited a few lines in the New York Times but when you're there, and you realize how vulnerable everything is to modern technology. You know, the Ukrainian sent the Moscow, the pride of the Russian military fleet with almost nothing. And we realized now that aircraft carriers are vulnerable to underwater drones, or drone technology can take out huge weapons systems. And the beauty of drones is if you've launched 1000s of them and an enemy only a few of them need to get through and they're cheap to build. So all of the world's energy infrastructure has now been weaponized.

Putin has used energy as a weapon, and has taught the Europeans how stupid they were, especially the Germans to be dependent on Russian natural gas. Donald Trump warned the Europeans that they were dependent on Russian natural gas. And you may love Donald Trump or you may hate him. You could say a broken clock is right two times a day, but he was 100% correct. The Europeans have no army to speak of, no conventional way of defending themselves. And so many bombs and shells have gone off in Ukraine right now that there's almost no base metal left in inventory. Every time a Shell has gone off in Ukraine, a bomb. And nobody has seen that much conventional armament used since World War Two. Every time a shell goes, boom, you need copper and antimony, and other metals that are not recycled Erik. So there's almost no metal left in inventory, just for conventional armaments. And so we are living in a much more dangerous period than we were a year or two ago. We're already in an energy crisis, it could be much, much worse. But hopefully it won't happen. But we see huge increases in the price of food globally, that will hurt marginal societies like Egypt, Nigeria, Pakistan. Places where if people don't have food, they ride on the third day. It's a human humanitarian tragedy, when energy prices rise, and so we have the opposite of food security, we have the opposite of supply chain security, we have the opposite of energy security. And anything we do to get out of this situation will be extremely metals intensive. And it's all utterly dependent on energy security from the Saudis.

Because I think the problem is that a lot of your listeners may not understand the fragility of the supply chain, and how markets actually work. And so Erik, if I or you were to hold a telephone book out at the end of your arm, just hold your arm out horizontally, and lift that old telephone book or an Encyclopedia Britannica volume. Just hold it out there, you could do it for an hour. But at the end of an hour, if you put a feather on top of that book, it'll break your arm. So financial markets are moved by marginal increases in supply or demand. If you were to lose 4 million barrels a day of Russian oil production, you'd have a ridiculous upward move in the price of oil, and then a huge jump in the price of food. And that's what we're facing right now that this isn't a future energy crisis. Europe, is it an energy crisis right now and it could easily get much worse.

**Erik:** Robert, you've mentioned Saudi Arabia specifically a couple of times. Why do you see Saudi Arabia's role is so important here, and what are the things we need to be watching for in terms of news events?

**Robert:** I've had the privilege of spending quite a bit of time in the Kingdom of Saudi Arabia in the last year. And I've been on a steep learning curve about oil and gas fundamentals. And of course, my old friend, Dan Yergin who wrote the book *The Prize* on the gas industry was there with me. He's an adviser to OPEC and I had the distinct honor to meet His Royal Highness Prince Abdulaziz who is the energy minister in Saudi Arabia, and have some very interesting talks with him. Saudi Arabia is the only country that has immediately available swing capacity. When the oil price really skyrockets, they might be able to produce with great effort 1 or maybe 2 million more barrels of oil a day. But the potential downsides from bad actors like North Korea, or Iran, or Russia, dwarf Saudi Arabia's potential ability to cushion an energy crisis with more production. So, if you want to shut down nuclear power plants, where's the energy going to come from? If you don't want to burn coal, where's the energy going to come from? Saudi Arabia has announced that they want to lead the world in the development of a hydrogen economy. They're developing unconventional gas, LNG is absolutely critical as an interim fuel, as the world looks for cleaner ways to generate energy. But I've come to realize the fragility of the whole global system. We've gone from an integrated world economy, sort of a just-in-time world economy to a very fragile just-in-case world economy. And this is all related to the price of food, the price of water and of course the price of peace because war has broken out. A lot of us may live comfortable lives. But we don't really realize what it's like to live in Ukraine, and to have children and be worried about being bombed in the dark. It's not clear why that's happening except basic demand for territorial imperative. But we now live in a very fragile world situation. And it's very important to give thanks, and support to where the energy is coming from because you don't know what you've got till it's gone. We're living quite a comfortable life. But there are a lot of societies that are suddenly on the edge where the price of food is very high or the price of energy is unobtainable.

South Africa right now is experiencing daily blackouts, price of coal is so high, they've under invested in their energy transition, they're still burning coal. The Germans are burning dirty coal to get through the winter. And we see that it's not going to be that simple. The way I like to explain this Erik is, you know, I've gotten to know a lot of billionaires in my life, I was thinking of male billionaires, as opposed to female billionaires, I think I've met over 50 Male billionaires that I know quite well. I do not know, a single male billionaire who jumps into his pants, both legs at a time, I took a poll, and every one of these billionaires puts in one leg into a pant leg and balances on that leg, and then sticks in the other leg. And the point I'm trying to make is I don't know of any way that we can just jump both pant legs at a time into an energy transition, and leave behind the fundamentals that were built with such great energy over the last century or two. And I'm telling everyone with the ears to listen, that this whole situation is far more delicate and complex than modern mass media seems to portray it.

**Erik:** One of the reasons that energy prices have come back down in recent months, is a lot of people are expecting a global recession as the stimulus from the wake of the pandemic is

starting to wear off. And inflation makes it much more difficult for central banks to fight it. Do you agree with that and can that hold energy prices down or do we get to a situation where energy prices are actually what prolong the recession?

**Robert:** Well first of all, you know, we had a ridiculously absurdly incompetent Federal Reserve Board who said, inflation is transitory. And they said that while giga-dollars was printed in deficit spending, so the old school of Austrian economics came to the fore. And of course, we have inflation. And it's no longer a matter of debate, we see inflation in the price of goods, people need to live and survive everywhere, the price of rice, and food, and electricity. Everything you really need is going up in price globally. And you know, it's masked if you're an American, because the US dollar is so strong, but the price of copper is up 40% in Japan because the Yen went from 90 Yen to 130, 140, 150 Yen to the dollar. So it all depends on your measuring stick. There's an enormous amount of inflation. The question is, what is the source of that inflation? I'd say at least two thirds of it minimum is supply side inflation, shortages of real things. 1/3 of it is demand side and so central banks can easily raise the price of money. If you add Volcker, with 21% interest rates the United States, of course, you can engender a recession. Of course, you can dampen demand for new housing by making mortgage unaffordable for example. And they will do that! Central banks in the United States can raise rates until they engender a recession and reduce demand.

But the problem is in the current situation, raising those interest rates doesn't make any new oil, it doesn't make any new gas, it doesn't make any new metal, it doesn't make any new food. We need to reinvest in supply. This is a supply side crisis. Too much money went into the new economy, went into Netflix, it went into Walt Disney, it went into the internet or the cloud. And we just didn't have sufficient monies invested into the basic old economy. The old economy has been starved of capital for a generation or more. The United States military has just woken up and said, my God, we don't have the basic raw materials we need to fight a war. I think five American administrations slept walked, just they were sleepwalking. Imagining that we're living in a safe world and suddenly, we are at war and that the United States Navy Army and Air Force are worried about the critical raw materials it takes just to produce something as primitive as 155 millimeter Howitzer shells. Every time you shoot a bullet it's made out of copper, it's got brass or bronze in it and so we're waking up to a shortage in everything simultaneously and it will take astronomic and amounts of capital investment in the old economy. This is why Jeff Curry, who is the head of commodities at Goldman Sachs calls this the revenge of the old economy, the old economy needs Giga dollars of capital investments.

So the only element of the old economy that has the ability to give us energy infrastructure are the key members of OPEC. That's the Saudis and the United Arab Emirates and the Qataris. The Qataris are trying to almost double their LNG capacity so Europeans don't freeze in the dark. Just think how much metal it takes to double LNG capacity, the LNG ships and the LNG production. The oil and gas, how much steel and sophisticated metals you need to increase oil and gas production. I always like to remind everybody of Bob Dylan when he was a kid, he started out as Robert Zimmerman. And one of his first songs was Subterranean Homesick Blues, you should play back that song, They are two great lines in that song. One was you don't

need a weatherman to know the way the wind blows. And the last line in the song was the pump won't work because the Vandals took the handle. That's what we have. Now we have a stressed supply chain, that the handle has been taken away. There isn't enough oil, there's enough gas, there isn't enough food for 8 or 9 billion people in the planet. And now we have the prospect of war. And every society is worried about securing the safety and the health of their own domestic population in a balkanized world economy. That's very, very dangerous, very inflationary, and requires deep, careful thought about every nation's national security.

**Erik:** Robert, it sounds like you and I are in strong agreement that the energy crisis is already here, the war makes it worse. Unfortunately, there's nothing that can be done. It's too late to prevent the energy crisis, which is only just getting started. But let's talk about longer term, how we're going to solve this. I've talked to you about the subject of deep geothermal before in the area of energy called renewables. There's generally three categories, wind, solar, and, geothermal and geothermal gets the least attention. Why does it get the least attention and what needs to happen in order for it to be a bigger part of the solution?

**Robert:** So this is a super giant question for the entire world of alternative energy. That, you know, we have these two words that you keep hearing, energy transition, energy-transition, two words. If you put 100 physicists in a room and you ask them to define the word energy, you'll see a two hour debate. And then transition to what? First, we have to define what is energy. I would say for the purposes of this communication. Energy is the movement of electrons to do useful work on behalf of humanity. That's energy, and then transition to what? We have to transition to... We're transitioning away from the burning of coal, to move electrons, we're transitioning away from the burning of hydrocarbon to move electrons. We're basically talking about electrifying the world economy. That is the energy transition. We're changing the way we move electrons. Now, in order to do that of course, we have to reorient the entire planet. Everything has to change. And that's not an easy thing because the energy density of solar and wind are extremely low. The problem with windmills is they only last for 20 years, then you have to take the blades down. A lot of people don't realize the core the blades are made out of balsa wood. And then hydrocarbon makes the blades, you need oil to make the blades in a windmill and after 20 years, the generators have to be rebuilt. And there's a huge amount of steel and concrete required to build those things and they're chewing up birds. Birds fly into those windmill blades, they can't even see them. They have a big impact on wildlife. There are American bald eagles that are being killed by windmills. A lot of people don't like windmills. They go whoop, whoop, whoop and they're ugly in your local neighborhood. You have a NIMBY (Not In My Backyard) phenomenon or a banana phenomenon in the United States build absolutely nothing anywhere near anywhere. So when you want to permit windmills, people hate the idea.

Solar is even worse. It has a very low energy density. So you have to pave huge amounts of the planet with solar. But the problem is the sun only shines four or five hours a day and the grid is not designed to take intermittent power. It just can't deal with it, you know our grid, it's like balancing a pencil vertically on your palm. So it can only absorb a certain amount of solar or wind. The Texas grid, which is not connected to the rest of the American grid went down just from a little, little period of cold weather. And we have a super cold wave right now, hitting the

United States today at minus 70 degrees Fahrenheit in Wyoming today. So the grid is not really ready for millions of electrical cars being plugged in at 5pm when people come home. And so you need unstoppable power on 24 hours a day to stabilize the grid that is designed to accept intermittent power like solar or wind. You either have to build giant batteries at grid scale, which is doable but needs a lot of investment, trillions of dollars of investment in metals and construction, and metals to build the batteries and rebuild the grid. Or you need nuclear power, or you need geothermal power and, and don't hold your breath on fusion, there's been a lot of talk of fusion, but the amount of energy it took to power that laser, and the fundamental breakthroughs at grid scale fusion, we're decades away from grid scale fusion. So in today's world, it's conventional nuclear power, perhaps modular, maybe we can get to a thorium cycle, and not use uranium and its geothermal power. Because Mother Earth is herself a nuclear reactor and we can go into that more deeply as you like.

**Erik:** Let's go deeper into geothermal. And I say that as a little bit of a pun, let's really talk about how to go deeper because as I understand it, the problem with geothermal. The reason it's not really favored that much, is with the existing technology, you can only drill to a depth where maybe you get to a couple 100 degrees Celsius. And if you pump water down into that, yeah, you can boil it and make steam out of it, you don't really get that much energy out of it, you can run a turbine and produce some electricity. But the amount of sunk cost in drilling all of those deep holes and making that geothermal electric power plant cost so much money versus the amount of electricity that you get out of it at 200 degrees Celsius, that it's barely worth it. What does it take to go much deeper? And I guess the deeper you go, the hotter it gets? How deep do you need to go? And how hot do you need to get to before that becomes scalable to where similar to nuclear, you could really look at geothermal as a realistic replacement for fossil fuels?

**Robert:** Well, the answer to this whole question is right under our feet, and even more so depending on where you happen to be located on the surface of this little planet. And the analogy is the automobile industry. In the very beginning and the dawning of the automobile age. Some of the first cars were actually electric. But they failed because the battery technology couldn't compete with the energy density of gasoline, which Henry Ford put into a Model T in the 1920s. As soon as Henry Ford figured out how to mass produce an automobile, and he pumped out those black Model T's say 1927. It was like lining up to get a new iPhone. People were just dying to buy one of his iron horses. Now, what we have in in geothermal is similarly embryonic. The first generation of geothermal power plants. There are some in California, north of San Francisco, at the geysers. There's some in Kenya, you got into this places in Africa with geothermal power. The Philippines is running some geothermal power Indonesia. If you happen to be in a volcanic belt, where there's a lot of heat, Japan has some geothermal energy. We have basically tapped naturally occurring fractures in hot rock, usually an area where you have naturally occurring hot springs. If you go to Japan, even the monkeys are taking hot baths and naturally occurring hot springs. So if you go to an area where people have had hot springs like Calistoga, California and you drill a well there are naturally occurring fractures, you can make electrical energy. I think the geysers in California is producing about 600 megawatts of huge pure geothermal energy, no global warming effects 24-hour day

electrical demand. Now the problem is that we don't have technology to drill in hot rock. There's lots of hot rock without naturally occurring fractures all over the world. Arizona, New Mexico, Colorado, Utah, British Columbia, Mexico, Chile, Indonesia, Japan, Saudi Arabia, large areas of Europe, Italy. There's an enormous geothermal endowment once we have a better way to drill deeper into hot rock.

And once we do that, we have limitless electrical potential with zero global warming affects 24 hours a day. We do that we don't have to pave the world with solar cells. If we do that we don't have to pave the world with windmills, chewing up bird life. We do that we have a simpler and better solution. There are technological challenges, no doubt. But Erik, I can assure you, it's nowhere near as tough as it was to put a man on the moon when John F. Kennedy, you know, Challenged America to put a man on the moon. And we did it that was a really great America those days. And we prove that we can do anything, you know, the computational power of the computers that took the first human beings to the moon is less than the computational power we have in a single iPhone. So if we rethink this from first principles, we think there is a better way to do geothermal energy and [I-Pulse](#), our own technology unicorn is working on it, and believes the problem can be solved in the near term in a sort of 5 or 10 year horizon. We should have the breakthroughs required for unlimited geothermal power.

**Erik:** Now, when I've talked to other people about this problem, including petroleum geologists, what they tell me is, look, the challenge is very, very difficult to overcome because to really make geothermal work at scale, not just in a few places around the world where there are these naturally occurring, low depth kind of, you know, hot springs and so forth. But to make it work globally, what you'd have to do is drill down to about 10 kilometers of depth to where you started approaching 400 degrees Celsius of hot rock down there. And what they've basically told me is that there is no drill bit technology, now or frankly ever even envisioned or hoped for, that can go to that depth and drill through rock at that temperature. And I suspect they're probably right, because they're talking about drilling. What's the difference between drilling and spalling and how does that come into this story?

**Robert:** Well, I don't know who they is but they're wrong and they're just lacking in vision. They're just flat wrong. One of the things we've had the privilege of doing is working with the and we have met with the research and development division of Saudi Aramco, which is the largest company in the world. And they know, they know everything there is to know about drilling, and they're making their own advances in drilling and they're interested in ours. So you do not need to go 10 kilometers deep, you can go much shallower, you can go two kilometers deep or less in large parts of the world, and then just put your electricity into the grid. There are hot dry granites all over the United States that are capable of providing all the electricity the United States needs. The same thing is true for Canada, Mexico, Latin America, Europe. So the hot dry granite as granite that is about 250 degrees centigrade, water boils at 100 degrees centigrade, that's all the heat you need. But the hot dry granite has no porosity and no permeability. Once you can crack drilling in that rock, you can release an astronomic amount of energy to drive a generator and nuclear power plant makes steam. It makes heat in efficient reactor and that generator, make that steam turns a turbine and makes nuclear power. You just



take the nuclear power out of it and make steam with the heat that Mother Nature gave us underneath our feet.

We've talked before about that the fact that the center of the Earth is her herself a nuclear reactor. It's the remnant uranium in the core of the earth under great pressure that causes a naturally occurring fission reaction and so you just saw Haleakalā, the big volcano in Hawaii erupt. That heat that drives that volcano is the nuclear reaction to the core of the Earth. I'm quite confident that we can now find a better way to drill in hot dry granite and liberate astronomic amounts of heat. Up until now, however, all conventional drilling technology relies on mechanical pressure on a rotating tool. If you think about an oil well, and let's say that an oil well goes down to 15,000 feet, say three kilometers, four kilometers. Some oil wells go down to 20,000 feet. So we're talking about four miles deep. You have a four mile piece of steel that you have to twist. And it's putting pressure on diamonds at the at the drill bit. And that drill bit is grinding the rock under huge pressure. That's the way we drill, a rotating tool grinding rock. But I-Pulse has been working with the support of the French government for 20 years on a tool that will drill in rock with no mechanical pressure on the rock. Rather, it's using bolts of electromagnetic energy to cause the rock to go from being granite, directly into a gas causing the rock to spall. It's called spalling into a gas. And once you can drill without mechanical pressure, you can drill faster and cheaper. And if you can drill in hot rock, you can liberate geothermal power. And so this instead of pointing a moon rocket as Elon wants to do to go to Mars or the Moon. You want to go down and find heat and free energy. Now, both enterprises are interesting. But going down and finding Geothermal power is not a subject of science fiction. It's something that we can do in our own lifetime and we can solve this whole problem.

**Erik:** Now when you say we can do it in our own lifetime, for 70 years now, scientists have been working on nuclear fusion. It was only in the end of December that they finally managed to get just barely a net positive experiment where they were able to get slightly more energy out than they had to put in. When we talk about getting to geothermal, where it would be scalable enough to be a suitable replacement for the use of fossil fuels in our economy. Are we talking about next year? Are we talking about 10 years? Are we talking about 30 years, how far off is it in order to use this new approach to drill these holes in hot granite in order to actually create geothermal energy at sufficient scale as to really start to think about it as maybe a replacement for something like natural gas in producing electricity.

**Robert:** Russia was working on electromagnetic pulse drilling when the Soviet Union fell apart and some of their most sensitive scientific work was done in Donetsk in eastern Ukraine. That region was always very sensitive in the former Soviet Union, and their military industrial complex, but when the Soviet Union fell apart, the research that the Russians were doing with pulse power collapsed. So we've been working with the French government support on super capacitors that can fire 1000s, if not millions of times, and we can electromagnetically drill in rock. Now this can be developed much easier than fusion. We employ scores of plasma physicists, who are very familiar with all modern attempts at fusion. Fusion is really tough. Fusion is really, really, really difficult. I'm not going to tell you, it's impossible. I'm just saying don't hold your breath. It's going to take decades, if not longer. The high energy lasers required

to be scaled the fundamental breakthroughs that are required, I don't want to go into here. It's just it's not a near term solution. Geothermal, however, is a near term solution. We've been talking to Saudi Aramco. They're a big oil company. They're a big energy company. They're very keen on it. Enterprise at the scale of an Exxon or Shell or BP, the United States Department of Energy, the Europeans, the Japanese, definitely have the scientific and financial horsepower to revolutionize geothermal energy. And we're doing it and we'll be able to tell you much more about it in the near future.

**Erik:** Robert, before I move on to the investment aspects of what you're doing with I-Pulse, and this fascinating new spalling technology to replace drilling. Let's come back to timeframes. When you say it's near term, how near term is it? Are we talking about we can get our way out of this coming energy crisis by starting to install geothermal power production plants, electric generation plants, you know, starting next year or is this still several years off?

**Robert:** Several years off, but very doable in several years is nothing in geologic time we, we've been burning crude oil for over 100 years. So today is the first day of the rest of our lives. Once a technological breakthrough is adopted, like the hand phone, the iPhone or anything else, government policy can make it ubiquitous. The United States Department of Energy, we've had this famous inflation creation act of the United States Congress. I mean, the United States covered could back this technology at scale easily once it's developed. So in the low hundreds of millions of dollars of technological development, we can move this forward with private industry, and then it can be scaled with the support of governments and I-Pulse is already in dialogue with governments that are very keen on providing additional support. As I've told you, about half our R&D costs at I-Pulse have been covered by the French government for the last 20 years. So it's a scalable technology once developed. All we need Erik is a new way to drill cheaply and quickly in hot rock. And that is closely related to the technologies we've recently announced taking investment from outside sophisticated investors.

**Erik:** Robert help me to frame a chronological roadmap for how we're going to solve this energy crisis, which we agree has already begun. It sounds to me like advanced nuclear and also advanced geothermal are not quite ready yet. So I would think the best solution is going to be to scale up existing conventional nuclear the stuff that's already legal and permitted, that could be scaled up immediately. And then it sounds to me like I don't know, 5 to at most 10 years down the road, we ought to be able to replace that with advanced nuclear in a thorium fueled, as opposed to uranium fueled nuclear cycle, and also start to bring in this deep geothermal, which would give a completely, you know, unarguably green way of producing the kind of electricity that we're going to need in order to replace fossil fuels. Am I on the right track?

**Robert:** Well, you know, if you're talking about a recipe to save the world. We have to be realistic and say it's a work of decades, it's not a work of days. And you're right, we need stability in conventional hydrocarbon just to prevent people from starving around the world. We need hydrocarbon just to make fertilizer to grow food and the harbor process converts natural gas to make nitrogen fertilizer. And so first, we need stability in hydrocarbon production, we probably cannot get around using LNG as a transition fuel for the world. And that's also very

necessary and the Qataris are nearly doubling their capacity in LNG so that Europe doesn't freeze in the dark. Beyond that, looking for ultimate solutions, thorium is much better than the uranium cycle, it's much safer, it's much cleaner. And the modular nuclear reactors that are certified and are produced at scale would probably be a huge improvement over building one off \$15 to \$20 billion reactors that take forever to permit and build. Geothermal power will be revolutionized. We don't have to drill that deep. We just have to drill in the right locations. But we need to revolutionize the way we drill. Our Breakthrough Energy Ventures is Bill Gates' venture fund. It's been funded by some of the wealthiest and most influential people in the world. For example, Jeff Bezos is a fundamental error and these are people that put up money for the long term, trying to finance knocking the cover off the ball on any technology that can have a disruptive impact on the generation of global warming gas.

So you have to look at where global warming gas comes from and what can be done about it. So the way we make concrete can be revolutionized. That generates a lot of global warming gas, the way we make steel can be revolutionized. You don't need metallurgical coal that can reduce global warming gas. The way we waste energy to crush and grind rock can be revolutionized that can reduce global warming gas. The way we generate power, it can be revolutionized with the thorium cycle or with nuclear power or with geothermal energy and to a lesser degree with solar or wind if we have adequate grid scale storage. And the answer is probably going to be some of all of the above. It's going to take an enormous, consistent effort on the part of humanity and probably we'll need a smarter market, where we put some pricing on carbon dioxide and methane generation. Because right now, there's no reward or penalty for being clean if you buy copper on the COMEX, it has a certain price like \$3.80 a pound today, and dirty copper and clean copper are priced at the same price. So the pricing signals are wrong. Clean copper if you can make it with less global warming gas should trade at a premium. And if it's dirty copper and you're burning coal to make it, it should trade at a discount. So even financial markets and the pricing cycle are going to have to change. So it's really unfortunately on all of the above answer, there is no simple snap your finger answer to humanity's propensity to generate global warming gas.

**Erik:** Okay, hang on because there's more to the problem than just the energy problem. Let's assume that we can somehow navigate through everything that you just said. We get to a new generation where with some combination of geothermal, nuclear, and so forth, we've got an ability to replace a lot of what we consume in fossil fuels today. People see this electric vehicle revolution. Right now as we're speaking at the beginning of 2023, there's less than 5% of vehicles on the road are electric and a lot of those are hybrids, which are still burning fossil fuels in order to charge the battery. To get to all electric, first of all, those vehicles are going to require an insane amount of copper to build all of the vehicles. But what most people don't bother to think about is if you're going to replace fossil fuels, every single bit of fossil fuel energy that you don't burn in an internal combustion engine, you're going to have to replace with electric capacity. And that means a much more capacious electric grid, which is all made out of copper. Robert, I'm concerned, you know, we've talked about peak oil and running out of oil. Are we going to run out of copper and what is it going to take me we're not talking about, let's call Ivanhoe up and just make a bigger order than last month We're talking about more copper than

the world has ever consumed before. Is the industry ready to scale up and step up to that demand?

**Robert:** We only have one periodic table to work with. And unfortunately, the whole situation is like squeezing one out of a balloon, the other end of the balloon pops out. There's no free lunch in physics. So, humanity has mined and consumed or utilized 700 million metric tons of copper to build the modern world. London, New York, aircraft transportation, and food. Now even an electric car is 50% hydrocarbon, the cost like when you try to make an electric car lighter and use plastics. The plastics are made from hydrocarbon. And if we had no hydrocarbon in the world, immediately half of the world would starve to death. I would recommend a great book by Vaclav Smil called *How The World Really Works*, is one of Bill Gates favorite books, and it really explains the basic supply chain. We are as a species, we're eating fewer and fewer grains, we're eating wheat. We have centralized agriculture, it's very energy intensive. The way we feed people, the way we clothe people is all very delicate, and the electric car phenomenon, it's not just the amount of copper you need to build the electric car. It's the amount of copper you need to generate and transmit the electrical energy to charge the battery in the car. And the batteries are the key part of an electric car. Any anybody can build the chassis, the wheels and the suspension. The hard part is the battery, we need to make batteries more energy intensive. We need to make them recyclable. We need to make them out of cheaper raw materials. And we need to make them non-flammable and we need to make them work in cold and hot weather. That's not easy. The batteries themselves are still in a state of evolution. So we have to look at the critical elements of the supply chain to build a car. The copper per automobile is skyrocketing as we go electric. The lithium per car is skyrocketing as we go electric. That means we need more copper mines. we need more lithium mines, and those mines themselves need electrical energy. And so we need a much more sober understanding on a womb to tomb or cradle to grave basis of how global warming gases generated and the enormous amount of work we need to do to get there from here. There's a lot of people that think this is going to be easy without giving sufficient respect and thanks to the incumbents, people just you know, think that some of the internet is green or doing a Google search is green or a bitcoin is green, or, you know, crypto is green. It's all nonsense. All of it is crazy, crazy, energy intensive. Google uses enormous amounts of electrical energy. They just don't charge you because it's the advertising revenue and Google that pay for what you're consuming. But every time you do a Google search, you're using a lot of electrical energy. Was it generated burning coal, was it generated burning natural gas, was it solar or wind? It's all very complicated.

We see less copper metal and zinc metal and other critical metals in inventory than we've seen in a generation. And a generation ago, there was no China. And now we have China, and India, billions of people, all of whom want an air conditioner, a microwave oven, a washing machine, a TV set, an electrical car. So the average human being is consuming much more electrical energy than they did a generation ago, the average American has 30, 40, 50 appliances that use electrical energy. The average American never even turns their computer off at night. They leave it off sleeping, but it's drying power all night long. So you can measure human progress by an increase in electrical consumption per person that's doing nothing but rising, and is putting more and more pressure on a fragile environment to build the whole system, in a more

thoughtful and sustainable way to do things. And so it's going to cost money, it's going to take effort, there has to be a price on carbon, we're going to have to think this through carefully. And the whole enterprise has been made fundamentally more difficult because Vladimir Putin has declared war on Ukraine. And war is a really, really, really big deal. Once war starts, it's very important to stop it, before it gathers momentum. The bad actors are very capable of creating grief for the good actors. You first have to decide, are we the good guys or are we the bad guys. And if we're the good guys, we want to feed and clothe the world. And we want to stop the global warming of the world. Russia is basically a huge oil and gas company. Russia Incorporated, has an interest in higher energy prices, conventional energy prices. I wish they could go back to the Russia there two years ago, when everything was great. The Russian oligarchs were happy. You know, the women were beautiful, and they were enjoying the south of France. Everything was fine.

But now Russia has gone back to about 1992. We think that the whole society is inevitably in a state of slow collapse. They're not acting in a very responsible way and they're driving up energy prices, which is driving up the price of food globally. And hundreds of millions of people are at risk of starvation and less nutrition is an indirect result of just the Ukrainian war. And yes, it is a war. It is not a special military operation or whatever the hell he's calling it. It's a war. Call it for what it is. And so, you know, the ultimate ESG issue is Russia and until that conflict is over and stopped. We don't even start the rebuilding of Ukraine where 40 million people need heat and housing and light. The whole country has been destroyed. So we need more copper metal, we need more zinc, we need more nickel, we need more cobalt, we need more scandium, vanadium, niobium... There's a number of metal we need to green the world economy, to find a better way to feed and clothe humanity. And it's an enormous, monumental undertaking. It's the largest undertaking humanity has ever attempted. And how do we... I am talking about energy transition those two famous words again. The energy transition is the largest undertaking ever attempted by humanity. It takes millions of individual steps. It's not me, or you're just dreaming up the answer. We can conceptualize it. We can see the basic direction we have to go. Hopefully the capital markets will direct capital in the wrong direction. We don't need more streamers. Netflix has been financed, Google has been financed. Now, we need more capital investment in basic human needs. In water, in fertilizer, in food, in metal. It's the revenge of the old economy and the old economy has to be fed and cared for in order to have a new economy. So, you know, Bloomberg Network has the new economy forum. I've been going to that forum and speaking. The most recent one was in Singapore, it's some of the smartest, most intelligent people in the world, talking about how are we going to get to what is defined as a new economy. An economy that does not depend on the burning of coal, an economy that does not depend on the burning of crude oil, and the Saudis are part of the solution and not part of the problem. The message I'm trying to tell you is they're working on unconventional LNG, unconventional gas, hydrocarbon transmission of hydrogen as ammonia, or synthetic methane. There's a lot of people at work and a lot of potential solutions. But all of them are metals intensive. There is no solution to humanity's dilemma that is not extremely intensive of critical metals.

**Erik:** If we saw cooperation from government, support from government and so forth, is the global middle and mining industry able to scale up to produce the amount of copper and other

metals that are needed for this transition in anything close? Let's say you got a call tomorrow and says congratulations Robert! We are so impressed with you on MacroVoices that we want to give Ivanhoe the contract for producing all of the copper needed in order to support this whole transition you just talked about and we want to get to net zero by 2050. We need the copper delivered in half of that time. So you got 15 years to deliver every single ounce of copper needed to accomplish all the things you just described. Can the global copper industry produce and deliver that much metal in that much time?

**Robert:** You know, we have an expression Erik in Canada, the sharp end of the stick is very pointed. I think I know every major CEO in the mining business personally. And when we get together we all look at each other and we just can't figure out where this metal is going to come from at the scale humanity requires it. We can't go mining in Russia. We can't go mining in Ukraine. We can't get title and go mining in China or Tibet. We can't mine where there's a tropical rainforest. BHP and Vale had a very terrible tailings dam disaster. So wherever it rains more than it evaporates. In the sensitive tropical environment, we can't go mining. The banks don't want to finance it. Most of Latin America is becoming very unstable. Chile is now run by a 35 year old young communist who is sort of great guy I guess. I think he'd like to have a better world but all of Latin America is swimming to the left. Peru is in a near civil war. It's very unstable. Venezuela and Colombia have gone to the left. Lula is running Brazil. Most of Latin America is largely uninvestable at the scale you need to build copper mines. Copper mines cost 10s of billions of dollars. First Quantum is in Panama and the Panamanian government is playing hardball with First Quantum on a \$10 billion investment. So resource nationalism, which is spreading virally as governments get greedy. They want to create consortiums around lithium, or nickel, or copper, or oil. The OPEC reflex makes it even harder.

So the mining industry is unfairly treated, unfairly judged and is going to have tremendous difficulty rising to the occasion. The industry is making great strides in their ESG governance and the way the industry is going but it has to go to challenging environments. Mining companies don't get to choose where they go mining. They have to go mining where the metal actually exist. In a lot of cases, these are underdeveloped societies, challenged societies. There might be countries where you don't have you know the optimal rule of law. And so we face very, very difficult questions of how we're going to get there on metal demand. Same thing applies for food and water and all human essentials. That's why it's so disappointing that the mentality of the war in Ukraine is so much like the 1930s or reminds me of the early years between World War Two. It's just, it's silly because I'm sure we could agree that Ukraine would be demilitarized as a buffer state, but it's an independent country. If people want their own country. Why should we threaten people with nuclear war? I mean, we actually had the Russian leadership threatened nuclear war over Ukraine. How absurd is that? That's crazy. Thank God that President Xi Jinping of China told Putin cool it man, we don't want nuclear war. The Chinese are calling for a dialogue, because there's just too many countries getting nuclear weapons. The Pakistanis have nuclear weapons, the Indians have nuclear weapons, the Israelis probably have nuclear weapons, North Korea's developing nuclear weapons. And we need to stop this slide towards ultra nationalism and the breakdown of the integrated world supply chain. Because

once everybody has their own vertically integrated supply chain, it's easier to go to war. We're unfortunately going in the wrong direction.

A globally integrated world supply chain was probably better for humanity. With China and America dependent on each other, they're less likely to engage in a war. So I'm very concerned that all of a sudden, the word genie came out at scale in Europe. It happened the last time since we spoke. And yet it's happening at a time when the existential challenge of taking on global warming caused for anthropomorphic reasons. Global warming, that is likely caused by human activity. I mean, there's only two kinds of global warming that can exist. One is global warming caused by God or nature, if you will. And the other is global warming caused by human beings. And you can't convince everybody in the world that human beings are causing the global warming, but I don't think we can afford to take the chance. If the chances that human beings are causing global warming. We have to we have to revolutionize the entire supply chain, and do it in a cleaner way. And our contribution, that's why the miners are the good guys, is to find the metal and it is going to be an incredibly difficult task. For the world mining industry to mine even another 700 million metric tons of copper. We're producing as an industry, not even 20 million tonnes a year. If we need 700 million tonnes in the next 20 years, 30-35 million tonnes. We have a huge shortage of copper metal facing us, by the end of the next decade, say 5-10 years from now.

We need a lot more capital, we need a lot more technology, we need host governments that welcome the idea and recently the United States has been going in the wrong direction. The major mines in the United States are not getting built. No one has attempted building a tier one copper mine in the United States in a generation or more. And so America needs mining, Canada needs mining, Australia needs mining, Europe needs mining, Africa needs mining, Latin America needs mining. Mining what? Mining the metals we need to have an energy transition. You know, I've started talking about the energy transition years ago, and a number of financial commentators are starting to drink my Kool Aid. I've been warning people about this for years. But now I'm saying when you add war to the equation, you're making it even harder because every shell, every cannon, every new killer submarine, every warship, every tank, every army is metals intensive. And that is stealing or creating additional metals demand that we need for the greening of the world economy. That's my point. I hope that point comes through into everybody's cerebral cortex as these electrons go through space through a podcast.

**Erik:** Robert, I can't thank you enough for a terrific interview. It's always a pleasure to talk to you. Before I let you go though, I want to come back to I-Pulse for the benefit of some of our listeners who are probably wondering how to invest in it. I'm used to telling our listeners will some of these things are for retail and some are only for our institutional listeners. This one is not just for institutional listeners, it's more like sovereign wealth funds. So what's the minimum investment to to get into I-Pulse which is still a private company and for the retail and everybody else, what's the timeframe for when this thing is going to go public where everybody can get a piece of it?

**Robert:** One of our spin off companies is already on the New York Stock Exchange. It's called Ivanhoe Electric. Ivan Electric is developing a new age copper mine in Arizona. It will be a very green copper mine. It will primarily be developed with solar power. It will run with extremely low energy consumption and very low global warming gas. It's in the early stages of engineering. It's also looking at other metals projects in the United States using technology developed by the parent company I-Pulse. I-Pulse is a private American unicorn. We recently announced an investment by BHP which is the largest mining company in the world. We will take additional strategic investors in I-Pulse. We became a unicorn five years ago and perhaps in the next few years, we will pursue a listing in the public equity markets. Right now, we're talking only to strategic investors that can invest large sums of money for a considerable period of time to help change the world. It is effectively our own Breakthrough Energy Ventures. Breakthrough Energy Ventures is on a funding model organized by Bill Gates and my hat is off to them. They're doing great work funding high risk, early stage ventures that can Green the world economy and one of their investments was in one of the subsidiaries of I-Pulse. It's called I-Rocks, it's a company that is revolutionizing a new way to crush and grind rock, which is currently generating about 4% of the world's total generation of global warming gas. I-Pulse itself for world class financial institution, for sovereign wealth funds, for major corporations, we have a website. You can go there and read about it at [www.ipulse-group.com](http://www.ipulse-group.com). We didn't have a website for about 18 years. We've been funded as to about 50% of our research and development costs by the government of France, because our research development arm is in Toulouse, France near Airbus. And we'll be talking a lot more about it in the next few years if it becomes a public company.

We are commercializing a plethora of applications and a third fundamental way to use electrical energy but besides direct current and alternating current. And that way to use electrical energy is pulse power. We concentrate small amounts of energy into very powerful bursts of power with super capacitors, military grade capacitors, capacitors that heretofore had been reserved only for strategic weaponry. This is an inherently a very efficient way to use electrical energy. We can generate electromagnetic waves, we can generate shock waves and with those electromagnetic waves and shock waves, we could do useful work and manufacturing in finding metals and finding water. And the technology is inherently hyper green because it uses extremely small amounts of energy to create very large amounts of power. Energy and power in physics are two entirely different things. It's disruptive technology and so I'm inherently an optimist. Working with plasma physicists, we think, you know, we can build a better world for our kids and our grandkids. But it's not a two year project. It's a very difficult profound undertaking. And it's going to take 20 Bill Gates's and 20 Elon Musk's and 20 Jeff Bezos pursuing technological dreams, the only way out of the mess we've created for humanity is to get it to bring a world at peace, and to bring a world with fundamental technological improvement and all of us are just trying to do our part. So in the future, we'll be able to tell you a lot more about I-Pulse.

But you can read about it just go to that website. And there's a little introduction there for the people that are listening to this telecast. And if any of you are interested in following my thinking, I'm at [@Robert\\_Ivanhoe](https://twitter.com/Robert_Ivanhoe) on Twitter and [Ivanhoe Mines](https://twitter.com/IvanhoeMines) is also on Twitter. And you can also follow Ivanhoe Mines quite easily on Twitter. And we are talking to people in the United States



Department of Energy. We're talking to Washington D.C. We've taken investment for the European Economic Community. We've taken investment from Bill Gates, we've taken an investment from BHP and we have many others and so we're just doing our thing. We grew up on the wrong side of the tracks in the mining industry. Now, the world is realizing that it's the revenge of the miners. You need us to make the metals you need. If any of your listeners are guilty of buying an iPhone, or buying an iWatch, or an iPad, or a computer. You're consuming our goods. A modern iPhone uses scores of elements in the periodic table, all of which have to be min. I like it that Elon Musk pointed out that most of us are already cyborgs. We're so addicted to our headphones, and our 5g wireless, we have become cyborgs already. So, since we can't break the addiction to the handphone, and we can't break the addiction to social media, and we can't break the addiction to servers and electrons. We better work together to generate peace. And we better work together to develop a global community that worries about the fundamental challenges we face as a species. Water, food, fertilizer, peace, communication, and some understanding of the other because I'm violently opposed to just objectifying people that are different from us. We need to work together globally to solve this problem, or we won't get there from here. And podcasts like yours are critically important to wake people up in how difficult this all is. So thank you for that Erik.

**Erik:** Well Robert, I look forward to getting you back for an update in a few months. Patrick Ceresna, Nick Galarnyk, and I will be back as [MacroVoices](#) continues right after this.