The Great Simplification

[00:00:00] **Nate Hagens:** You're listening to The Great Simplification with Nate Hagens, that's me. On this show, we try to explore and simplify what's happening with energy, the economy, the environment, 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.

[00:00:33] **Nate Hagens:** There's kind of a general recognition that diesel is somehow important to our lives, or it's the name of an actor in a Pulp Fiction movie. The reality is that we assume that oil equals gasoline, but oil equals far more than gasoline, and each barrel of oil requires a certain sequence of when the different products are distilled off.

[00:00:59] **Nate Hagens:** With me today for a second conversation on The Great Simplification is my colleague, Art Berman, who is a petroleum geologist who's going to explain the importance of refining and other products than gasoline in a barrel of oil, what this means for the future, why we are currently having a diesel shortage and higher prices, especially in the East coast, and what this all means for the future.

[00:01:27] **Nate Hagens:** Please welcome Art Berman.

[00:01:41] **Nate Hagens:** Hello my friend. Art.

[00:01:43] **Art Berman:** Hey Nate, how you doing?

[00:01:44] **Nate Hagens:** I'm good. How are you sir?

[00:01:46] **Art Berman:** I'm doing very well, thanks.

[00:01:49] **Nate Hagens:** So you and I, I've never thought about this, but we've probably been parties to 10,000 emails in our little group over the last decade. As you know, the first podcast I did with you was in January and since then, some large energy relevant world events have happened, and so a lot more people are becoming less energy blind as a result of the NATO Russia situation.

[00:02:21] **Nate Hagens:** And so there's a lot of things that we could talk about and I expect we will talk about in the future. But let's take it one topic at a time. There's been a lot of information in the news about diesel fuel and some of the shortages of various fuels in Europe and so on. Our first discussion, which I hope everyone can go back and listen to, and you did a very helpful PowerPoint that was attached to it.

[00:02:49] **Nate Hagens:** We talked about what is oil, where does it come from, how much is left, the relationship to our economic system. Today, I would like to cover What do we get from oil? And I think there's a common assumption in our society that, "Oh, we get oil out of the ground to create gasoline." And that is true, but that is just a tiny part of a much more complex puzzle, which with your help today, we can unpack for our listeners.

[00:03:20] **Nate Hagens:** So let's start there. Do you have any comments to that brief intro?

[00:03:26] **Art Berman:** Yeah, sure. No, I think you are absolutely on the right track. First of all I fully agree that the world is becoming more energy aware. And by that, I think we both mean that, whereas say a year ago, or, you know, 10 months ago you talk about energy and people didn't really think about it all that much in their lives.

[00:03:48] **Art Berman:** You know, if a gallon of gas costs more than they're used to, okay, that's a drag and they'll complain about it. But I think that the events of the last several months, certainly since the Ukraine invasion, have heightened the world's sensitivity to the fact that energy is really important. The inflation that's affected the world is due largely to the cost of energy.

[00:04:12] **Art Berman:** That's not the only source, but it's the biggest one in my view. And people are slowly starting to make that connection. But, and the big but is that the rest of it is understandably just kind of a black box for people. You know, you mention gasoline costs too much and I don't use diesel, but I guess it's a big deal.

[00:04:35] **Art Berman:** And I don't think people really understand where all that comes from, what has to happen to get it. And nor do I expect them to understand it. And you and I know each other well. And I'm a geologist. I'm a petroleum geologist. I'm not a chemical engineer, chemical engineers are the guys that design and run refineries.

[00:04:55] **Art Berman:** I'm not a refinery expert. I know a fair amount about it. And maybe that's perfect for the people who listen to your podcast, because I don't know enough to get everybody too confused about isomers and polymers and alkaloids and you know, let's keep it simple.

[00:05:13] **Art Berman:** But I think there's a huge amount of information that should cause people to say, "Oh, okay, I never knew that before." And that's my hope.

[00:05:25] **Nate Hagens:** And that's what we're after. And I'm less concerned about forecasting oil and gas, price movements or imports and exports in the next six months or anything like that.

[00:05:36] **Nate Hagens:** I'm trying to get a lot more people to understand the energy landscape so that we can make better intermediate than long term decisions. So let's just start with diesel. What is diesel? Why is it important, and why is it in the news?

[00:05:54] **Art Berman:** Diesel is one of the many refined products that are created from a barrel of oil.

[00:06:02] **Art Berman:** And in the United States we have a culture, a society that runs a whole lot more on gasoline than it does on diesel. That's not the case for most of the world. There are a lot of reasons for that. But let me just keep it simple and say that in the end, Diesel is cheaper to use, and

it's more diverse in its uses. So diesel's important because it literally is the hemoglobin of the world economy.

[00:06:32] **Nate Hagens:** I often say that gasoline is the hemoglobin of the world economy, but to be technically correct, gasoline is the hemoglobin of the consumer economy. Diesel's, probably the hemoglobin of the actual industrial transportation systems and the heavy lifting of the world economy.

[00:06:48] **Art Berman:** Yes. And consumers you know, you and me and everybody else when we order products, most of those come to us in some fashion thanks to diesel. So diesel is the primary fuel that runs mines, oil rigs, all of the extractive operations that get the raw materials out of the earth and into our grubby little human hands.

[00:07:16] **Art Berman:** It is the primary fuel that runs ships, trains, and trucks, which are the main way of moving those natural resources from where they come out of the ground to where they can be converted into products it goes back into those same forms of transport to distribute it to the rest of the world.

[00:07:39] **Art Berman:** You know, just to use an example we want steel. And so we may iron, or let's just say in South America using diesel powered equipment. We put it on a ship which uses diesel. We send it to say China. China manufactures it into steel from iron. An awful lot of that process uses fossil fuels.

[00:08:01] **Art Berman:** They put the finished product on a boat, send it say, to the United States by diesel. It gets picked up, say, in the port of Los Angeles, either by a truck or a train, and it goes out to its consumers of whatever that steel product is by diesel. So by the time it finally arrives you know, I might put it in my gasoline powered car if I bought a, you know, a steel pipe at, you know, at Home Depot or whatever.

[00:08:29] **Art Berman:** Everything that led up to it is principally diesel.

[00:08:35] **Nate Hagens:** So one clarification in what you said, and then I have a bunch of questions. I am not a consumer. I am a human. But other than that was a good description and can't we just use gasoline to replace that diesel? Why? Why do we have to use diesel for all those things that you mentioned?

[00:08:53] **Art Berman:** Well put most simply, it's first of all, because all of the equipment that uses diesel is designed for it. So let's just say it was a coin toss. You know, you could use either gasoline or diesel. Somebody made a decision 30, 40, 50 years ago that we're gonna use diesel. So even if it were a bad decision, and it wasn't by the way, I'll get to that in a second.

[00:09:17] **Art Berman:** If we decided that we wanted to change, we'd basically have to scrap all of the equipment that runs our transportation and mining system, or retrofitted or something.

[00:09:29] **Nate Hagens:** Which is probably tens of trillions of dollars of equipment or something in that magnitude and decades of time.

[00:09:34] **Art Berman:** And not to mention a big waste of material.

[00:09:38] **Art Berman:** But the reason that diesel was chosen over gasoline way back when is because it's a more energy compact form of fuel that it can, you know, to, to use the cliche, it has more bang for the buck. So it's more energy dense. It has more energy per cubic meter than gasoline.

[00:10:01] **Art Berman:** So we, you know, it's a more productive fuel and it runs more efficiently, so it costs less, the fuel itself. Costs more per gallon or per liter or whatever you're talking about than gasoline, but it runs so much more efficiently that in the end you end up saving a lot of money. So that was why 30, 40, 50 years ago, the decision was made.

[00:10:25] **Art Berman:** Let's use diesel for all this equipment.

[00:10:28] **Nate Hagens:** But if that was true and this is gonna get to a core part of the topic we're gonna discuss today. If that were true 30 or 40 years ago, why didn't we run all of our vehicles on diesel instead of gasoline?

[00:10:44] **Art Berman:** Well in a lot of the world, they do run most of their vehicles on, on diesel instead of gasoline.

[00:10:51] **Art Berman:** But here in the United States where the automobile started, was invented for that matter, we have a peculiar kind of oil it's called a light oil, and we'll talk a little bit more about why that's but for right now, let's just say our oil is light and it lends itself to manufacturing gasoline.

[00:11:13] **Art Berman:** It's a very easy, quick step to go from US oil into gasoline and let's go. In time and think about what was going on in the early 1900s. So Henry Ford is, you know, trying to commercialize an automobile and the first you know, model A or whatever it was actually ran on ethanol.

[00:11:35] **Art Berman:** It ran on alcohol. And that was for a variety of reasons, but just about the time that automobiles or internal combustion engines were being thought through. Also in Europe actually a little earlier in Europe, there was this huge discovery of oil just north of where I'm sitting here in Houston at a place called Spindletop.

[00:11:56] **Art Berman:** Most of the oil produced in the United States or in the world up until that time came from kind of crappy little wells that produced a couple of barrels of oil a day. And people were smart and they said, Well, you know, gosh, oil would be nice, you know, we could use some distilled form of it, but you know, we don't get the volumes.

[00:12:18] **Art Berman:** And this discovery at Spindletop, it blew out millions and millions of barrels a day. And the whole world said, Oh my God we had no idea that you could get volumes like that. If we can get volumes like that, then let's rethink this whole ethanol formula. Let's use oil.

[00:12:38] **Art Berman:** Another historical fact that's interesting is that up until that time, until the automobile, the main use of oil was for kerosene, for lighting, Okay. John D Rockefeller and his standard oil empire, I'm, you know I'm a little concerned about what they did with all the products that come out of a distillation tower before you get to kerosene.

[00:13:03] **Art Berman:** But I'm guessing they just dumped it on the ground or burned it because kerosene was the product Americans demanded for lighting.

[00:13:10] **Nate Hagens:** So there's so many questions that I want to ask you. I mean, I've spent 20 years researching energy and its importance to our society. But I know very little about the processing.

[00:13:23] **Nate Hagens:** And I think most people just assume, "Oh, there's oil in the world and it's pretty uniform and we turn it into gasoline and a few other things." So was the oil that we had at Spindletop also relative to the rest of the world, light oil and what are the differences in oil and in the salient differences around the world without getting too much in the weeds?

[00:13:48] **Art Berman:** Sure. Let's just say for argument's sake that all oil in the world is essentially the same. Okay? It's not. But for this high level conversation, let's say that it is. And so what determines whether an oil is light or heavy, its density basically is how deeply it was buried and to what temperatures it was exposed to.

[00:14:16] **Art Berman:** So think about the earth as a kitchen and you know you've got all kinds of dead algae plankton that settled to the bottom of the ocean, got buried and went deeper and deeper into the earth. And the organic matter that made up their bodies and their cells is slowly converted into oil. And to the extent that oil is less cooked, it's gonna have more of the heavy parts that make heavy oil.

[00:14:47] **Art Berman:** And the more and more you cook it, the more and more it changes its form and becomes lighter and lighter. And when Rockefeller wanted to make kerosene he didn't go to Texas, he found a field on the Ohio, Indiana border, which was very shallow and just happened to be relatively heavy oil. So the United States is not exclusively light oil, but predominantly it is.

[00:15:17] **Art Berman:** And so Rockefeller happened to intentionally find some heavy oil so he could get the kerosene out of it. Now the oil at Spindletop would be fairly useless for kerosene because it was buried more deeply, exposed to more heat and more pressure, and all those heavies, the heavy parts of the petroleum molecule were essentially burned off.

[00:15:43] **Art Berman:** They were naturally distilled off. And so the oil at Spindletop, and of course I'm generalizing hugely here, but is mainly a gasoline prone kind of an oil, and so you can't really make very much or very good diesel or kerosene outta Spindletop oil.

[00:16:04] **Nate Hagens:** We have a lot of oil refineries in the world and in the United States.

[00:16:08] **Nate Hagens:** So what you're saying is the oil refineries kind of accelerate the processes of pressure and time that mother nature did over millions and tens of millions of years to create lighter or heavier oil and the various things that are distilled from it.

[00:16:26] **Art Berman:** Yeah, I mean what happens in a refinery it looks a lot like an alcohol still. Instead of putting in corn and water, you put in crude oil and you heat it up and when you heat it up, the light stuff comes off first.

[00:16:42] **Nate Hagens:** And what's the lightest, What is the light stuff?

[00:16:45] **Art Berman:** The light stuff is gonna be natural gas and natural gas liquids. Okay. Things like propane and butane. You know, when you go out and buy a lighter to start your charcoal grill, or if you smoke cigarettes, a cigarette lighter, that's butane. If you heat your house, if you live in the country and you don't have a pipeline to your house to deliver natural gas, you buy a tank of propane.

[00:17:08] **Art Berman:** Okay?

[00:17:08] **Nate Hagens:** Propane is, that's how I heat my house. Propane.

[00:17:11] **Art Berman:** So propane is just one step heavier than butane, which is one step heavier than methane, which is natural gas.

[00:17:20] **Nate Hagens:** So we have a refinery, which is like an alcohol still, and the inputs is a barrel of crude oil, which obviously for a US refinery, it optimally would be US oil because it's close and we don't have to import it and we heat it up.

[00:17:37] **Nate Hagens:** And to what temperature are we talking about roughly?

[00:17:41] **Art Berman:** We're talking about hundreds of degrees. And let me step back and say, actually not most of the oil that goes into US refineries are, let's just say, you know, at least half is not from the United States because the United States oil doesn't have the necessary components to make the cash products that the world wants, like diesel, kerosene, jet fuel, et cetera.

[00:18:08] **Art Berman:** That's the reason that the US imports oil. Because our oil isn't right for what the world needs. It's right for some of what the world needs, but not the rest of it.

[00:18:19] **Nate Hagens:** So we're an energy lauderer.

[00:18:22] **Art Berman:** We are an energy launderer. That's correct. That's right.

[00:18:26] **Nate Hagens:** So it's heated to hundreds of degrees, naive non per person who got C's in college chemistry, why doesn't it explode if it's gasoline and butane and propane? There's no oxygen in there or...

[00:18:41] **Art Berman:** Yeah, it's contained in a pressure vault. It's maintained at a pressure in which and you're right, there's no oxygen. So any kind of volatile reaction is not able to take place.

[00:18:54] **Art Berman:** But talking about those temperatures we're talking about, if you want diesel you're talking about something like 400 degrees centigrade.

[00:19:02] **Nate Hagens:** Let's start at the top and go down the entire barrel. If you're willing, I think this is important to understand.

[00:19:09] **Nate Hagens:** So we put in a barrel of oil well, thousands of barrels or whatever in the mix, and we're probably importing a different sort of oil to combine with our light more cooked oil that's in the United States into some of these big refineries all over the nation, but a lot of them are in the area where you live in Texas and Louisiana, and at a lower temperature, the whole barrel is being cooked.

[00:19:34] **Art Berman:** Right.

[00:19:35] **Nate Hagens:** But at a lower temperatures, like 150 degrees Celsius or something like that, the lighter fractions are boiled off or distilled off. And you said that is butane and propane. And then what comes after.

[00:19:51] **Art Berman:** Gasoline. So gasoline is, you know I mean so oil is just a chain of molecules that have a carbon center with various hydrogens around the outside. And so natural gas methane is the simplest. It's got a carbon in the middle of four hydrogens, so it's CH4. Okay. And then you can, you know, you start doing, even though I wasn't terribly good at math either. I mean, you can do the arithmetic, C2H8 and so it's just a very simple step that the lightest stuff comes off first because it has a lower boiling point, if you will.

[00:20:34] **Art Berman:** I mean, it's kind of what we're talking about here. But butane has got a few more carbons and a few more hydrogens than methane. Propanes got a few more than butane. There's a bunch of other stuff that there's Heptane and Octane and all that.

[00:20:54] **Nate Hagens:** What are those used for?

[00:20:54] **Art Berman:** Those are used for similar, they're flammable substances that are used for different kinds of fuels also. But they're, you know they're a little bit more, I mean we don't consume them ourselves. They're mostly used as feed stocks for other petrochemical processes.

[00:21:12] **Nate Hagens:** Okay, so creation of plastic bags and medicines and football helmets and things.

[00:21:17] **Art Berman:** Yeah. Yeah. So I mean, yeah like baggies and, you know, all the plastic that we use come from these natural gas liquids that come off before gasoline.

[00:21:30] **Nate Hagens:** So the heavy type, I mean, the light type of oil that we have in the United States is good for those plastic product precursors.

[00:21:37] **Art Berman:** It's great. Absolutely great.

[00:21:39] **Nate Hagens:** Yeah. Okay. So precursors, plastic, octane, things like that. Then propane and butane, then gasoline. And at this point how much of the barrel of oil is left rough?

[00:21:52] **Art Berman:** Oh probably 80%. So yeah, so we're talking about yeah, so I mean, roughly speaking, something a little bit less than half of a barrel is gasoline. And 20% is diesel. And then the various natural gas liquids, those are about 15%. So we take off the 15% right away, and we've got 85% left to play with.

[00:22:19] **Nate Hagens:** But 40 to 50% of it is gasoline.

[00:22:24] **Art Berman:** Yeah. Yeah. Okay. It is.

[00:22:26] **Nate Hagens:** And then 20% is, So what comes after gasoline?

[00:22:29] **Art Berman:** After gasoline comes diesel, so gasoline comes off first, kerosene jet comes off next, and then diesel, and then, heating oil, Fuel oil.

[00:22:40] **Nate Hagens:** Oh, yeah. Well, in preparing for this podcast, I'm actually learning some of these things. So what is kerosene used for currently? The same lighting and lamps and such, or,

[00:22:52] **Art Berman:** Well, not so much kerosene. I mean, the words kerosene and jet are usually hyphenated.

[00:22:59] **Art Berman:** Okay. Because they're not exactly the same, but they're, their principle use as far as humans, as consumers are concerned, is for aviation fuel. That's the main use.

[00:23:11] **Nate Hagens:** Okay. So gasoline, then kerosene, jet, then diesel fuel. Right. And diesel is also called distillate and it also functions as heating oil, for example, on the east coast of the United States. Very prevalent.

[00:23:25] **Art Berman:** Yeah. Well, I mean, heating oil technically is actually a little bit heavier there. There's a fair amount of overlap between kerosene, jet, diesel, and fuel oil. It's a spectrum of which kerosene is the bottom and fuel oils are the top.

[00:23:39] **Nate Hagens:** Okay. And fuel oil is for ships and such.

[00:23:43] **Art Berman:** It's used for ships, you know, and again, like ships are required to shift to a lighter type of distillate, when they're within territorial waters for environmental reasons, they get outside-

[00:23:58] **Nate Hagens:** Because the heavier stuff is more polluting?

[00:24:00] **Art Berman:** Exactly. So the heavier stuff is what you'll hear, it's called bunker fuel. Don't ask me why. Okay. So when you're within the territorial waters of a country like the United States or Europe, where they have concerns about emissions and air pollution the ships are required to use a lighter form of distillate that doesn't pollute when they get out to sea, they can do what they want. Although just to cover that and complete it the Marine community got together a couple of years ago in 2020 and said, "All right, you know, we need to regulate more carefully what we burn at sea." And so a tremendous effort was made to lower the sulfur that was emitted and to basically clean up the act when it's at sea.

[00:24:49] **Art Berman:** But still, there's, you know, there is a double standard.

[00:24:51] **Nate Hagens:** Octane, chemical precursors, butane, propane, gasoline, kerosene, jet diesel, fuel, oil, what's left after all that? Just some really heavy gook?

[00:25:04] **Art Berman:** Heavy gook, which is used to pave our our roads, asphalt, various kinds of lubricants. You know when you lubricate your bearings, I mean, if you've ever looked at the stuff that comes out of that tube, I mean, it's, I mean it's thick and pasty.

[00:25:19] **Art Berman:** I mean, it doesn't look anything like oil. And then there are things called paraffins which are very -- they almost look like wax. And they're used for, well, I mean when you want to keep mosquitoes out of your yard when you're having a barbecue, you might put some kind of a thing that looks like a candle into something on a pole, and you light it. And that's paraffin. So yeah, by the time you get to the bottom of the distillation tower, I mean, you're basically talking about tar. I mean, that's what it looks like. It's black, gooey tar.

[00:25:52] **Nate Hagens:** So in the same way, well, not in the same way, in a very different way, but the same metaphor that Native Americans used every part of a buffalo, current Americans use every part of a barrel of oil, it seems.

[00:26:03] **Art Berman:** We do. Yeah. Cuz it's all, it all contains energy.

[00:26:06] **Nate Hagens:** So this is a tangent. But we've emailed about this before. The whole electric car battery emission story, you know, that's a topic for another day, but in each barrel of oil is the roads that the electric or regular cars will drive on.

[00:26:29] **Nate Hagens:** And how in the heck will the world create roads if we don't have the bottom 10 percent of the sludgy asphalt from every barrel of oil that is the leftover, which we use to not only create roads, but to maintain and repair them. I've just went on a bike ride today and someone just smoothed out the asphalt which without it I would've had a bumpy ride.

[00:26:57] **Nate Hagens:** Are there, is this a topic? I don't even remember hearing or reading about how we're gonna replace asphalt if we have to go fossil free.

[00:27:08] **Art Berman:** Yeah. These are some of the details that somehow often get left out of the story because we, the public, are assumed to be energy blind. And maybe the politicians who, you know, who spin these stories are nearly as energy blind as the public that they're speaking to.

[00:27:28] **Art Berman:** But, you know if you read our you know our mutual friend, Vaslav Smil who, for anyone who wants to get a little bit more deeply into energy than we're talking about right now, the guy's written-

[00:27:42] **Nate Hagens:** That guy writes as many books as I have podcasts. But go on.

[00:27:45] **Art Berman:** The guy's, he's amazing. He's written 40 books, right?

[00:27:48] **Nate Hagens:** I keep pestering them to be on this show. And eventually I think he'll crack, but he's like, I'm too busy writing books, Nate, I don't wanna do any interviews. But go on art.

[00:27:56] **Art Berman:** So you know, he says that the four pillars of modern civilization are plastic, steel, cement, and fertilizer, all four of which require petroleum.

[00:28:14] **Nate Hagens:** How does cement require petro?

[00:28:17] **Art Berman:** Well, you've got to extract the materials. I mean, if you've ever, you know, if you've ever seen a sidewalk that's broken or somehow cut, you'll notice that it's full of rocks, right? And so the cement making process is very energy intensive that you have to extract, just like you extract iron or from a mine in South America, or you extract oil from deep in the subsurface.

[00:28:44] **Art Berman:** All of the operations that go into getting the materials and assembling them for cement require fossil fuels. So you got plastics that come from oil and natural gas liquids. You've got steel which has to be extracted, the iron has to be extracted, it has to be transported, it has to be heated at very high temperatures, usually using coal.

[00:29:14] **Art Berman:** We don't really have a very good way. I mean we could theoretically smelt metals using electricity, but it would be unbelievably complicated, super expensive, and we're just not, we're not engineered to do that at this time. So steel and fertilizer is something that most people don't even think about very much.

[00:29:38] **Art Berman:** But I mean, most of the reasons that we have nearly 8 billion people on planet Earth today is solely because of fertilizer, which is made from petroleum. So at the end of World War I, the world population was a little bit more than 2 billion people. And without fertilizer, it would've stayed at about two, 2.2, 2.3 billion people because the planet couldn't feed more than two or 2.3 or four billion people. But a couple of German guys figured out how to liquefy air under great pressure and temperature, which provided the source of nitrogen needed to create fertilizer. I mean, humans have known how to make fertilizer forever. We just didn't have enough free nitrogen on planet Earth to do it until Haber and Bosch came along, figured this out, and all of a sudden we could fertilize the world and we could start growing the population because fertilizer expanded the productivity of the soil.

[00:30:43] **Art Berman:** And so most of the problems that we have on planet Earth today, in my opinion, are because we got too many people, and we got too many people because of fertilizer. But you can't do fertilizer without petroleum, mostly hydrogen from natural gas, other fossil energy. So those are Smil's four pillars of modern civilization.

[00:31:07] **Art Berman:** And I mean, I'm as sympathetic as I know you are to people that put the environment first. And I think you do, and I do, but when they talk about, well, let's just get off of fossil fuels, they're cutting the pillars off of the four elements that uphold modern civilization. You know, it's okay if you want to do that, but it's got real consequences.

[00:31:35] **Art Berman:** I mean, you're bringing down the civilization that you want to keep. So you can't have it both ways.

[00:31:42] **Nate Hagens:** There are alternatives to many of these things, for instance, there's biodiesel, right? Can you talk about that for a moment?

[00:31:52] **Art Berman:** Yeah. So you can essentially synthesize the heavier components of diesel using things like soybeans and other agricultural products.

[00:32:05] **Art Berman:** Now it's not exactly the same, but it's similar enough that you can actually run a diesel engine off of it. Okay. That's what's called biodiesel. And people say, "Oh, well, you know, easy peasy. You know, let's just, let's stop using oil. Let's start making biodiesel." And I'm one of those who say, I wish it were true.

[00:32:25] **Art Berman:** And so what are the obstacles to biodiesel? Well, first and foremost, in my opinion, is that you're using a food product to create energy, which means that you're competing for food, which feeds human beings and animals and the rest of the planet. So it's the same argument there is with corn ethanol, exactly the same.

[00:32:52] **Art Berman:** So at the very least, you're making it more expensive to get food. And at the very worst, you're crowding certain people out of the food market because you wanna make energy with it. The biodiesel, it turns out, is not as energy dense as the diesel from petroleum. So it doesn't have the same level of efficiency.

[00:33:14] **Art Berman:** You have to put more energy in to get the same energy out, which is kind of inefficient. Turns out that it's for reasons I couldn't even begin to explain, it's tremendously corrosive. And so whereas you can put diesel into a pipeline and just pipe it all over the country, with biodiesel, you actually have to put it into a special truck that is sealed on the inside.

[00:33:39] **Art Berman:** So now you're using real diesel to transport biodiesel. Just as an aside, I read the other day about, now there's a kind of tanker ship used to transport coal that runs on wind. Okay. So we're using wind energy so we can move the world's worst polluting fossil energy around the world.

[00:34:02] **Art Berman:** I mean the irony there is just exquisite, I think. But so the transport part of it is a problem. And it also turns out that it's corrosive to the engine when you put it in. So I'm not trying to make a case against biodiesel. I'm simply trying to say that, you know your premise was, well, aren't there alternatives?

[00:34:20] **Art Berman:** And yes, there are alternatives and none of those alternatives, at least purely from the standpoint of efficiency, can compete with the real thing, with diesel.

[00:34:33] **Nate Hagens:** And it's the same for many of the other alternatives. We can over build solar and wind and, via hydrolysis, create fake fossil fuels, CH four and other things.

[00:34:46] **Nate Hagens:** That could be chemical precursors for some of the other things on your list, but that is massively more expensive and complicated than the current refined stuff that we're pulling out of the ground and just turn it into this distillation to create all these products.

[00:35:06] **Nate Hagens:** You know, one of the things that I increasingly point out to people is all these technological answers to our energy and environmental situation, these newfangled tech that creates alternative energy. All of these plans are predicated on this 200 year history of more and more energy available to humans every single year, with the exception of financial crises, covid and a few big recessions. Every single year we've had more access as a species to energy, and I think that also blinds us to the potential of technological fixes to this because at some point we're gonna have less energy every year.

[00:35:53] **Nate Hagens:** And so what does technology do for us then, when we have a declining amount of access to energy every year? So that's something that I think about.

[00:36:05] **Art Berman:** Well and it's an important thing. So it's not just, it's not just availability of energy. It's the cost of that energy. And I mean, energy costs go up and down as everyone who pays any attention knows, but the unfortunate truth is that energy kept getting cheaper and cheaper up until around the beginning of the century, and it's been getting more and more expensive ever since then. And so all these technological fixes were based on an assumption of not only abundance but cheap, and the cheap went away, and the abundance is on its way out as you point out.

[00:36:45] **Art Berman:** And hopefully one of the things the world is starting to awaken to with what's happening today is it's getting really expensive and all the money in the world can't necessarily get it all to the right place at the right time. So maybe there's beginning, you know, all the supply chain issues that, that everyone is frustrated by.

[00:37:08] **Art Berman:** I mean, that wasn't something anybody, well, I wouldn't say anybody, but that wasn't something the average person thought about. Two or three years ago now everybody's aware of it, and that's a good thing. And my point is that all of these alternatives to say diesel, aside from their cost and et cetera, et cetera, they're not without environmental consequences.

[00:37:31] **Art Berman:** And that's something that somehow doesn't come across when we're being pitched on green products. And again I'm not trying to in any way dissuade people from using, you know, more environmentally sound practices and products, but everything has a consequence.

[00:37:52] **Nate Hagens:** So as you were speaking lots of thoughts are rolling through my head.

[00:37:57] **Nate Hagens:** Let's get back to the different fractions that are distilled off from a barrel of oil. If we were headed to a world, let's just say hypothetically that there was a diesel shortage and we had this machinery around the world and we needed to have X amount of diesel, but at the same time we had switched to electric cars or people didn't drive as much because there was public transportation, In order to get to the diesel, in order to produce diesel, we need a certain amount of oil and we first need to burn off those fractions that are lighter than diesel, and gasoline is one of those, and gasoline is 40 to 50% of the volume of a barrel of oil. So you can't just say, Oh, I need this asphalt, or, Oh, I need this diesel. The only thing you could say is, Oh, I need this octane or butane, and that's the first thing that comes off. Everything else, you have to burn off all this other stuff before you get to it.

[00:39:07] **Nate Hagens:** So this itself is a complexity problem in our global system. Yes? Well, what do you think about this?

[00:39:15] **Art Berman:** 100% true. It's a process, it's a sequential process. You can't get from A to D without going through B and C. And what you just said was that the b and c part of the process are like more than half of all the stuff that comes out of oil.

[00:39:36] **Art Berman:** So what are you gonna do with it? Let's just say you live in a world where nobody really needs very much gasoline. Okay, that's great, but you need the diesel. What are you gonna do with all that gasoline? Are you gonna, you know, are you gonna bury it in the ground? Are you gonna burn it? I mean, what are you gonna do with it?

[00:39:53] **Nate Hagens:** If we get off of internal combustion cars, we're still going to need the diesel machinery and the asphalt and the other products from a barrel of oil. So what do we do with it? Can we shift our refineries so that the gas, what's currently the gasoline, could actually be diesel? Or doesn't it work that way?

[00:40:16] **Art Berman:** The refineries don't work that way, but there is a process which is called reforming. And so it is possible to take gasoline and using some fairly intensive chemical processes, you can basically add carbon to it. So going back to where we started all oil is carbon plus some hydrogens around it. And so the problem with the light parts of the distillation process and up through gasoline is there's not a whole lot of carbon in there, at least compared to the kerosene-jet, the diesel, and the fuel oil.

[00:40:54] **Art Berman:** So chemists know how to force more carbon into those compounds and then can essentially synthesize or they reform the lighter molecules back into heavier molecules.

[00:41:10] **Nate Hagens:** At a cost, at a big cost, probably?

[00:41:12] **Art Berman:** And there's a scaling problem too. I mean you can do it for relatively small volumes without that much difficulty. But if you're talking about, let's take half the gasoline or a quarter of the gasoline that we refine and let's turn it into something else. Whoa. I mean, now you're talking about two and a half million barrels a day of something just in the United States, a quarter of all the gasoline that now has to be reform into something else.

[00:41:43] **Art Berman:** And that's a scale that's, as far as I know, we're not set up for.

[00:41:48] **Nate Hagens:** So let's talk about US refineries for a moment. Do we have a problem with a mismatch between the type of oil supply and the eventual desired products going forward, because we have primarily light oil?

[00:42:05] **Art Berman:** No, not really. And that's because we live in a connected world, and so we take a lot of the light oil we produce and we export it. Okay. We're currently exporting--

[00:42:18] **Nate Hagens:** Because other countries have heavy oil and they want the light oil so they can get the butane and propane and other things.

[00:42:25] **Art Berman:** Yeah. And there are specialized refineries in parts of the world that are just geared toward gasoline. Okay. And such refineries actually exist in Europe. They're generally kind of

smaller refineries. They exist in Latin America, they exist in China. These are the teapots you hear about.

[00:42:43] **Art Berman:** Okay. So these countries, most other countries are a lot less gasoline driven, and, excuse the pun than the United States. Most other countries in the world use at least a third diesel, two-thirds gasoline, or 50 50. But they all use gasoline. I mean, automobiles that run on gasoline are all over the world.

[00:43:08] **Art Berman:** So there's always a need. It's just, we don't need it here. So we export three, 4 million barrels a day of light oil in the United States. So a lot of what we produce just goes somewhere else, and then we turn around and we import heavy oil. So you hear about this theater that goes on between the US presidents and the kings of Saudi Arabia.

[00:43:31] **Art Berman:** Well, what's that about? Well, it turns out that Saudi Arabia has just the perfect oil that you can just dump right into an American refinery. It's got exactly the right consistency, and so we don't have that oil. And so we need that oil from someone else, and Saudi Arabia is a perfect place to get it.

[00:43:53] **Nate Hagens:** So they have the perfect oil period, or they have the perfect oil for our situation?

[00:43:59] **Art Berman:** No, so the average refinery in the world is very similar to the average refinery in the United States. It takes a medium heavy input grade, much heavier or heavier than the average oil the United States makes.

[00:44:18] **Art Berman:** And you can get to that level two ways. You can either buy the perfect oil, say from Saudi Arabia, or you can take a little bit of our light oil and mix it with some nasty heavy stuff from Canada and you get a blend.

[00:44:33] **Nate Hagens:** Is that why there was such a push to approve, and we know about the push to boycott and not build, but is that a big reason why we wanted the keystone pipeline, so that we could import heavier oil to merge with our light oil?

[00:44:49] **Art Berman:** Yes. But an important 'And' is, we're already importing it. Canada is the biggest source of foreign oil to the United States, and we're importing just as much oil from Canada today as we would have with the Keystone XL Pipeline or without it, which is the case today. It's just that instead of being able to get here by a pipeline, it gets here by trains and trucks.

[00:45:19] **Art Berman:** So the Keystone XL, it made sense to me just purely as a scientist because it's a more efficient way of getting the oil to the United States and empirically it's a safer way. I know people hate to hear this, but I would much rather trust a pipeline than a bunch of train cars knocking around in rail yards, to prevent spillage and explosions.

[00:45:45] **Art Berman:** And there were a lot of explosions and some of that's been fixed. But to be clear, the US is, In no way, constrained on its supply of oil from Canada because Keystone XL didn't happen. It just costs a little more to get here.

[00:46:02] **Nate Hagens:** While we're on that topic, there is this Byzantine media blitz that's all over the place on Twitter and elsewhere that the US is an oil exporter. Can you just briefly unpack how much oil and oil products the United States uses daily or yearly, and how much we produce domestically versus how much we import? If you could just summarize that in as simple terms as possible. Cuz I think there's a lot of confusion about that.

[00:46:37] **Art Berman:** Right. So when we hear people talk about, Oh, the US is a net exporter of oil, okay.

[00:46:43] **Art Berman:** They're talking about crude oil plus refined products like diesel, gasoline, et cetera. Okay? Now, nobody else in the world except the United States defines net exporter that way. A country is a net exporter of oil. If it exports oil, if it exports more than it imports, okay?

[00:47:09] **Nate Hagens:** But since we're an energy launderer, we get to redefine what it means to be an exporter.

[00:47:13] **Art Berman:** Exactly. So now, without, and again, I'm not trying to be critical, the US imports a lot less crude oil than it did say 10 or 15 years ago-

[00:47:27] **Nate Hagens:** Because of the shale situation, right?

[00:47:30] **Art Berman:** We had to import a lot of light oil 10 or 15 years ago because our production had declined.

[00:47:36] **Art Berman:** So we've pretty much eliminated that. We no longer have to import other countries' light oil, but since we don't produce very much of the heavy oil ourselves, we, never as a strong word, it's very unlikely that we will ever stop importing other people's oil until the world just doesn't use oil anymore.

[00:48:00] **Art Berman:** As long as we're in the business of exporting refined products, we need heavy oil or we can't do it. It's just that simple. So when people say we're energy independent, first of all it's really not true. It's really not.

[00:48:14] **Nate Hagens:** Well, compared to Japan and Europe and the UK it is. But go on.

[00:48:18] **Art Berman:** Well, but it's still not true. I mean we're a whole lot more energy independent than Japan and Europe. Okay. Absolutely. But now we're talking about who's the best of a bad lot.

[00:48:30] **Nate Hagens:** Well, so we're 80 to 85% energy independent. Yes? I mean, you could break that down if you like, but I want to talk about the oil part, especially, I think we're at. We consume 20, 21 million barrels of oil per day, and we produce 12 or 11.

[00:48:47] **Art Berman:** Well again, so nobody consumes crude oil, Right?

[00:48:51] **Nate Hagens:** Right. Except the refineries.

[00:48:53] **Art Berman:** Except the refineries. So America consumes 20 million barrels a day of refined products, not oil. But so what? So to keep the arithmetic straight, let's talk about how much crude oil goes into American refineries, and the amount of crude oil that goes into American refineries is something around 13 to 14 million barrels a day.

[00:49:20] **Art Berman:** Okay. The United States produces about 11 or 11.5 million barrels a day. And so you could say, Oh, well we're almost there, you know? Couple of more million barrels a day and we're there. Well, but what I just told you a little while ago is, except that we turn around and export three or 4 million of our produced barrels elsewhere, because we can't use it in refineries here.

[00:49:46] **Art Berman:** So we have to then import more appropriate oil to replace that and also get back to the 13 or 13.5 million that goes into our refineries

[00:50:00] **Nate Hagens:** And we consume 20 million barrels worth of product.

[00:50:04] **Art Berman:** Now, and somebody is gonna say, in fact, you said it to me in an email not very long ago, "Well, wait a minute, that doesn't make sense. How can we have 13 million go in and we get 20 million out?" And the answer is that a lot of what we consume are natural gas liquids, many of which don't come from this refining column at all. They come from natural gas. Completely different source.

[00:50:27] **Art Berman:** And an awful lot of what we consume goes into the plastics that you talk about, go into all sorts of natural gas liquids. And then there's biofuels. Okay? There's a million, and I don't even know what the night number is, but it's more than a million barrels a day of what we call gasoline comes from corn.

[00:50:45] **Art Berman:** But that's counted in our consumption. And then there's another thing called refinery gain: when you take crude oil, which has a very high density, and you refine it into products that have a lower density, there's actually an added volume. There's more oil, there's more product that comes out than goes in.

[00:51:04] **Art Berman:** So you take all that confusing gobbledy gook that I just mentioned and the arithmetic does add up. But just to make it clear and to get back to your laundering comment Michael Levi is a guy that used to be an energy analyst and now I think he's part of a hedge fund or something like that, because he's a smart guy.

[00:51:22] **Art Berman:** But years ago he talked about, he said, "Now if a country manufactures, no automobiles, zero, but buys 5 million automobiles every day from let's say Italy, imports them, paints the car green, and then exports them back to Italy and Europe and sells them, are we a net exporter of automobiles? No, we're a net exporter of green paint." That's what we've done. And so the oil refining analogy that Michael was talking about there is, I buy oil from you, I put it into my refinery, I turn it into gasoline and diesel and other products, and then I sell it back to you. And I call myself a net exporter.

[00:52:14] **Art Berman:** I'm selling you green paint, man. Now, I'm not criticizing the process. You wanna make money? It's a legitimate way of making money, and you're providing a product that people need. But let's be honest about what you're doing. You're exporting green paint.

[00:52:31] **Nate Hagens:** So in this discussion, I've come away so far with two main takeaways. Number one is, we are not going to seamlessly, or in any near term timeframe, get off of oil because it is central to our modern way of life. If we radically change our way of life, we then might be able to get off of oil. And then the second takeaway is our system is so complex, our global supply chains and the systemic risk from any international hiccup due to Russia or China, or a financial meltdown or any other international risk, really can gum up this just in time global import export of green paint, in this case the hemoglobin inputs to our modern economy. Because an Autarchy or a world without trade, the US has plenty of oil, not as much as we used to. And what we have now is mostly light tight oil, which depletes very rapidly, but we still have a lot, especially relative to most countries in the world.

[00:53:47] **Nate Hagens:** But we cannot produce the things we need just from our oil. It has to be either build different types of refineries - and why would they do that? Because they're not getting the signals from the market to do that. Or we need to continue to merge our oil, mix it with heavier fractions that we get from other countries' flavors and types of oil.

[00:54:11] **Art Berman:** Yes. And let me add one important footnote to that, we could build new refineries or different refineries, Okay? I mean, we're talking tens of billions of dollars per refinery, and it's like a 30 or 40 year investment, okay? So we live in a world today where most of the investment money, the smart money, rightly or wrongly, doesn't believe there's 30 or 40 years of investment life in an oil refinery.

[00:54:47] **Art Berman:** That somehow we're gonna be driving electric cars, true or untrue. And you and I know, we don't think it's true, but it doesn't matter.

[00:54:55] **Nate Hagens:** Well, we think it's true for a different reason.

[00:54:56] **Art Berman:** Well, okay, fair enough. Yeah. But the point is that you need credit. You need somebody else's money to make these big capital intensive projects happen. And if the investment community says no, we don't see it, guys. If you could do this in five years, we'd talk about it, but 30 years, forget it. So that's a problem. Now will that change? I don't know.

[00:55:20] **Art Berman:** Maybe not. But just because somebody says, "Well, we could do it," doesn't mean that it's realistic to expect that it will happen.

[00:55:32] **Nate Hagens:** So what are the risks you see from the current refining situation and the current diesel, I don't know if shortage is the right word, but the very high price of diesel and the burning of oil for heat in places in Europe that didn't happen before the war in the next 10 years? Are there risks you see to the refining situation in addition to what we discussed?

[00:55:59] **Art Berman:** Well, sure. And some of those risks, well, let me just back up and say for a moment, unknown to most people the guy who's running Russia right now, Vladimir Putin, has a PhD in energy economics.

[00:56:14] **Art Berman:** I didn't know

[00:56:15] **Nate Hagens:** that.

[00:56:16] **Art Berman:** Yeah. He wrote a thesis, his thesis is that the Soviet Union fell apart because it mismanaged its oil resources, that it didn't invest in the necessary infrastructure and refining, and therefore was at the mercy of the West. And so what's happening right now, this mega hiccup, as you call it, you didn't say mega, I've added that, what's happening right now with diesel and with natural gas is not an accident.

[00:56:49] **Art Berman:** I mean, this guy knows exactly what he's doing, and I'm not one of those people that, you know, secretly admires Vladimir Putin. I'm just saying he knew exactly what he was doing. He said, Look, I got the, I got all the cards right here. I'm gonna play those cards. And when those cards don't work to his satisfaction, he plays another card.

[00:57:13] **Art Berman:** So right now he's bombing energy infrastructure in Ukraine. The guy knows about energy. Say what you will. And if you Google Putin's PhD dissertation you'll see there are lots of people who think that he had a ghostwriter do it or he plagiarized it, you know, I don't care. Because that's not the issue here.

[00:57:32] **Art Berman:** Point is even if all those things are true, this man knows more about energy than all the leaders of NATO put together. Because he somehow did have to pass his defense. So we're dealing with a guy who understands how to play with energy much better than any of our NATO leaders, and I would argue probably any of the other leaders in the world.

[00:57:57] **Art Berman:** So this was a planned intervention. So is it likely that we'll see something, will a hiccup have the same implications in the future? We don't know, but this one's here to stay. I think this is, in my view, this is part of a radical restructuring of the world order. Whether Putin lives or dies or stays in power or is taken from power I don't think that's going away.

[00:58:24] **Art Berman:** I think the world is pretty evenly divided. And one side of that divide sees natural resources and the means of production of those natural resources as the key to their success. And they're not us.

[00:58:41] **Art Berman:** And their idea is not a bad one.

[00:58:46] **Nate Hagens:** Well, let me let me put you on the spot here. So usually at around this time, I ask my guests some personal questions about the future, and I think I'd like to withhold that opportunity until we have less of a chemical discussion and more of an organic human discussion about future trajectories.

[00:59:07] **Nate Hagens:** But I will put you on the spot and ask, given everything you just said about the importance of oil and oil products to our current way of life and the mega hiccup in Ukraine and what that portends for a biophysical awareness of what holds our system together. If you were energy czar or benevolent dictator in this country, what are some of the measures you might consider to make our path, either the United States or the entire global culture, more resilient to maybe a more energy scarce, less affordable future?

[00:59:51] **Art Berman:** Yeah, you are putting me on the spot. Not that I didn't expect it. I don't have solutions, but if it were me, the word I would use is cooperation. Rather than beat our chests about how we are the badass United States and we're a net exporter of oil and we don't need no stinking, whatevers in Saudi Arabia a bit of humility would be a really good thing.

[01:00:16] **Art Berman:** And say, you know what? Whether we love these guys or hate these guys, we really need these guys and these guys need us. I'm speaking generally, but whether it's Saudi Arabia, whether it's Russia, whether it's China, that this aggressive approach that we seem to be taking- and when I say we, I'm not talking about political parties, I'm talking about we as the United States of America and NATO, certainly in the last few years- it's a recipe for disaster if you wanna maintain civilization in some form like we're used to. Now, if you don't, that's another conversation altogether.

[01:00:57] **Art Berman:** And I'm not even beginning to suggest that we just shuck all the plans of decarbonizing and trying to consume [less]. I mean, we really do need to radically modify our behavior towards energy as a species. But that's not the question you're asking me. And so, if the question you're asking me is how do we manage the systemic risk, the way you manage it is cooperate.

[01:01:26] **Art Berman:** Now, there are red lines that you cannot cross. I mean, somebody does something that's so horrible that you say, Look, we can't work with you anymore. I get that. And I don't have a degree in diplomacy, or I probably would be a different person, but that's what I think is important.

[01:01:41] **Art Berman:** And as far as managing this current crisis, all of this aggressiveness, I think, just gets us faster and faster to an outcome that doesn't have anything to do with what we're

talking about. It has to do with nuclear war or war, which is, you know, how much do you want to be right?

[01:01:59] **Art Berman:** Is being right the answer or is preserving the planet the answer. Probably neither one of those is the right answer, but something in between, Right?

[01:02:06] **Nate Hagens:** Well, yeah. The challenge is that historically when there's a phase shift to a smaller physical pie cooperation is against outgroups is not the first thing that we fix, and that is worrisome. But in addition to the nuclear war risk and the financial overhang, you've laid out a case for the complexity of our energy infrastructure and all these different products that don't just naturally spring out from a barrel of oil. There's a big intermediate step, which is the refiners and that process.

[01:02:44] **Nate Hagens:** Art, I know you are leaving for a well-deserved vacation in the morning. I think this was a very helpful conversation, at least for me, to understand how oil turns into these other products. There's a ton of other things I want to talk to you about, but maybe we close this.

[01:03:00] **Nate Hagens:** If you have any other final thoughts on this broad topic of diesel, oil refining, et cetera. And then I'll have you back in a couple months to talk about many other topics relevant to our energy future, including one that you and I email about a lot, which is, what can renewables do and in tandem with depleting fossil fuels and what are the barriers and opportunities there.

[01:03:26] **Nate Hagens:** So any closing words, my friend?

[01:03:29] **Art Berman:** Yeah. My closing words are, that you shouldn't expect, nobody should expect that whatever the problems that we identify, let's just say here in the United States, since we're both here at the moment, nobody should expect that we're going to solve these problems in the near term, whatever they are.

[01:03:50] **Art Berman:** And if you do, then you probably don't understand them well enough to really have a vote at the table. You're entitled to your opinion. But when I hear people say, "Oh, well, you know we just need to get these refiners off their ass and tell 'em to make more diesel." Well, I think we've pretty much put that to rest.

[01:04:11] **Art Berman:** You can't make something without making a lot of other things, and you can't make something out of something that doesn't have what you need in it. You know, the idea of, "Well, let's just stop importing other people's oil and use our own." Okay live on gasoline, everybody, you're not gonna get your diesel. Oh, whoops. I didn't know that.

[01:04:30] **Art Berman:** Recognize that all of these people, these groups, whether they're refiners or oil producers or whatever, they actually have a business to run. Now, you may not approve, I may not approve of their corporate governance and their ethics and all of that, but when we have

political leaders who stand up and say, "Well, these guys shouldn't charge us as much because they're making a lot of money right now." Okay. You wanna apply that across the board to all corporations and all sectors, okay, I can get behind that. But, you're not gonna get away with singling out one sector and saying, "Well, you guys can't charge as much."

[01:05:10] **Art Berman:** But, if Amazon or Facebook or Apple wants to do it, "Well, Sure. Why not?" I mean, it's just so unrealistic to make comments like that. Okay, so it's red meat. I get it. But my point to your listeners, who presumably are on a more thoughtful level, is if you want something, let's make sure that it's realistic and feasible.

[01:05:30] **Art Berman:** And just because it sounds good, it probably has all sorts of problems that the people that are talking about it either don't wanna acknowledge or don't understand themselves. It's not a perfect world, but this petroleum system that we've been talking about for the last hour or so, as you've correctly pointed out, man, it's got a lot of moving parts.

[01:05:54] **Art Berman:** It's really complicated. I mean, what I'm talking about here is just the surface of it. And I'm sure that there are plenty of listeners that are confused enough as it is and I get confused about it, but let's just leave it with, it's hugely complex and hugely important.

[01:06:10] **Art Berman:** And to think that simple solutions will solve it, is just not consistent with life.

[01:06:19] **Nate Hagens:** Thank you, my friend. Enjoy your vacation and I'm sure we'll be emailing soon and I will have you back because you and I share a looking-two-or-three-steps-ahead at our energy in society conundrum that we face and I like to hear your insights and wisdom.

[01:06:37] **Art Berman:** Always a pleasure to talk to you, Nate. Thanks.

[01:06:39] **Nate Hagens:** Thanks so much, Art.

[01:06:41] **Nate Hagens:** If you enjoyed or learned from this episode of the Great Simplification, please subscribe to us on your favorite podcast platform and visit TheGreatSimplification.com for more information on future releases.