

Speaker 1 ([00:04](#)):

Welcome to The Bill Walton Show, featuring conversations with leaders, entrepreneurs, artists and thinkers, fresh perspectives on money, culture, politics, and human flourishing. Interesting people, interesting things.

Bill Walton ([00:24](#)):

Welcome to The Bill Walton Show. I'm Bill Walton. Today, I want to talk about some of the catastrophic dead ends we face if we plow blindly ahead with the promised green energy future. Today's elites are obsessed with CO2 and climate change and are determined to replace hydrocarbon fuels with solar and wind energy and other yet to be invented technologies. But have they really thought this through? Do they understand the physics and the economics of the so-called green utopia? My guest today, Mark Mills, has thought it through and has a stark message, an inconvenient truth. Mark tells us and I agree, there won't be a world powered entirely by wind and solar or batteries. The reason I say that is because it is not possible.

([01:19](#)):

We don't have the materials and we can't afford it in either environmental or economic terms. Mark and I have talked about this before. I think this is the third or fourth time Mark's been on because he is brilliant, but I think we agree we need to push back even harder against where the climate change agenda is leading us. Mark probably knows more about this than anyone. He's a senior fellow at the Manhattan Institute, focusing on science, technology, and energy issues. He's also faculty fellow at the McCormick School of Engineering at Northwestern, where his focus is on future manufacturing technologies.

([01:57](#)):

He's also a strategic partner in an energy software venture fund, and he also wrote one of my most interesting favorite books, *The Cloud Revolution: How the Convergence of New Technologies Will Unleash the Next Economic Boom and A Roaring 2020s*. To get to the point of today's show, Congress has appropriated trillions of dollars to which should now be properly called the Climate Change Industrial Complex. People are getting rich from the green agenda, and if you consider the vast worldwide habitat and species destruction that will be caused by substituting wind and solar for hydrocarbon energy, I believe these people should be called villainous, not virtuous. So, Mark, this is great to have you back. As you can see, I have a pretty strong point of view.

Mark Mills ([02:56](#)):

Well, don't hold back, Bill. Don't hold back. Tell us what you really think.

Bill Walton ([02:58](#)):

A lot of which I came to from reading some of the great stuff you've written, including your recent testimony, the Congress. I think you were in front of the US House Committee in Energy and Commerce just last month.

Mark Mills ([03:11](#)):

Yeah, back preaching the gospel of reality or trying to. Of course, apropos, the subtitle of my book, the *Roaring 2020s*, Congress and the Federal Reserve are working very hard to make sure that doesn't happen, it feels like these days, not only by printing money, as we all know, but by implementing

programs of spending on the "Green New Deal," which is exactly what Inflation Reduction Act is. It's funding of the Green New Deal.

[\(03:43\)](#):

In fact, they've come out of the closet and admitted as much. It's no longer a secret. It's an open secret that the hundreds of billions of dollars of subsidies, mandates, and funding are being directed at changing how we get our energy. Goldman Sachs did an analysis that confirmed my back of the envelope and I'll confess that physicists, which is how I was trained.

Bill Walton [\(04:04\)](#):

You're trained as a physicist. Yes.

Mark Mills [\(04:07\)](#):

A lot of them do back of the envelopes because it's easier than doing massive calculations of spreadsheet.

Bill Walton [\(04:12\)](#):

We've got a whiteboard over here if you want to.

Mark Mills [\(04:14\)](#):

Well, back of the envelope is actually often pretty accurate. I was guessing the Inflation Reduction Act's total cost because of both mandates and subsidies. So, it mandates things that you have to spend money on that are appropriated money. So, I guessed it was a trillion dollars of spending that's coming down the pike of green stuff, and Goldman Sachs did a pretty detailed analysis. I think it was only about a month and a half ago, came to the same conclusion. Ballpark, trillion dollars. Even in America today, that's a lot of money.

Bill Walton [\(04:44\)](#):

But the difference is Goldman Sachs was writing it to show investors that there's a jackpot out here.

Mark Mills [\(04:49\)](#):

Well, there is.

Bill Walton [\(04:50\)](#):

This is where you should rush into as a wealthy investor.

Mark Mills [\(04:53\)](#):

It's a moral hazard problem. So, the obvious thing is once the government starts throwing money around, they distort markets when they come in forms of both subsidies and mandates. So, the market has been distorted. It's going to be distorted more in service to your point of replacing hydrocarbons, oil, gas, and coal, which supply about a little over 80% of our energy with wind and solar and mediated and moderated by batteries, which today, after half a trillion spent, provide about 4% of all our energy.

[\(05:26\)](#):

So, we got a long way to go from 4% of all of our energy with wind and solar, and less than 1% of our cars in America, by the way, despite all the hyperbole, we haven't breached the 1% of cars being electric

vehicles in America. Of the 0.8% of vehicles that are electric in America, more than half are in one state and you can guess which state that is.

Bill Walton ([05:50](#)):

Well, you make a point in your testimony and I think in other places you've written that you need to think about energy as something that's manufactured and what goes into producing hydrocarbon energy versus wind and solar, et cetera. Let's start there. Build the pyramid of how we get from-

Mark Mills ([06:10](#)):

Yeah, the energy stuff is about money always, always, always. But people forget and this is not philosophical, it's practical. All energy is free, and energy is infinitely available to humans, all practical purposes. The universe is gushing with energy. Energy is everywhere in the nature of the universe we live in. So, the sun is free, but so is oil, coal, and gas. We didn't invent it. We didn't make it. It's just there. It doesn't matter why it's there. There's a lot of it there. It's just there. All energy systems to deliver useful power to society require building machines, all of them. You have to build machines.

([06:48](#)):

So, what you really want to know is how much material does it take to build the machines to make windmills and solar panels and how much material does it take to build the machines that produce energy from oil and gas, to get the oil and gas, to move it and to make it into electricity or make it into motion, mechanical power or heat. You want to know how much material you need, how many machines you build, because everything that exists in our universe, everything in our society requires firstly, digging something out of the ground.

([07:19](#)):

You have to get minerals and materials to make all products, and you have to make products to make services. So, everything begins with mining. In fact, mining is boring industry. It's the oldest industry in humanity. It predates written history. It's not the oldest profession. It's the oldest industry. Actually, mining may be the oldest profession. Who knows? Not to go down that rabbit hole. It's an old industry.

Bill Walton ([07:43](#)):

That's another show. Well, it's another show.

Mark Mills ([07:47](#)):

You get nothing without mining first. You have to mine stuff, and then that takes information, knowledge to know where the mines are. You have to build machines to do the mining. You have to build machines to convert the raw materials into useful minerals and materials. Then you have to build machines to build machines. You have to build machines to install the machines. Everything's about machines and materials, including computers, including software, including AI, including healthcare. It all begins with mining and machines. So, if you dig into that subject, no pun intended.

Bill Walton ([08:20](#)):

Well, this is your specialty at Northwestern. You should manufacture.

Mark Mills ([08:24](#)):

Yeah, manufacturing's a big deal, right? That's why we want to repatriate a lot of our manufacturing because it really matters. What we're trying to do with manufacturing is to reduce the number of

human beings involved in manufacturing the stuff we need, because that is called productivity. It lowers costs of goods. So, we've been trying to automate manufacturing of all kinds forever and there'll be lots more of that, but repatriating is not a jobs issue. It's a political supply chain issue as you know. We import roughly 80 to 90% of the manufactured solar modules we use to make solar panels in America. They're manufactured, now, this is news alert to nobody, in China. Why does China manufacture most solar modules? Because they chose to.

[\(09:06\)](#):

We chose to run those businesses out of our country by virtue of regulations and taxation. China did the inverse through subsidies and we'll call it light regulations, combination of those two things. They became the dominant producer of polysilicon to make solar modules and the manufacturing of solar modules. It is relevant to say that not just because of geopolitics, but because it's an incredibly energy intensive process, but 100 times more energy to produce a pound of silicon than a pound of steel. We have to produce mega tons of silicon to produce all these solar modules and solar arrays, and they're doing it in China on coal-fired grids. So, when you do the underlying forensics, where does the stuff come from? Where do we dig it up? Who refines it?

[\(09:52\)](#):

What you find out, there's a lot of energy used, carbon dioxide emissions associated with making windmills and solar arrays enough to offset a lot with say, not burning hydrocarbons. But more importantly, the point you began with is that environmentalists have fundamentally thrown under the bus all of the issues they used to care about, everything. Land use, use of toxic chemicals, visual pollution, habitat destruction, all those things have been thrown under the bus, because the quantity of materials you need to produce the same unit of energy going wind and solar increases by at least 1,000%. You have to mine-

Bill Walton [\(10:31\)](#):

Ten times.

Mark Mills [\(10:32\)](#):

... 10 times more stuff to deliver the same mile of driving, same hour of YouTube, same hour of AI, tenfold increase that's locked into the physics of those machines. The land use, the amount of land you occupy, you cover also increases about tenfold.

Bill Walton [\(10:49\)](#):

Well, you've compared the natural gas plant that could heat and cool roughly 75,000 households or homes with an equivalent of wind fields or I guess a wind farm.

Mark Mills [\(11:08\)](#):

We call it wind farms, but we should call oil fields now oil farms, it seems to be. I mean, the world farming has been co-opted and perverted. This is oil welling, and again, it's not a farm. It's a giant field full of big machines.

Bill Walton [\(11:21\)](#):

I call them Condor Cuisinart.

Mark Mills [\(11:23\)](#):

Well, they give you that too.

Bill Walton ([11:23](#)):

We're killing billions of birds every year with these so-called wind farms.

Mark Mills ([11:27](#)):

You get dispensation for killing bald eagles with wind turbines. But if you do that as an oil guy, you better get ready to be zip tied and perp walked.

Bill Walton ([11:34](#)):

Yeah. But what about the land use and the manufacturing cost or not cost, but also the amount of stuff you'd need to dig up to basically equal what that natural gas plant does?

Mark Mills ([11:49](#)):

A way to visualize it is wind turbines that are being built today are about the size of a Washington Monument, two to three megawatts each. So, you could have a field of 50 of those covering 100 square miles, 10 miles by 10 miles.

Bill Walton ([12:03](#)):

Ten by 10.

Mark Mills ([12:05](#)):

It could be five by five square miles. It could be two miles by two miles. It's 20, 50, 100, a lot of square miles. You need to build obviously 50 things the size of the Washington Monument, and you could replicate the amount of energy produced by that. This will power a small town, let's say 20,000 to 50,000 people that range. So, you're not talking about a city or Manhattan or Washington. You're talking about a village-sized stuff. A single gas turbine whose gas pipe is bare and you can't see, the size of a tractor trailer can provide the same amount of electricity.

([12:44](#)):

This is the profound visual difference obviously. It doesn't take very much land. If we count the land upstream, so now I've just counted the land you have to look at, but no one cares where we mine stuff because it's in Africa or Asia or Canada, my homeland. But if you count that too, you also have a 10 tenfold increase in land use.

Bill Walton ([13:06](#)):

Well, part of the wind and solar agenda is to shove all the cost of this off to developing countries, Central America, South America, Africa, wherever else, someplace else. Because permitting won't let you mine stuff here. What goes into making a windmill or wind farm? What's the manufacturing? What are the materials? What's that cost, compared to what we have with the natural gas?

Mark Mills ([13:35](#)):

So both machines, you have to use steel. Both machines use concrete, the concrete foundations. Wind turbine are huge, big concrete foundation. Combustion turbines use steel to build the turbine itself. The wind turbine tower is made out of steel. Then you have the electrical components, which involve what's

called electrical grade steel and neodymium and cadmium of all kinds of metals. Then you have the big plastic blades. So, you obviously don't have big plastic blades for a combustion turbine, but the big difference is in two areas. The quantity of stuff you need per unit of energy, again, the amount of concrete glass, polymers, plastics, and steel you need per unit of energy goes up again tenfold per unit of energy produced compared to the gas turbine.

[\(14:27\)](#):

Then you have to have somewhere between 10 and 100 fold increase or infinite if you like, but increase in use of metals that the gas turbines don't use. Neodymium magnets require the rare earth neodymium to be mined and refined somewhere, most of which is in China again. So, the quantities of these materials are huge. They are often different in nature. As we produce concrete here, we actually produce a remarkable amount of steel in America. The interesting thing about wind turbines, of course, is they're blades. That's what they gather the energy from the moving wind. They're reinforced fiberglass. They're sets of plastic.

[\(15:06\)](#):

So, that small wind farm that I just described for 20,000 to 30,000, maybe 40,000 people, it requires production of enough non-recyclable plastic. It's not recyclable plastic. This is just buried in landfill when you're done. The quantity of that plastic in that one small wind farm is greater than all the plastic used to make all the world's plastic straws, which environmentalists are very upset about. Now, plastic straws are recyclable.

Bill Walton [\(15:32\)](#):

Are they upset about that fact or they're upset about the... Well, I would think both. As soon as you tell them that, they're going to be-

Mark Mills [\(15:37\)](#):

They'll be upset of all kinds of stuff.

Bill Walton [\(15:38\)](#):

... either way.

Mark Mills [\(15:39\)](#):

But just the asymmetry in our anxieties, if you like, about plastic straws versus unrecyclable plastic blades and wind turbines. To which the response is we'll make them recyclable one day. Okay, well, we could wait until you figured out how to do that.

Bill Walton [\(15:53\)](#):

Well, that's what I mentioned. There's so many things are TBD, to be determined, on the technologies that haven't been invented yet.

Mark Mills [\(16:01\)](#):

Yeah, that's my favorite line is that they want to bill everything from unobtainium.

Bill Walton [\(16:04\)](#):

Just define out unobtainium.

Mark Mills ([16:06](#)):

Unobtainium is the magical, perfect element that you can produce with no consequence, no minings required, produces infinite energy supplies with no emissions of any kind. It's free and cheap. Makes your life wonderful, unobtainium.

Bill Walton ([16:21](#)):

This is The Bill Walton Show, and I'm here with Mark Mills, Manhattan Institute and a lot of other great affiliations. We're talking about the new holy grail, which is an element called the unobtainium.

Mark Mills ([16:35](#)):

Unobtainium.

Bill Walton ([16:37](#)):

I can't pronounce it, unobtainium.

Mark Mills ([16:39](#)):

It's a new element.

Bill Walton ([16:39](#)):

New element. Okay.

Mark Mills ([16:40](#)):

Out of the periodic table.

Bill Walton ([16:43](#)):

Anyway, it's a great metaphor for what's happening with the environmental movement as they try to push us to be totally dependent on wind and solar. Now, the wind farms we're talking about, so you've got the cost of that, but then to mine this, how many mines are we going to have to create around the world if they realize the dream of significant dependence on when?

Mark Mills ([17:07](#)):

Well, so we come back to the baseline. You have to increase the total supply of metals and minerals, copper, nickel, lithium, aluminum, molybdenum, neodymium. Not unobtainium because that doesn't exist, but you have to increase that tenfold. So, how many more mines would you need? It's a reasonable question. The question has been answered by the International Energy Agency themselves, by the World Bank, by geological surveys. It's knowable because we know a lot about these minerals. The answer is we are not now mining, nor have enough mines on the planet to do this. You need hundreds of new mines, not a few, hundreds of new mines. By one estimate, nearly 400 new giant mines across the different types of metals and minerals, nickel and cobalt to lithium and aluminum.

Bill Walton ([17:57](#)):

So we're not going to put those in Martha's Vineyard.

Mark Mills ([18:01](#)):

You'd say, why not just build them? Market forces will work. I mean, after all, if demand goes up, supply will follow. This is true. Then you have this disingenuous, peril, infantile response from many environmentalists. Oh, Mills is a Malthusian. Doesn't think we have enough minerals in the earth. I'm accused of being a Malthusian recently, one of the most grievous insults to me. I'm an anti-Malthusian.

Bill Walton ([18:24](#)):

Sure.

Mark Mills ([18:25](#)):

There are plenty of minerals in the Earth's crust. I'm on the camp of a functional, infinite supply of minerals and energy and food for humans. The limits are what we're willing to do and where, at what price environmental, economically. What you want to know is not whether there's enough copper in the Earth's crust. That's a silly, silly distraction. It's how many copper mines exist? Is anybody expanding the copper mines? How much the copper mines? Let's pick copper, because it's one of the oldest, maybe the oldest mined metal. So, we need to increase copper mining about 200 to 250% alone in the next decade to meet the aspirations. Just copper to meet the aspirations.

Bill Walton ([19:07](#)):

Mark, be sure to turn off your phone.

Mark Mills ([19:11](#)):

I think that's your broker.

Bill Walton ([19:12](#)):

It's my phone. No, this is Steve Moore. We're worried about the debt ceiling right now.

Mark Mills ([19:16](#)):

Steve is a friend. Tell him hi. Tell him I'm glad he fixed the debt ceiling.

Bill Walton ([19:20](#)):

I think I'll wait to call him back.

Mark Mills ([19:24](#)):

Yeah. He takes second tier after me after all. He's just Steve Moore.

Bill Walton ([19:28](#)):

He's just Steve Moore.

Mark Mills ([19:30](#)):

The uber economist.

Bill Walton ([19:31](#)):

So all these mines, we're not going to put them in Martha's Vineyard. We're not going to even put him in the United States. You can't do it because of the permitting.

Mark Mills ([19:39](#)):

It's very tough.

Bill Walton ([19:40](#)):

They're going to go where, Chile?

Mark Mills ([19:41](#)):

Well, this administration has banned three mines that got through the permitting process, spending millions of dollars in the last year. So, you're right. We're not going to expand mining at the level needed to do it here. So, you'd want to know where the world's mines are, where they're willing to expand. We know that. It's places like Chile, Bolivia, China, a lot of the African countries. Chinese investors are very active in Africa, expanding mines there. You can say it's because they have rich ore bodies, which they do.

([20:09](#)):

They also are far more susceptible to corruption unfortunately than this is what the Chinese is pretty much overtly engaged in. We go to a country to say, "We'd like to help you open a copper mine to feed our appetite for electric cars and windmills, solar arrays, and loan them money." We attach lots of strings to it, many of them reasonable about environmental practices and child labor laws. It's nice to mine things not using children in my opinion.

Bill Walton ([20:37](#)):

Which is what they do in Congo.

Mark Mills ([20:38](#)):

Exactly. Well, the Chinese are not quite that strict. They don't have any of those strings attached to it. They simply loan the money, build the infrastructure, and harvest the minerals, refine them in China, and ship them to us so we can use our taxpayers' money to pay more for our electricity. I mean, it's an opposite of a virtuous circle, to your point, a villainous circle when it evolves abrogating basic labor standards. I don't mean labor union standards. I mean labor standards we take for granted in our country. They don't take for granted in many places in the world.

([21:11](#)):

We can mine cleanly and safely. They can be done. We do it in America. It's not done that way everywhere in the world. So, to your point, environmentalists are broadly sweeping under the rug these consequences, environmental and human consequences. Those that are noticing it, I got to give a shout-out and credit to both the Washington Post and New York Times lately.

Bill Walton ([21:34](#)):

We just lost half our viewers.

Mark Mills ([21:36](#)):

Yeah, but you can use magic Dr. Google. Do WaPo or New York Times mining for minerals for energy. They've just published in the last few months, excellent investigative journalism. Washington Post went to Indonesia, one of the world's biggest source of nickel. Nickel's on every electric car. It's on steel. It's the essential metal. We're going to have to increase nickel supplies several hundred percent in the

decade. So, the world's biggest nickel producer is expanding nickel mines and they're embargoing the export of nickel ore, requiring you to invest in their country in nickel refineries, all things.

[\(22:17\)](#):

So, Washington Post went and did an investigation and discovered that it's a big, dirty process. Really hard, involves lots of toxic chemicals. It's a very honest eye-opening piece for people who have not read anything about what's involved in mining. It's a big difficult industry. Doing it in countries that are not, let's just say, meeting Western standards and they'd say they're trying. The government probably states that, and they may actually want to. I don't want to judge them morally in that sense, but as a practical matter, what's going on will shock most people.

Bill Walton [\(22:56\)](#):

Well, if you multiply the number of mines we need for solar, add number of mines for wind and also batteries.

Mark Mills [\(23:06\)](#):

Hundreds and hundreds of mines.

Bill Walton [\(23:08\)](#):

We're talking millions of square miles really. We're going to kill the habitat all over the planet.

Mark Mills [\(23:14\)](#):

Well, it's not just land use. I mean when you mine, you do create a lot of waste. It's probably unavoidably the most wasteful process that humans engage in. Nothing comes close. This is not a news alert. What people don't realize is that with very few exceptions, the minerals that we need, let's use copper, because again, it's not substitutable, but this is true for all the minerals, the share of the ore, the rock that you mine that contains the metal you want is very small. Few percent, copper ore grades average 1%. Put differently, it means you have to mine a ton of copper to get 20 pounds of copper ore, a ton of copper ore to get 20 pounds of copper. If you need megatons of copper, you're talking gigatons of rocks dug up, crushed, creating waste.

[\(24:05\)](#):

Then to get the copper out of the copper ore, this is just something that most people haven't really thought about. You have to literally dissolve rock with chemicals. It's not like you're digging up soil and ooh, there's copper. You have to dig up rock, crush it, grind it, dissolve it with chemicals, toxic chemicals. You have to handle it carefully and then chemically refine the material to get the pure metal, whether it's copper or molybdenum or neodymium or rare earth, whatever the rare earth is. These are very, very land and materials intensive processes.

[\(24:43\)](#):

We've spent centuries trying to get good at it. We've become very good at it, but it's slow process. You talked about land use. What about just money? I mean, each new mine is billions of dollars of capital investment or a big copper mine, \$10 or \$20 billion. We're talking dozens of copper mines.

Bill Walton [\(25:03\)](#):

Well, and none of this would be investible with that government subsidies.

Mark Mills ([25:07](#)):

Exactly. So, you'd want to know-

Bill Walton ([25:09](#)):

I mean, one action, I mean I want to get to that at the end, is that we need to stop these subsidies, because it's eliciting behavior, which is egregious.

Mark Mills ([25:19](#)):

It's a grotesque moral hazard when you engage in subsidies. Subsidies have a role. Narrowly targeted, time limited use of subsidies is a very, very old tool in governance and has unequivocal value in very specific areas, particularly military domains, those kinds of things, but it comes to general markets. The behavior markets are egregiously distorted by massive subsidies. I mean, it's crazy. It's a moral hazard. If you're in a business and you've got hundreds of billions of dollars gushing into the federal trough, every business out there, certainly everyone I've talked to overtly, they're searching to see how they can bend their business to get some of that free money.

Bill Walton ([26:03](#)):

The recent bill, we now call it the Green Energy Act, instead of the Inflation Reduction Act, which is-

Mark Mills ([26:09](#)):

Yeah, exactly.

Bill Walton ([26:10](#)):

... grotesquely misnamed. That's really also provided incentives for the communities all over the United States, of course, to try to get some of that subsidy.

Mark Mills ([26:18](#)):

Of course, of course.

Bill Walton ([26:20](#)):

So they're embedding a constituency for the climate change agenda, lot like they embedded a constituency for let's say ethanol.

Mark Mills ([26:28](#)):

It's pretty powerful. As you know, Republicans have a hard time speaking truth-

Bill Walton ([26:32](#)):

Republicans are all in on this.

Mark Mills ([26:33](#)):

... on ethanol because of Iowa. The truth be told, there is a role for a small amount of ethanol. Let's just assume for the sake of discussion that ethanol can be produced at breakeven with oil, which is not true, but it's not crazy far off, not the way wind and solar are for the sake of discussion. If you want to replace 5% of our oil use with ethanol, even if it's a little more expensive, it's a domestic product that doesn't

distort the market profoundly. So, if you said to me, "I want to do the same thing with wind and solar. I want to replace 5% of our energy with wind and solar."

Bill Walton ([27:12](#)):

Just 5%.

Mark Mills ([27:13](#)):

5% or pick 10. I mean, small numbers.

Bill Walton ([27:15](#)):

Pick 10.

Mark Mills ([27:17](#)):

Not a profound distortion in markets really, if you subsidize that. I'm not endorsing it. When you say, "Oh, we need to replace all hydrocarbons with wind, solar, and batteries," you're not making a small subsidy distortion. You're now saying, "I have to subsidize by definition, all American energy production." When you subsidize electric vehicles, you want them to all be EVs, which are inherently more expensive because of the materials. They're inherently more expensive because of the materials. We're not going to engineer that away. The battery weighs 1,000 pounds to replace about 80 pounds of gasoline. So, if you want to subsidize that, you have to subsidize all car purchases in perpetuity, because there's no engineering path to make them cheaper.

Bill Walton ([28:01](#)):

Without subsidies, none of this is investible. I'm speaking as an old private equity guy.

Mark Mills ([28:07](#)):

Yeah. I would say a few percentage points of-

Bill Walton ([28:10](#)):

Okay, I won't say infinitesimal amount. It meets the market test.

Mark Mills ([28:15](#)):

Yeah, if you're investing in private equity on this, you're making a bet on the government subsidies.

Bill Walton ([28:21](#)):

So we've got a couple of other effects here. We've got the manufacturing mining issue, but then you've also got the fact that wind and solar is not storable. So, you've got to build massive batteries to store this energy. Whereas if you've got natural gas or a barrel of oil, it's not only the energy, but it also is a storage unit.

Mark Mills ([28:43](#)):

Right. Well, so then you'd want to know the obvious. Well, you can always store it. There's all kinds of ways to store energy. There's practical ways like oil in the tank. There's obvious ways like electricity in a battery. There are goofy ways that are even being proposed and funded by goofy private equity guys,

which I call the Fred Flintstone technique for storing electricity. They take big rocks when you have extra electricity when nobody needs it from the sun. You drag the rock up with a crane, and then when you need the energy, you let the rock drop connected to a wire, to a motor generator, and it generates electricity. It works. It's silly. It's infantile.

[\(29:24\)](#):

All you'd want to know is Fred Flintstone come to life. You'd want to know what does it really cost compared to say, just storing the oil in the first place. Depending on the technology, somewhere between 10 and 100 times more expensive to store the same unit of energy with these, whether it's a battery, I don't care what the battery is, or Fred Flintstone techniques. There's somebody even proposing using trains, filling the trains full of rocks when you have extra electricity when nobody wants the wind power, because that's what happens. Wind produces it, you don't need it, and not when you do need it.

[\(29:56\)](#):

You run the train up a hill with electric motors, and then when you need the energy, the train runs down the hill and the motors reverse and become generators, Fred Flintstone on wheels. I mean, it's really silly stuff. It technically works, but it's profoundly silly and profoundly expensive. So, with windmills and solar, you need to store the energy. You can do it. It just costs money. Just costs money. So, then the response is, "Well, the technology, it will get cheaper." Yes, it will. But when you're starting with a basis that's more than 10 times more expensive-

Bill Walton [\(30:27\)](#):

Even cheaper doesn't meet a market.

Mark Mills [\(30:29\)](#):

... it doesn't get you close.

Bill Walton [\(30:30\)](#):

No, it doesn't get close.

Mark Mills [\(30:33\)](#):

It's always windy or sunny somewhere. You've heard that. So, just build more transmission lines, just build.

Bill Walton [\(30:39\)](#):

Well, the transmission lines are a huge problem.

Mark Mills [\(30:42\)](#):

Exactly.

Bill Walton [\(30:42\)](#):

Because all the wind and solar is off in some remote place, and you got to get it to a city.

Mark Mills [\(30:47\)](#):

Apparently, that costs money too, apparently, but more importantly-

Bill Walton ([30:51](#)):

Well, that's in the last bill.

Mark Mills ([30:53](#)):

It is in the last bill. Also, they're hoping to override local communities and state's objections to transmission lines. That's the goal. Most of the goals, if you peel away the layers of costs-

Bill Walton ([31:05](#)):

So right now, the states control whether you can have a transmission line. They want to make that a federal power.

Mark Mills ([31:11](#)):

So they want the FERC, Federal Energy Regulatory Commission, to preempt any state inputs on where this moves. Now, what happens is there are federal preemptions, but in our federalist system, this is the kabuki dance that we've had, which has been extremely effective at preserving freedoms and liberties and the diversity of solutions in American states as you know. But in service of the climate agenda to change our energy systems, all those things are to be thrown out. All of the freedoms, all the subsidiarity of pushing decisions to states are to be thrown out.

Bill Walton ([31:45](#)):

Yet another attack on federalism.

Mark Mills ([31:47](#)):

Oh, it is. This is not a subtle attack. It's an overt attack.

Bill Walton ([31:53](#)):

So this is Bill Walton. I'm here with Mark Mills, the Manhattan Institute, a deep thinker about all things energy and many other topics as well. I'm about to learn what embodied energy is. Yeah.

Mark Mills ([32:07](#)):

Do you really want to know?

Bill Walton ([32:08](#)):

I really want to know. It's in your testimony, and I thought it was extremely interesting about... Well, I'll let you explain embodied energy.

Mark Mills ([32:17](#)):

Well, since I started by pointing out that you can't build anything without digging something out of the ground first, you need to get minerals to make everything. Polymers is not digging stuff. You have to drill for oil and gas. It takes energy to do that. So, the energy that's used to make a product is called the embodied energy. When you make a glass, the energy it takes to make a pound of glass is a well-known number. The energy it takes to make a pound of steel is a well-known number. We know how much energy it takes to make a car. So, the energy used to make something also has associated with it emissions for making that thing.

[\(32:54\)](#):

So, when you import an electric car, you're actually exporting energy used elsewhere by definition and emissions that have happened elsewhere. So, to make an electric car battery that stores the electricity, you have to use energy. How much do you have to use? Well, it depends on where you make the batteries' materials. But something on the order of 300 barrels of oil equivalent of energy are used to make enough batteries to store one barrel of oil, equivalent of energy. So, you buy the energy.

Bill Walton [\(33:29\)](#):

Three hundred barrels to get one barrel?

Mark Mills [\(33:31\)](#):

Right, to store one. You still have to make the energy, but the battery that can store a barrel of oil equivalent in electric form requires energy use somewhere else 300 barrels of oil equivalent worth. That number, the energy used to make the battery. This is the key thing that is being ignored at all these futuristic debates. That number is going up, not down. While we engineer better and better ways to mine and manufacture things that reduces energy use, Mother Nature has a surprise for us. The ore grades, the percentage of minerals in rocks has been declining for centuries. So, every time ore grade goes down, you can do the arithmetic here, you have to dig up more rock to get the same quantity of copper or nickel or aluminum, which means you use more energy.

[\(34:19\)](#):

So, the marginal new pound of copper, the marginal new pound of aluminum, the marginal new pound of nickel in the near future has higher energy use because of declining ore grades locked into the geology of the planet we live on, which means the emissions for each marginal powder time are going up. So, the embodied energy, the embodied emissions for building wind turbines, solar arrays, and electric cars are rising. We know they're rising. This is not Mark Mills saying. This is a geologist telling us something. The World Bank knows this.

[\(34:52\)](#):

Again, back to the IEA, the International Energy Agency who are indefatigable champions of the energy transition, in their technical documents, they point out in elliptical language but clear that the emissions and energy use from mining each new pound of metals that are needed are rising. I love this language they use, could offset some of the benefits of not burning gasoline. Could offset? Excuse me.

Bill Walton [\(35:21\)](#):

You've got a chart in your testimony that I thought might be useful to put up on the screen now. It's called mineral requirements to build different energy machines. You want to speak to that?

Mark Mills [\(35:34\)](#):

Well, what we have are two classes of minerals you need to build energy machines. Everything requires almost everything using steel, copper, glass and plastics, aluminum, so the basic metals. So, you have roughly a tenfold to 20 fold increase energy delivered to go from combustion turbines or coal plants or nuclear plants to wind and solar. That's the basic material. So, that's a lot of land use. I mean, you got to dig up a lot of rock. You got to make a lot of concrete, a lot of glass. Glass uses natural gas. Glass uses coal. Concrete uses coal, natural gas. Steel uses metallurgical coal.

[\(36:12\)](#):

We have no other way to make steel right now, and we won't for a long time without using metallurgical coal. Coal use in the world's going up, not down, by the way. So, all those material uses were going to accelerate their use not because of population growth, not because of wealth growth, because the decision to go from combustion of hydrocarbons to wind, solar, and batteries will increase by more than tenfold basic material requirements.

Bill Walton ([36:35](#)):

So show me on this chart what you mean, because we're going to have this up on the screen.

Mark Mills ([36:39](#)):

We'll put this on the chart. So, if you look at the graph that shows you a natural gas combustion turbine and you can see that the bar height to produce the metals and the concrete and the glass you need, it's almost invisible. You're looking at something on the order, if you do the math, per unit of energy, you need 1,000 tons of X, 1,000 tons of those materials. If you go to solar PV, you need something on the order of 15,000 tons. So, you have 15 fold increase on the basic materials. We're not talking about exotic materials like rare earths. We're not talking about cobalt, lithium. Basic materials. Now, you'd say, how could that possibly be? The sun is free. Well, the sun is dilute.

([37:24](#)):

So, if you go back to just image, you can go to Google Images and get an image of 100 megawatt power plant combustion turbine. Again, it's about the size of a tractor trailer and get a picture of 100 megawatt solar farm. You look at acres and acres of land covered in aluminum frames, copper wires, glass covered solar cells. These hundreds of acres of stuff takes 15 times more physical tonnage of materials just to build.

Bill Walton ([37:57](#)):

So we build all these machines, these wind machines, we build the solar machines, but then they wear out. What happens then?

Mark Mills ([38:06](#)):

Details. Details. I mean just waste, whatever.

Bill Walton ([38:09](#)):

Well, it's massive waste.

Mark Mills ([38:10](#)):

It's massive waste. So, the waste production, we have another graph.

Bill Walton ([38:15](#)):

We've got another graph there.

Mark Mills ([38:18](#)):

Again, we go to IEA data, World Bank data. What you find is let's just do the wind turbine blades because this is what is not recyclable. This is what the World Bank and IEA are worried about. You can recycle the steel. Steel's very easy to recycle, and you can recycle aluminum, extremely easy to recycle.

So, recycling rates are very high, but you've got all this non-recyclable plastic. You have to throw it out. When you find out, if you go from today where you have a few thousands of tons of these plastic blades being cut up and put in a landfill, because we're just at the beginning of the end of the life of all these solar farm wind farms, they last about 20 years. Sometimes they only last 10 years. They wear out prematurely or you have a new blade that's more efficient, so you replace them.

[\(39:06\)](#):

But let's just take the 20 years. Most combustion power plants have a lifespan of 30 to 40 years. So, you're not only using 10 times more material and you build triple the number of power plants. So, now we're going to 30 fold increase in the tonnage of stuff it accumulates. You're going to do something with it. So, that you've got a lot of people in the environmental community and we'll call it the global World Bank class of community looking at this and anxious that we're going to generate this massive quantity of waste. What will we do with it? So they're pushing hard to come up with the next generation of blades being recyclable, for example.

Bill Walton [\(39:46\)](#):

But it doesn't exist yet.

Mark Mills [\(39:47\)](#):

They don't exist today, and it's not theoretically impossible. It's they don't exist today. So, we're going to have not just a few tons, tens of thousands, and then ultimately, millions of tons of waste, including solar panel waste. I mean the kind of metals that are put in the glass on top of solar panels to stabilize the glass from being damaged by UV light render most solar glass as a technical hazardous waste. So, it can't just be casually thrown away. So, ultimately, somebody has to break down all those things, spend the money and time, bury it somewhere. By the way, I'm not in the camp that was worried about having enough landfill for this. The plant is really big.

Bill Walton [\(40:28\)](#):

Well, China no longer will take it.

Mark Mills [\(40:29\)](#):

They won't take it, but build a big hole in Nevada.

Bill Walton [\(40:32\)](#):

They declared a couple years ago, they didn't want to take it. It was dangerous.

Mark Mills [\(40:35\)](#):

Well, I think this was a stick in the eye frankly to the United States. They're not really that worried about the danger stuff, we don't think, but they were getting in trouble. They were getting spanked for putting... Well, I think it's 80% of the world's plastic waste going into the oceans comes out of the Yangtze and a few other rivers in China where they don't particularly take a lot of care to handle the trash that we were sending themselves.

Bill Walton [\(41:01\)](#):

China has the dirtiest rivers on the planet.

Mark Mills ([41:03](#)):

They do. They do. So, the path to clean rivers is called wealth and the path to wealth is called cheap energy. What we're now doing is making energy more expensive and increasing the quantity of waste.

Bill Walton ([41:14](#)):

Not slightly more expensive. Dramatically more expensive and also not available. You mentioned something in your testimony, a Dutch government sponsored study concluded that Netherlands alone at green ambitions would consume a major share of all the world's minerals.

Mark Mills ([41:32](#)):

Yeah. Of today's world production level. Yeah, one region, one country. Yeah, exactly. If they want 100% green, they're called cobalt lithium, but they did the calculation. It's to do everything, not just electric cars. Everything in society is going to be powered by electricity, produced by windmills and solar arrays.

Bill Walton ([41:50](#)):

So cobalt, lithium, indium, and then all those other elements that I can't pronounce.

Mark Mills ([41:58](#)):

The alphabet soup from the periodic table that everybody's forgotten from high school chemistry.

Bill Walton ([42:03](#)):

I'm sure you have the periodic table memorized and neodymium.

Mark Mills ([42:06](#)):

Neodymium.

Bill Walton ([42:06](#)):

Neodymium. Okay, well, but that's there.

Mark Mills ([42:08](#)):

That's a magic metal.

Bill Walton ([42:10](#)):

We need 400 times more neodymium if we do this. This is according to the World Bank.

Mark Mills ([42:16](#)):

That's right.

Bill Walton ([42:19](#)):

We talk about becoming more dependent on China. This is dependency on steroids.

Mark Mills ([42:25](#)):

Well, sure. This is now an open secret. China's the utterly dominant producer of refined what the IEA calls energy minerals. Just to put this in the context of the things that are being vilified, China's market share for refined energy minerals is more than double opex market share of world oil. So, the geopolitical and price concentration power of energy stuff for China is double that of OPEC. So, we spent 50 years wringing our hands over resource concentration and hydrocarbons. Now we've allowed to happen and are now going to encourage accelerating a resource dependency on China that's more than double, more than double the resource dependency.

Bill Walton ([43:17](#)):

There used to be all these stories about whether OPEC could agree on something. I'm sure China will agree with itself.

Mark Mills ([43:23](#)):

It does. Exactly. Would China exercise pricing power when it's convenient for them? This is a question as they say, that answers itself.

Bill Walton ([43:35](#)):

Oh, yeah. President Xi. Yeah. There's so many factoid. I'm running a bit out of time. I just wanted to get some things in here that I think people who are pushing electric vehicles and mandating electric trucks in California ought to learn that electric car battery, a single battery has about 1,000 pounds, but the total amount of mining materials required is 500,000 pounds.

Mark Mills ([44:02](#)):

Yeah. Well, this is the easiest way to explain. When you talk about increasing world mining by tenfold-

Bill Walton ([44:08](#)):

That doesn't even get close.

Mark Mills ([44:13](#)):

Saying something about the world growing-

Bill Walton ([44:15](#)):

It's hard to visualize.

Mark Mills ([44:18](#)):

... it's hard to visualize. What you want to visualize is for one car, if you have the gasoline version, you have a gas tank and you put about 70, 80 pounds of gasoline in it. The electric field doesn't have a gas tank. The battery weighs 1,000 pounds, which is why the electric vehicles use a lot more aluminum, which is a whole another embodied energy story. But to get the materials to make that one battery, on average you have to dig up about 500,000 pounds of the earth or put differently. This is doing tons. One car, which weighs about a ton roughly with a half-ton battery, takes 250 tons of digging up rock and stuff somewhere else to make that one car, that one EV.

Bill Walton ([45:01](#)):

It's the same.

Mark Mills ([45:02](#)):

Now, to do it for the regular car, I don't need to 250 tons to be dug up. I need tonnage too, but I don't have a battery. I don't have to get copper, the same quantity of copper. I don't need any cobalt.

Bill Walton ([45:15](#)):

So another one, if wind turbines were to supply half the world's electricity, nearly two billion tons of coal would've to be consumed to produce the concrete and steel.

Mark Mills ([45:28](#)):

Yeah, it's an inconvenient fact. So, we use coal to make steel and concrete. The energy transitionists, those who think we should get off of coal, oil and gas, point out that it's theoretically possible to use other means to make steel. This is true. You can use hydrogen to make steel and produce the hydrogen by electrolyzing water with wind turbine electricity. All these elliptical solutions are in theory possible. They're extremely expensive, not scaled or scalable in the world we live in that were subsidizing today. So, invoking new technologies to make steel, for example, without using coal is silly and irrelevant. The subsidies are intended to pay for what we know how to build today.

[\(46:16\)](#):

So, the wind turbines we're going to build tomorrow with today's subsidies, we'll use technologies that we know how to use today, which means millions and billions of tons of coal consumed in service of making polysilicon for solar modules, steel for wind turbines, aluminum for solar modules, lithium and cobalt for batteries using coal, gas, and oil largely in China, but also in Africa and South America. Some of it in Canada and Australia. I keep coming back there, because one of the outs in the subsidy game is to subsidize mining in our friendly neighbors like Canada and Australia, which is what's going on right now.

[\(46:54\)](#):

So, the requirement in the Orwellian Inflation Reduction Act that the subsidies require you to use US-sourced materials unsurprisingly elastically meant to define from our friends too. So, we're doing direct subsidies from US taxpayers from mines in Australia. Hey, I like the Australians. I think it's a great country and God bless them, but why are we subsidizing Australian mines?

Bill Walton ([47:25](#)):

Great question.

Mark Mills ([47:28](#)):

I know the answer.

Bill Walton ([47:29](#)):

Well, you do know the answer.

Mark Mills ([47:29](#)):

Desperation.

Bill Walton ([47:30](#)):

But implicit in what we're talking about today is this whole madness that's been aimed at reducing CO2. You and I can talk at length, I think, about whether we think that's a real problem, but that's not what we want to do now. But it strikes me as listening to everything you're saying and we've only talked about a half dozen of many, many more examples you got, it seems like all that activity is going to increase CO2 levels, all the manufacturing, all the embedded energy, all that stuff. So, in order to knock out so-called CO2 increases from hydrocarbons, we're going to increase it dramatically from manufacturing all this stuff to stop the thing we're trying.

Mark Mills ([48:18](#)):

Yeah, sure.

Bill Walton ([48:21](#)):

I'm trying to come in for a landing here.

Mark Mills ([48:24](#)):

Yeah, it gives you a headache. Yeah. So, it is entirely reasonable to say, and this is not hyperbole, that many of the electric cars that will be driven in America in the near future, of course, they aren't burning gasoline and that eliminates the CO2 from that combustion. But the CO2 emitted to build the electric cars batteries and mine the materials will offset most, if not all, of the CO2 then not emitted by not burning gasoline in the first place, which means the economic trade through this massive subsidy buys you not only nothing in CO2 terms or very, very little, but it buys you the export of jobs, geopolitical dependencies, and environmental impacts somewhere on the planet for no benefit.

([49:13](#)):

So, this total fuel cycle analysis, which is difficult to do, everybody would like to do it, is impossible to regulate because it's the world's labyrinthine mineral supply chains, industrial refineries all over the planet, but we do know that CO2 emissions on the planet are going up. The world has spent something on the order of \$5 to \$10 trillion in the last two decades in service of avoiding using hydrocarbons. The quantity of hydrocarbons used by the world has increased over that time. Total CO2 emissions have gone up on the world, and that's what's going to keep happening. That's locked into the nature of the engineering physics of the universe we live in. It's locked into the nature of the fact that China... China has announced that whatever they're going to do to cut hydrocarbon use will be post-2050.

Bill Walton ([50:09](#)):

Post-2050. Yeah. Whereas we have all the trucks in California on electric vehicles by 2030.

Mark Mills ([50:20](#)):

I'll take the bet that that won't happen, but it will cost a lot of pain and money along the way.

Bill Walton ([50:28](#)):

One last point and then we got to get out of here, but I've got about 53,000 other things I want to talk to you about. So, you have to come back.

Mark Mills ([50:37](#)):

Come back with another [inaudible 00:50:38].

Bill Walton ([50:40](#)):

If you spent your life in the investment world looking for growth companies and you're a big believer that growth is the way to make people more prosperous and happier and make society a more livable place, everything we're talking about here seems to be killing economic growth.

Mark Mills ([50:58](#)):

Yeah, it does.

Bill Walton ([50:59](#)):

But as you and I have talked about, they don't care. In fact, they think that agenda ought to be de-growth.

Mark Mills ([51:06](#)):

Well, I think you're right. It's no longer an insult or an invective to accuse a lot of environmentalists of being de-growth. This is overtly a strategy, honestly, outwardly pursued. There's a big conference coming up in Europe that EU is funding on de-growth, how to make people happy in a de-growth world. So, what they're in effect implicitly, if not explicitly, acknowledging is that all this green stuff we're spending money on doesn't solve the problem. Some of them are overtly admitting because the things I'm saying are not disputable, they're just facts. It's not about whether the climate is warming or not. Copper is copper whether you think the climate's warming or not. Ore grades are declining, no matter what you think about climate change.

([51:55](#)):

They know this, the smarter environmentalists. So, what they're saying overtly is therefore, if wind, solar, and batteries won't cut CO2 emissions, the way you have fewer emissions is to use less energy, less growth, fewer people. So, they're overtly for engineering a society in which you will be happy without growth, without economic growth. If you like to see [inaudible 00:52:23] civilization has been to elevate the prosperity of the maximum number of people-

Bill Walton ([52:30](#)):

Those people out of poverty.

Mark Mills ([52:33](#)):

We're going to reverse that and create this fiction. Again, they're overt about this. That you could be happy, you'll be happier in the future where you have less stuff, less travel, fewer freedoms, because that will be in service of less energy uses, which is they are saying a priori needed to achieve the goals they have articulated for cutting the carbon dioxide emissions of the planet. What they're essentially saying, there is no possibility, and I agree with them, on cutting carbon dioxide emissions to the planet, absent, huge degrowth, which is a euphemism for massive global recession. That's what it's a euphemism for.

Bill Walton ([53:18](#)):

I'm speechless and what you say confirms what I've been hearing. So, we've got a lot of work to do. It's been The Bill Walton Show. I've been here with Mark Mills, Manhattan Institute. Although we ended on a fairly dour note, Mark's written a terrific book title-

Mark Mills ([53:40](#)):

Where are my roaring 2020s? The Cloud Revolution. Yeah.

Bill Walton ([53:45](#)):

Because there is another side of this story. I think there are two things we need to get into here in the future when Mark comes back, is we need to have a real discussion about CO2 and whether that's really the threat that it's supposed to be. The other thing we need to talk about is all the positive things that are happening in the technology area. People are now worried about artificial intelligence. Obviously, that's something we need to be concerned about, but there are a lot of things that are going to make the world a lot better. So, we've got these opposing forces and we need to know what side we're going to be on. So, Mark, pleasure. Thank you.

Mark Mills ([54:21](#)):

Good to be here. Thank you for a chance to be dystopian, as opposed to being the last optimist.

Bill Walton ([54:28](#)):

Well, but next time, you're going to come on as the last opposite, then I think I'll join you on that, I hope. Anyways, Bill Walton Show. You can find us as always on all the major podcast platforms, YouTube, Rumble, Substack now. We're on CPAC now on Monday nights and probably soon to be adding another night since we're doing more shows. Send us your comments either through Substack or on our website. As you know, we pay a lot of attention to the people you'd like to hear from, the topics you'd like us to get into. As always, we're trying to take complicated matters and make it plain what's at stake for us and what we can do about it. So, anyway, thanks for joining and talk with you soon. I hope you enjoyed the conversation.

([55:12](#)):

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