The Great Simplification

Nate Hagens (00:12):

You are listening to The Great Simplification with Nate Hagens. That's me. On this show, we try to explore and simplify what's happening with energy, the economy, the environment, 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.

(00:43):

Today's guest is Arthur Berman. Art is a petroleum geologist with over 40 years of oil and gas industry experience. His background includes a Master's in Geology from the Colorado School of Mines, and over 20 years working at Amoco, which is now British Petroleum, as well as writing articles and analysis for the energy website, The Oil Drum 10 years ago, which is where we became colleagues. In this discussion, Art and I do a bird's eye view of what oil is, what oil does, and some common misconceptions about oil and human futures. I hope you enjoy this conversation.

(01:33):

Art, you and I have known each other for over a decade. We talk all the time about energy and the economy. I thought it would be a good idea to maybe record one of our conversations. But instead of taking a deep dive into kind of the advanced nuances of oil depletion and credits growth energy, I thought for this first time that we talked together, we might do a little primer on oil and the economy and energy, et cetera. If you're willing, I've never done this before, but maybe we'll just start with a speed round where I'm going to ask you a series of basic questions and you give me like 15 to 30-second answer, and then we'll get into some of the nuances after.

Arthur Berman (02:17):

Sounds good to me.

Nate Hagens (02:18):

So Art, what is oil?

Arthur Berman (02:22):

Oil is a substance that results from the cooking in the earth of organic-rich material, mostly dead marine algae. And over a period of geologic time, millions of years of

increasing burial and heat and pressure, it converts into the substance that we know oil as oil and very slowly migrates out of the organic rich beds that it was deposited in and finds its way into various better quality rocks we call reservoirs, which are then drilled into and produced.

Nate Hagens (03:06):

You get an A on accuracy and brevity. That was great.

Arthur Berman (03:10):

All right.

Nate Hagens (03:10):

Where is oil found generally?

Arthur Berman (03:13):

Well, oil is found pretty much everywhere, but like income, there's a great deal of inequality as far as the volumes and the quality. And so the Middle East has by far the richest endowment of oil. Places like Saudi Arabia, Persian Gulf countries, including Iraq, Iran, et cetera. Russia has a ton of oil, the United States and Canada and Mexico. So really North America, Middle East, North Africa, West Africa, and parts of Eastern South America have the most oil.

Nate Hagens (03:59):

What those locations have in common was they were all or almost all where oceans were previously in Earth's history?

Arthur Berman (04:07):

That's right. Unlike the, I think there was a Chevron commercial many years ago that gave the impression that oil comes from dead dinosaurs. That's not true. Oil comes mostly from marine algae, very tiny little organisms that whales eat, in fact, and some other marine mammals. And yes, it's mostly where oceans used to be, but the caveat is is that the geologic conditions of depth of burial, heat, and pressure have to be just right. So there's a lot of places in the world where oil was but no longer is because

things got too hot or areas got uplifted and it leaked out. That's the reason principally for the inequality of the distribution. Everything has to be just right.

Nate Hagens (05:02):

Who are the world's largest oil producers and consumers?

Arthur Berman (05:06):

The United States is the largest oil producer and we are followed pretty closely by Russia, Saudi Arabia, Canada.

Nate Hagens (05:18):

And then a big drop-off after those three, right?

Arthur Berman (05:20):

Yeah, after those three. So we're going from numbers of 10 to 11 million barrels a day. When we get down to Canada and Iraq, we're sort of in the 4 million barrels a day range. And then after that, it falls down into the kind of 1 to 3 and et cetera. The biggest users, consumers of oil, are the United States and China by a long shot, followed by countries like Germany, Japan, and India.

Nate Hagens (05:54):

So you've often been quoted by saying that oil is the economy. What do you mean by that?

Arthur Berman (06:00):

Right. Hard to be brief, but basically the economy is formed by work. Work done by people, by machines, by animals, by all sorts of stuff. And everything that lives, as you've noted, lives off of energy. We hunt, or animals hunt, and they get energy through food. The principal source of the most productive energy in the modern world is oil. Now, there are other sources of energy, but by far, the biggest bang for the buck, if you want to use the cliche, is from oil and also the largest percentage of our sources of energy. And so as goes oil, so goes the economy. Countries that use the most oil have the highest gross domestic product. United States and China, I just told

you, use the most oil and without question, they are far and away the two countries with the largest economies and the highest GDP.

Nate Hagens (07:06):

Why is oil so special as an energy source?

Arthur Berman (07:10):

It's special because it has an awful lot of energy, a lot of work. We're talking about calories or joules in a very compact area that can also be moved around easily. You can put oil into a barrel, into a plastic container. You can put it on a truck, you can put it in a pipeline, you can put it on a boat. You can do just about anything with it and move it around the world fairly cheaply. Other sources of energy, let's say natural gas, you can put it into a barrel, it won't stay there. You can seal it up, but it's diffuse. And so really the only way to move it around is in a pipeline or compress it a whole lot into a liquid and put it on a boat. And that's real expensive. So there's just something kind of special about oil and that it's got what we call a very high energy density, a lot of energy per unit volume. And it just so happens to be in a pretty convenient liquid form that can be carried around, moved around without too much trouble.

Nate Hagens (08:30):

When we talk about millions of barrels, we extract oil and store it in barrels or tankers, but oil isn't just gasoline that we fill our cars with. What are the other components of a barrel of oil and what products are made from a barrel of oil? Briefly again.

Arthur Berman (08:50):

Yeah, so we take what we call crude oil. That's the oil that's produced out of the ground, and we put it into a big, ugly plant called a refinery and we heat it up. The various things that are distilled, just like in an alcohol still, same concept, we get first some gases, principally ethane that we make plastics from. We get diesel, we get gasoline, we get just a whole variety of other substances that I won't go into, but the largest portion of every barrel is gasoline, probably like 40%. Diesel is next, jet fuel is up there. And so those are principal components. But I think the important thing for listeners to understand, it's not a pick and choose kind of thing that you put a barrel in and you have to take all the stuff that comes out like it or not. You can't say, "Oh,

well, I'd really like to have some diesel, but I don't want any gasoline." It doesn't work that way. You get the whole spectrum.

Nate Hagens (10:06):

What is depletion? I had a conversation a while ago with my mother-in-law, and I said, "How many years of oil do you think is left?" And she's like, "What do you mean?" And I said, "Well, at today's consumption, how much oil is left under the ground in number of years?" She's like, "I don't know, a million?" I'm like, "A million years?" She's like, "Yeah, I have no idea." So the concept of depletion, since you and I have been alive, we've always had more oil every year pretty much except for recessions, and it's largely been pretty cheap, but it is a finite resource and it depletes. Could you briefly describe oil depletion?

Arthur Berman (10:49):

Sure. Let me just make a distinction between depletion and decline. Everything in life declines. And so if I have an oil well and I start producing it, the rate in the first year will be higher than the rate in the second year, which will be higher than the rate in the third year. And so people talk about the decline rate of oil and gas and all sorts of things, and that that's fine.

(11:19):

Depletion is similar except that depletion refers to how much you've proven you have in the ground. So you drill a well, or you drill a field and you do a lot of calculations. Engineers work on their computers and they say, "Oh, well, we think there's 5 billion barrels of oil in this field." So every barrel you produce then subtracts from that proved reserve. That's depletion. The problem with depletion is a perfectly fine concept that everyone understands, but as soon as more wells are drilled and more reserves are found, then which of those reserves are you depleting? And so when you ask your mother-in-law, "Well, how many years of oil do we have left?" Well, if we don't drill any more wells, then maybe we've got 10 or 20 years. But if we drill more wells, at least for the last 75 years or so. We've always had 10 years of oil left because people are constantly drilling more, finding more, adding to reserves. And therefore, even though we're using more and more, we're finding more and more. Now, it's more complicated than that, but that's the simple answer.

Nate Hagens (12:36):

So there are different qualities of oil and different geologic provinces of oil. What is the difference between what we used to refer to or what I used to refer to as the conventional oil or the Beverly Hillbillies, just bubbling out of the ground oil and the larger category of unconventional oil?

Arthur Berman (12:58):

The Beverly Hillbillies oil is sort of the standard oil you find in the United States, which by global standards is actually fairly light stuff. So you drill into the ground or as Jed Clampett shot into the ground and it just kind of comes up by itself because it's got a lot of natural gas in suspension that lifts it to the surface. Now, the standard stuff that goes into refineries these days is a little bit heavier than that. And so the typical oil from Saudi Arabia, while it's still fairly light, is not that light. And then there's all sorts of stuff that comes along with it, like sulfur.

(13:45):

U.S. Oil has very little sulfur in it. That's a good thing. Saudi oil has more sulfur in it. Some oil has so much sulfur and it's a problem. Some oil is super light and some of it's almost like tar. Again, there's sort of an income inequality between the quality, the thickness, and the components of oil around the world.

Nate Hagens (14:12):

What is tight oil or shale oil?

Arthur Berman (14:15):

Yeah. Well, so now we're getting into sort of colloquialisms. Tight oil or shale oil is oil that's produced from the actual source rocks from which it was generated. Now, you might remember that a while back I said, well, it's generated in these organic-rich, kind of shaley beds, but in most situations, it migrates out. It kind of slips out of the cracks, goes into a nice sandstone that has lots of pore space to store it in, and life is good. But over the last 10 or 15 years, as we've run out of the easy stuff, we've had to resort to actually producing the source rocks, and that's what's called shale oil or tight oil.

Nate Hagens (15:08):

What's left after the source rock, after the shale oil or tight oil?

Arthur Berman (15:14):

Damn little. There's plenty of gas, natural gas, a little bit more than there is oil. There's various kinds of exotic things, maybe...

Nate Hagens (15:25):

Like oil shale?

Arthur Berman (15:27):

Yeah, like oil shale, which is oil that hasn't been cooked yet. So at some time in the geological future, it might become oil, but today, it hasn't been cooked yet.

Nate Hagens (15:39):

Right. It has the energy density of a baked potato or so, so it takes a lot of energy to get out. Even though it is an oil resource of sorts, how useful it is to our economy might be a different question.

Arthur Berman (15:51):

It's completely useless. I mean, we would literally have to heat it to hundreds and hundreds of degrees centigrade in an area around the surface deposit, and you can imagine the kind of environmental issues that might create. So no, it's not very useful.

Nate Hagens (16:12):

Okay, last question in the speed round. What is peak oil?

Arthur Berman (16:16):

Peak oil is the notion that you produce oil up to some maximum level where beyond which you've optimized all of the ways you know how to drill it and produce it. And after that, it starts to decline. And there's not very much you can do to meaningfully increase that production level. So it's sort of like life. We grow as human beings until we're 20 years old and we stop growing and then we start aging.

Nate Hagens (16:57):

I'm 55 and I'm still growing, but not vertically, but go on.

Arthur Berman (17:02):

Well, so it's like life. I mean, things don't grow forever. You reach a maximum point and then things start to decline, and that's what peak oil is.

Nate Hagens (17:13):

And so there's peak oil, there could be peak oil for a country or a region like the North Sea or a field like Cantarell in Mexico peaked some 20 years ago. But when we hear the term peak oil, at least historically, it's meant to refer to as all the countries in the world combined at a global level, oil production all added up at some point will hit its maximum and then go into permanent decline.

Arthur Berman (17:42):

Right. And there's sort of this idea that how do we know that? And we can say, well, we've got estimates of what proved reserves are. When we get to half of that, we'll call it peak. And maybe that's just a technical definition.

Nate Hagens (18:00):

We do know that many, many countries in the world have some sort of a Gaussian normal curve and are on the down slope unequivocally and will never regain new highs. Do you have any comment on that?

Arthur Berman (18:18):

Absolutely. In fact, today, really the only countries in the world that are still on the upswing potentially are the United States and Canada, that everybody else is either on some sort of a plateau or is past peak.

Nate Hagens (18:41):

Okay. That concludes the speed round. That was very informative, Art. I actually even learned a few things. Let's take a deeper dive in some of these things. Let's talk about the United States as an example.

(18:58):

M. King Hubbert was a geologist at Shell that predicted that the United States would peak in its oil production in around 1970 or '71, and that the world would peak in the year 2000. And lo and behold, the United States did peak in 1970, and then we had a three and a half decade decline until 2008 or so when we started to access the tight oil, the shale oil you mentioned earlier. And then we pierced the 1970 peak as if to show that technology overcame depletion.

(19:39):

One of your charts that I use in almost all my presentations shows U.S. oil production history from two lenses. The first lens is to lump all the oil together and show that there was this peak in 1970 and a decline, and then another peak surpassing the 1970 production. But then you so artfully created a duplicate graph that breaks out that production by sector or geographic province. The conventional oil, the Beverly Hillbilly oil, as it were, peaked in 1970 and it has been declining ever since. And then laid on top of that is the North Slope of Alaska oil, which is not contiguous to the lower 48 states, but it is part of our country. So we include that oil in the total. On top of that is oil underneath the ocean that we drill under the Gulf of Mexico, which is a province of the United States. So that gets added to our total. And those three together are continuing to decline. But then we have this massive addition because it comes out so fast when we drill lots of wells of the light tight oil in the shale provinces.

(21:01):

So if you add that all together, we had a new peak close to 13 million barrels in 2019, and we're down from that right now. So could you, from a geologist perspective, describe that a little bit and maybe describe how your forecast going forward might differ from some conventional forecasting agencies like the International Energy Agency or the Energy Information Agency?

Arthur Berman (21:31):

I don't think that there's a lot of geologists or geophysicists or even engineers that work for those agencies. And so they're just dealing with numbers. This is not in any way meant to criticize them, but they just project numbers. For those of us that actually look at the details, we find out that there's a certain amount of inequality in the distribution of this, the shale oil and tight oil as well. And so these big numbers

that sometimes are thrown around that say, "Oh, we're going to be producing as much tight oil in 2050 as we are today." Well, those include way beyond proved reserves.

(22:18):

I mean, that includes possible resources, probable resources. In other words, a resource is something that may be there or may not, but we haven't found it yet. And so those very big numbers are, they're not made up, but they're not exactly real either. My take is that I think we've got probably about 10 more years of shale oil or tight oil before it gets just as thin and expensive as conventional oil. And then we're going to be in big trouble. I say 10 years and that that's kind of a ballpark. We easily could be there in five, maybe. Maybe we get lucky and it doesn't happen for 15. But in real life terms, it doesn't matter. We're in trouble at some time in maybe in our lifetimes, but certainly in my children's and grandchildren's lifetimes.

Nate Hagens (23:26):

Well, the way that I see it, and I expect you know what I'm about to say is we were running out of oil from the first moment we drilled the first well in the U.S. 150 years ago. The issue isn't now that we're running out of oil, the issue that is going to be relevant to our global situation is that we're running out of enough cheap energy, especially oil, to support the gargantuan financial claims that have been created over the last 50 years. So there's three layers here. The first is, do we have enough oil to continue economic growth in order to maintain our financial system, which requires growth? Because as you know, a barrel of oil does around four and a half years of my work, and the world uses around 35 billion barrels of oil per year in aggregate with coal and natural gas. It's about 100 billion barrels of oil.

(24:31):

So we're getting almost 500 billion fossil workers in the form of fossil carbon and hydrocarbons that we pull out of the ground and only have to pay for the cost of extraction. But the other thing that happens here is that if we are unable to grow, then there potentially is a phase shift in the geopolitical response to we've all been riding in these ships as the tide lifted all boats. But now as things get more difficult, there's plenty left, but there's not enough left to continue growth. I think oil production growth was 6% a year from the '30s until the '70s. And since the '70s, it's only been like 1% a year. I don't want to go down this rabbit hole on this show, but one of the reasons

for that is debt, not only global debt to support economies, but debt that went to the shale companies in order to get the more expensive oil.

(25:34):

But then the third thing, which is what you're bringing up, is irrespective of the next decade, if we have a 20, 30, 40, 50-year lens where your grandchildren and people I know will still be alive then, there will be hardly anything left. What will be our main energy source then is a question that our culture doesn't ask. So let's get to the decline rate chart that I use of yours that I'll paraphrase and you can expand on it. Correct me if I'm wrong, but approximately 80% of U.S. oil production currently comes from five regions.

Arthur Berman (26:18):

Mm-hmm.

Nate Hagens (26:19):

You can explain where those are. But those regions, it's very high decline rates in the production because it's mostly tight oil, and so it depletes very rapidly, like 80% in the first 18 months or something like that. In those five regions that produce 80% of U.S. oil, the yearly decline rate is around 40%. Meaning, if we stopped drilling, not that we're going to, but for environmental reasons, for affordability reasons, for complexity reasons, or for any other reason, if we were to stop drilling, 40% of our production would drop in one year of that 80% and then 40% the second year. Can you expand on what I just said or clarify it or correct it?

Arthur Berman (27:09):

Right. The reason that these wells decline so fast is partly what you said, they're crappy reservoir rocks. But the other thing is is that we've gotten so good at our technology that we're getting much, much higher flow rates than we ever used to. A lot of people think that somehow technology creates energy, but it doesn't. Technology is just the straw.

Nate Hagens (27:43):

It's a bigger straw.

Arthur Berman (27:45):

It's a bigger straw, and our straw has gotten huge. And so we can suck out a ton of oil and gas very, very quickly, but that doesn't increase the container that it's in, and that's a real problem.

Nate Hagens (28:01):

So we're patting ourselves on the back for the increased amount of milkshake that we're eating, but we're ignoring the upcoming slurping sound.

Arthur Berman (28:12):

Well, exactly. We're getting near the bottom of the glass. And there isn't any technology in the world that can create more oil except time.

Nate Hagens (28:22):

And how much time?

Arthur Berman (28:24):

Millions of years and a whole lot slower than society is using oil, even what society was using 100 years ago. It's a painfully slow process.

Nate Hagens (28:38):

Well, as you know in DJ and my materials, we refer to the era that we're living in as the carbon pulse. This one time era where we are drawing down Earth's carbon battery 10 million times or more faster than it was trickle charged by daily photosynthesis in the past. And yet, because of your straw, we just focus on how much is coming out at the top of the straw and all is good, at least for the moment, which is why I'm doing this podcast and you and I have been working on these issues for a long time is because we're trying to look two or three steps ahead on how society might respond to this. But one of the problems, as you are well aware, is we get economists and technologists that look just at what's happening right now, and they extrapolate that trend into the future.

(29:32):

And so let's briefly move to this peak demand theory that electric cars and other alternative energy sources are getting cheaper and better, and for carbon reasons, but partially also due to technology reason, there's this concept of peak demand that oil production is going to decline in the future, but not because of depletion, but because we're not going to need it anymore because we've shifted to electric cars instead of internal combustion cars, therefore we won't need gasoline. And so the world will move away from oil because of alternative energy and technology. I know you have a lot of thoughts on this. What are some of them?

Arthur Berman (30:22):

Well, some of them are that we have to have oil to extract the materials for solar panels and wind turbines. We have to have oil to transport those metals, if you will, to places that they're manufactured. We have to have oil to transport the manufactured materials to the markets. That's a problem. The maritime world runs on diesel, and that accounts for something like 90% of global trade. Somebody might say, "Oh, well, you know, we'll replace that too with electric power." Well, maybe over time, but that's not going to happen very quickly.

(31:11):

The other thing is, if you go look at a wind turbine, go look at the rotor itself. It's made of plastic. Where does plastic come from? It comes from oil, it comes from natural gas. If you want to get off of oil, then you can't have the turbine that spins the windmill and then you get into all the embedded or the supply chain, oil and gas that's needed to manufacture all this stuff. I'm not trying to make a partisan case for oil. I'm just saying people are not looking at the whole picture. If they did, they would say, "Oh my gosh, the idea of getting off of oil altogether as soon as we can is a huge problem. It's a problem for renewables, and it's just that simple.

Nate Hagens (32:11):

I struggle with this all the time because I started in this space 20 years ago because I deeply cared about the environment and climate change. As you know, I've come to the conclusion that climate change and environmental damage are downstream of human overshoot, which is completely linked to the amount of energy surplus that we are riding on top of from the carbon pulse. Quite quickly, in addition to climate change, we're going to have economic, political, geopolitical issues as, not energy goes

away, but energy becomes more expensive. Because for every process that we use fossil energy for, we use between 1,000 and 5,000 times more energy per unit of output than humans used to do manually. And we pay pennies on the dollar for this. So we have traded energy efficiency because that's very inefficient, right? Relative to draft horses and humans for monetary efficiency because we just had to pay a tiny amount for this stuff.

(33:30):

But for the really energy intensive processes in the world, like cement or aluminum or air travel, as energy costs go up, that trade that we initiated where we added all this fossil energy to the process in return for higher wages, higher profits and cheaper stuff starts to break down. And so that is one of the problems. As oil gets more expensive, it's going to have a huge impact on our economy because if we have 500 billion human worker equivalents, you can't just say, "Let's go to renewables and fire all those 500 billion workers." As we go to 500 billion to 450 billion to 400 billion to 300 billion, eventually to 100 billion or 50 billion additional workers in the form of fossil hydrocarbons, that's going to have enormous impacts on the amount of work done in our economy and the complexity and the expectations, et cetera. So I don't think that is talked about much when we talk about peak demand, because peak demand also will mean peak growth almost certainly.

(34:45):

But here's a side of it that I would like your take on. As you've mentioned, we get thousands of products that the precursors come from oil and gas. Let's just assume that some of the Wall Street investment bank forecasts are nominally correct, that we are going to massively scale electric cars and we will have less internal combustion cars because people will be able to buy and afford electric cars. Ostensibly, we're doing that for carbon reasons. For the moment, let's not get into the discussion that the wider the boundary you use, electric cars may or may not be lower CO2 emitting. But here's the question I have for you.

(35:35):

Let's assume that we do eventually have all the cars that are produced are electric cars, therefore, ostensibly, narrow boundary analysis, we don't need gasoline anymore. So that's a great win for climate change and the environment because we don't need gasoline, except gasoline is only around 40% of the barrel of oil. So all the other

things created from oil, like you mentioned before, jet fuel, diesel, petrochemical inputs, football helmets, medicine, condoms, tents, crayons, a huge amounts of plastics from wind turbines, et cetera. What do we do then? We just stop producing those things? Unpack that a little bit. How much can refineries change in such a world, or is this really a critical issue that isn't talked about much?

Arthur Berman (36:29):

It's a really critical issue. Refineries, as I said initially, they can't get away from making gasoline in order to produce the other things that we need and want. There are some tricks that engineers can do where they can do what they call reforming the gasoline. They can add, subtract some carbon and hydrogen and maybe make the gasoline into diesel. But to do that at scale means a complete re-engineering of the entire refinery complex. So the same Wall Street people are saying, "Oh, well, there's peak demand. We're not going to need oil in 10 years or in 15 years." So I have a hard time understanding who's going to make the multi-billion dollar investments to modify refineries if oil only has a 10 or 15-year lifespan. It's not going to happen. So that's a problem.

(37:44):

The other problem is that internal combustion vehicles are only responsible for 15% or 20% of global emissions. It's significant, but it's not huge. Most of the emissions that come from internal combustion engines are from things like agriculture, from construction, from industry. And so focusing just on the cars, okay, it's a win, as you say, but it's a small piece of the bigger picture.

Nate Hagens (38:22):

I think you had a tweet a couple of weeks ago where you said switching from electric cars from internal combustion cars is basically you're using methadone, but you're still a user.

Arthur Berman (38:38):

Exactly. Yeah. Yeah. I also had a tweet where Elon Musk had said that solar is by far the biggest source of energy in the solar system. And I said, "Yeah, and oil's the biggest source of energy on Earth. What are you going to do with it, buddy?"

Nate Hagens (39:00):

Yeah. Why is our society so energy blind?

Arthur Berman (39:03):

Because as you said, Nate, we haven't had to think about it. It's like there's a lot of water in the ocean. We don't have to think about throwing garbage into it until the garbage comes back to us, until we have to live with it and see it, until the fish get poisoned. I think energy's the same way. We have a psychology as humans that says, well, we must grow and we'll always find a way to continue to grow. To grow the economy, to grow our population. And so we have this kind of faith in the fact that somebody's going to figure out a way, even though we have no idea what that is right now. We place huge faith in that idea. I think it's like a defense mechanism. It's cognitive dissonance. We don't want to think about, what if that's not possible? What if it doesn't happen in time? So we just don't want to go there. That's what I think.

Nate Hagens (40:13):

I think that's absolutely right. But even before that is the dead end path that economists have led us down, treating a dollar's worth of energy the same as a dollar's worth of any other input into our economic system when it's not. Energy is vastly more important to our economic system, to the natural world. Energy is the currency of life and of human systems, yet our economist and therefore our leaders, our culture, our media treat it the same. Sure, everyone knows energy's important. That's why we have military bases in the Middle East. But the fundamental underpinnings of economic growth, our goods and services, our standards of living is directly linked to the amount of energy surplus we have. Most people, because of our media and culture, think it's because of our ingenuity, our technology, our innovation. Yes, that stuff has been important, and it always will be important, but it's the coupling of that with this low entropy bonanza of carbon that we happened upon a couple centuries ago.

Arthur Berman (41:31):

Yeah, and I think to carry it a step further, the simple reason that the United States became the dominant power in the world was, first, we won World War II and everybody else was in collapse. So you don't have to be an MBA to know that having no competition is a big competitive advantage. Secondly, we were the first developed

economy to shift to petroleum. So the Brits were still running around their economy on coal, we were on oil. So we had this huge double advantage of the most productive energy source and no competition. And as you said, sure, we're ingenious, we're inventive as a people. But compared to those two singular events, I would say a more objective and realistic approach is we got lucky and we had a very hard time maintaining our advantage beyond 1970 or 1975.

Nate Hagens (42:47):

Well, we got lucky in the sense that we landed on a geologically rich province that used to be an ancient ocean that had lots of great resources in that sense. And then because of the things you just said, we created the petrodollar that we get seigniorage from the world because the U.S. dollar is the world currency. And so we also had additional benefits from that. But getting back to your previous point, the United States, most people don't think about this, if you think about the massive benefits of fossil carbon and hydrocarbons, the United States in the last 20 years, in the last 50 years, in the last 100 years, since the dawn of time, has used more of those fossil workers than any other country in the world. It largely describes our modern wealth, or at least the complex system that we're sitting atop.

(43:50):

Art, we could go a bunch of different directions here. I would like to have you back every few months, but for now on this introduction to oil, the economy, depletion, et cetera, do you want to offer any recommendations or suggestions or your philosophy regarding our future, regarding energy and our future, regarding how all this fits together? I've come to know you over the years as extremely knowledgeable on energy topics, but you also read quite a lot of philosophy and different aspects. So you're kind of a polymath on this stuff. So I'll give you the mic. What else would you like to discuss or opine on?

Arthur Berman (44:40):

Well, I think we have to find ways of being satisfied with enough as opposed to constantly needing more, chasing more in order to be happy, if you will because the physics of it is unavoidable at some point. We can argue about when. But the physics of it says that at some point, maybe in our lifetimes, but certainly in the lifetimes of my children, we will be using less energy, not by choice, because that's what's going to

be left to us. When that happens, we're going to have a much less robust standard of living.

(45:31):

It's still going to be okay in countries like the United States, but we're going to roll back to a standard of living maybe that I grew up in 30, 40 years ago, which compared to today is not great. It was okay then. But I think we have to be realistic. And realistically, I hope, I sincerely hope that we find a way to stop poisoning the Earth with our emissions from oil and gas and coal, and that we find a way to make renewables work better than I think they do right now. But I think it's unavoidable that the amount of net energy that we get out of those sources will be less. It's just physics. It's not preference. And therefore, I think we have to psychologically prepare ourselves and future generations for finding out how to be satisfied with what we have versus always needing more and to grow.

Nate Hagens (46:53):

You know I agree with that, but I'm wondering if you're giving that recommendation to listeners as individuals or as a culture as a whole, as a nation, or as a global culture that we have to stop pursuing more. Because I don't know how in aggregate… I mean, COVID was a pretty low bar as a cultural challenge that we barely are crossing. When we talk about oil depletion and some of the things we brought up here, I just don't know how collectively we will ever choose to stop pursuing more until we have to. So my reason for doing this podcast and teaching students is that we have little pilots of learning and behavior change and cultural trajectory going down different paths by individuals in small groups, because I think that's how we might be able to influence things in the future. Unless there's some top-down rationing, et cetera, but that will only come in response to a crisis.

Arthur Berman (47:58):

Well, that's the keyword, Nate. Unfortunately, as a former history major, I don't know if you can ever be a former major. That's what I majored in. In aggregate, we only learn to change not by crisis, but by catastrophe, by trauma. I mean, the Great Plague in Europe was on that level where half the population died. That's a pretty big level. There was a rebirth called the Renaissance, and there was an economic rebirth that followed. That's a huge price to pay in order to reorganize your society.

(48:43):

The answer to your question is my advice, I'd like everybody to listen to it, I'd like everybody to say, "Yeah, I should do that." But realistically, I know most people won't. But if a few do or some do, then when the catastrophes happen, then those will be the people who can lead the way who say, "You know, look, I'm prepared for this and this is what I see while everybody else is freaking out and saying it's over, we're done." That's not real optimistic advice. But I think if some of us don't do that, then as a species, I don't think we're going to go extinct anytime soon. But I think things could degenerate into a real ugly place if there aren't people that are capable of seeing through that ugliness and lead.

Nate Hagens (49:41):

I happen to agree with that, which is why I do this work. But on that note, let me just give you a chance to personally respond to this. Over the years that you and I have been in discussion with people on our Listserv and others, you seem to be facing these deep species level challenges with a lot of equanimity and you are intelligent about them, but you don't seem freaked out or stressed or anxious about the things that we discuss relative to our peers. Do you have any advice on your stoic philosophy for listeners on how you can be so balanced when discussing and thinking about these deep topics?

Arthur Berman (50:29):

A big part of that is the scientist in me. I'm a geologist, I'm a scientist, and what I know about the universe, and I didn't figure this out myself, but what I know from standing on the shoulders of Einstein and Heisenberg and others is that uncertainty is the nature of the universe. Those who think otherwise are relying on the human imagination. And so uncertainty is the nature of things, and it's just a whole lot more satisfying to not only accept it as such, but to even be in wonder and awe of it. So that's the scientist in me. And then there's the human being, the flawed human being in me who says, well, I can let myself get all freaked out about this stuff or I can spend my time reading the experience of people who came before, meditating, exercising, doing things that are well known by everyone to be just good for the human psyche, except most of us don't find time to do it.

(51:52):

I put it high on my list of things that I must make time to do because if I spend 90% of my energy being freaked out, I'm not much good to myself, to my family, or those who like to laugh at my funny ideas about oil, gas, and energy. But people do like to pay attention to what I say, they fight with me on it, but why is that? Maybe because of what you say, because people say, "Well, you know, you're kind of a voice of reason." I take that as a very high compliment that, okay, maybe I have a certain ability to sort out these things and put them in context. If I can do that, then I'm a better scientist for it. I don't take credit for it. I'm just learning, just doing what I think all of us know are smart things to do.

Nate Hagens (52:48):

I'm trying to do many of those things myself, and it takes discipline and effort, as you know. What is something that's alive for you right now intellectually, energy-related that you would've liked to talk about today, but given the constraints of time we couldn't get to and maybe we talk about next time?

Arthur Berman (53:09):

I'd really like to talk about the reality of renewable energy and a net zero future. I'd like to do that as someone who, as I said before, is 100% in favor of it and 99% sure that we can't do it the way that most of us would like and are being told we can. And so I think there's an important subject to provide information for people because what they're hearing is, in my opinion as a scientist, simply a fairytale and incorrect. And so we have to know the truth before we can navigate our way through it. That's my position.

Nate Hagens (53:54):

That's mine as well. Thank you. Let's do that as a plan and consider this a teaser for that next episode. Art, thanks so much for your time and wisdom today, and I'm sure we'll talk soon.

Arthur Berman (54:08):

Thanks, Nate. I've enjoyed it as I always do.

Nate Hagens (54:11):

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