The Great Simplification

Nate Hagens (00:00:02):

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.

(00:00:33):

Joining me today is Sir David King, who is an emeritus professor of chemistry at the University of Cambridge in England. He's also the chair of the Climate Crisis Advisory Group and the founder of the Center for Climate Repair at Cambridge. Previously, Sir David King was the Chief Science Advisor to the British government, as well as the foreign secretary's special representative on climate change. On this channel, we're trying to integrate and explain how all the parts and processes fit together of the human predicament.

(00:01:11):

We had in the past month alone, Sean Sutherland talking about plastics. Robert Sapolsky talking about brain and behavior. Luke Graman talking about interest rates, peak cheap oil, currencies and financial risks. And last week, Chuck Watson talking about geopolitics and the risk for nuclear war. A lot of people are hyper-focused right now on the warming Earth and the impact of global heating on the oceans and the biosphere. A lot of people still are not, and we are becoming increasingly compartmentalized and tribal in the things that we care about. It all fits together. This was a deep dive with a physical scientist who's been working on climate his entire life and is deeply ensconced in political circles around the world and knows what's going on. What a wonderful man, Sir David King is articulate, warm, and he deeply cares about our biosphere and the future. I hope you enjoy this conversation with Sir David King. Good afternoon, Sir, and in this case, I really mean it. Welcome to the program.

Sir David King (00:02:41):

Good afternoon, and it's very good to be on the program.

Nate Hagens (00:02:46):

You can see in the globe behind me, I have both South Africa and the UK on screen in your honor.

Sir David King (00:02:54):

Thank you.

Nate Hagens (00:02:54):

We have a lot to discuss, but let me start with this. You are a chemist, a scientist, and working on the important issue of climate change with your organization and in your career. Let me ask you this, when did you personally first learn about the climate system dynamics and when did you first get personally really concerned about the human aggregate impact on the biosphere from the metabolism of our CO2 burning?

Sir David King (00:03:29):

That's a relatively easy one because I'm a physical chemist, between chemistry and physics, and I got the chair of physical chemistry in Cambridge in 1988, and that was when I was exposed to the atmospheric scientists here who were world leading, particularly on the destruction of the ozone layer by CFCs. And that then led me into discussions with this wonderful group here about climate change and the realities of the science underlying what we understood about climate change. I would say 1988 is the date when I began. And I would say about the same time I began to get very worried about it and had discussions, for example, with somebody who's now Lord John Browne and John was the CEO of BP and he had a house here in Cambridge and we used to have many, many discussions. And at first John said to me, "David, I'm not convinced the jury's still out." And then I would say about the year 2000, John was saying to me, "I get it, climate change is real." And that's when BP changed its logo from meaning British Petroleum to meaning Beyond Petroleum.

Nate Hagens (00:04:57):

And 1988 was 35 years ago. If you were concerned then personally, psychologically, then this is a bit like watching an unfolding tragedy than knowing what you know.

Sir David King (00:05:12):

It's very much like watching an unfolding tragedy. Because at first when we were discussing this issue, it seemed to all of us that we had time to manage the problem. We had that 1992 meeting in Rio, which was very strongly supported by the American government, by governments around the world. And I said the American government because frankly if the American President had led the way from that point on, on climate change, we wouldn't be where we are today. 10 years ago, I said, "We've got 10

years to get everything in place to see that we can still manage the challenge." Five years ago I said, "There's five left." Well, you can see where we are now. Time isn't on our side and we are having to adapt our strategy to meet the very real challenge that we have.

Nate Hagens (00:06:11):

I know you're working on adaptations and technological strategies and we're going to get to that. But let me first take a step back. I don't know how much you know about this podcast and my work, but I'm trying to paint a systems picture of how everything fits together. And climate is, in my opinion, a symptom of a larger dysfunction of a social species that found a huge amount of fossil sunlight and is throwing a party for the last 150 years. But that involves economics, money, debt, geopolitics, human behavior, all these things. And those of you who are scientists deep in the climate space, obviously know and feel the urgency of the situation, but many other people are focused on poverty, or debt overshoot, or many, many other issues. And I'm trying to convene people at the same table. A lot of my listeners listen to this because of energy depletion and finance and such. For now, David, could you assume that I have no background at all in this field, but am just a pro-social, civic-minded human alive today at this amazing and perilous time. Can you give me an elevator pitch on why climate change is happening and what it implies?

Sir David King (00:07:44):

Yes. But first of all, Nate, can I just say I know what you're doing and I very strongly support your whole program. We're on the same page, I think. Then, in answer to your question, the science of climate change was really developed after Fourier, the great French mathematician back in 1824, published a paper in which he said, "We know how much energy is coming to the Earth from the sun, and we now know that a hot body radiates heat outwards at a rate which is equivalent to the fourth power of the temperature of that body. As the body heats up, the radiation increases enormously at fourth power. That's a very high power. And he said, "Therefore, we should be able to calculate the temperature at the surface of the Earth very accurately."

(00:08:45):

And interestingly, first of all, he found a number which was way out minus 30 degrees centigrade. I'm going to talk in centigrade, minus 30 degrees centigrade. And what that meant was that he realized he had not included the function of the atmosphere

in capturing radiated heat from the hot surface of the Earth. In other words, his model was to take a cold Earth radiated with sunlight, and then as it heats up, it radiates heat out equal to the amount of sunlight coming in to heat up the earth. He then includes what we would call a Fourier coefficient. We might even call it a fudge factor to get the right number plus 15 degrees centigrade average for the planet. He does that, putting that coefficient in, but honestly stating, "I had to develop this because I don't know how to calculate how much heat is captured by the atmosphere."

(00:09:47):

Then we come to a very important scientific development, which is the understanding, and let me say how this was measured, the understanding as to how the atmosphere captures heat. We have this great Irish scientist, Tyndall and Tyndall takes a glass tube, puts heat in at one end and measures how much comes out the other end. A very simple experiment, except that very fortunately at first he cleaned the air that he was putting into the tube, cleaning the air, something a careful scientist might do meant that he removed literally all of what we call greenhouse gases. He removed carbon dioxide, methane, water vapor from the sample and he found a coefficient of zero. It looked as if Fourier had got it wrong, and then he just tried it again with air as it comes with all its impurities and bingo, he got Foerier's coefficient very accurately.

(00:10:54):

Now this is a very neat piece of science because that confirms that we understand how the atmosphere captures radiation. Now we understand radiation from a hot body at a relatively low temperature like the temperature of the earth is in the infrared region. And infrared radiation can be captured by molecules that don't have the same atoms at each end, and oxygen and nitrogen, oxygen has oxygen atoms at each end. Nitrogen has nitrogen atoms at each end, can't capture radiated heat. It has to be a molecule like carbon dioxide, methane, et cetera to capture the heat. We now understand all this and we can calculate these numbers theoretically because the understanding from quantum mechanics of the behavior of molecules is pretty damn good today. Then we come to 1897 when a great Swedish scientist by the name of Svante Arrhenius said, "Okay, I can take Arrhenius's equations with the coefficient fully established by Tyndall and I can calculate what the temperature rise average for the whole planet would be if we continue burning fossil fuels." He said this in 1897, "If we continue burning fossil fuels and eventually put as much in the atmosphere as we've got already double the amount there," and he calculated the temperature rise would be five degrees centigrade.

(00:12:35):

The biggest computer in the world today, which is busy working on these equations, but with much more sophistication introduced demonstrates that by the year 1900 we really had most of the physics well established. There's some key things left out, but most of the physics is established. And if I say to you, "The number's actually three plus or minus two degrees centigrade today," it's not very different from what we knew in 1897. I think that's the basis of our understanding. And if I can explain it in very simple non-scientific terms, you get into bed at night and it's winter and it's cold and you've only got a sheet over you, you put a blanket or a duvet over you, your radiated body heat is captured by the blanket, keeps you warmer. If then somebody kind came along and put a duvet over you, you would say it's too damn hot. You'd simply exceed the temperature you would need. That's what we are doing today. We're adding another duvet onto the bed and the result is global temperatures rising.

Nate Hagens (00:13:51):

Thank you. I've got some follow-ups to that based on things that I frequently get asked or people in the news have little soundbites. You've described what CO2 and methane and other things do, they act as blankets or duvet covers. But an often repeated claim in the news is that CO2 originally was only three parts per million and now is just over four parts per million, maybe headed towards five parts per million. How can such a small amount, three or four or five parts per million actually change the heat flux and the temperature on Earth?

Sir David King (00:14:40):

All right, let me just put a slight correction on that. Today we're at 420 parts per million of carbon dioxide in the atmosphere. And if you add methane to that, we're now at well over 500 parts per million expressed as CO2 equivalent. Now if I go back to the pre-industrial period, it was 275 parts per million. Greenhouse gases have got a very bad press at the moment. We need them. We should never bring greenhouse gas levels down below 275 parts per million because we'd all start getting extremely cold. The temperature at the surface of the earth is almost precisely what Fourier first calculated, sorry, at the surface of the moon, it's about minus 30 degrees centigrade. It has no atmosphere. I would just say, look at the moon guys, that has no atmosphere, same distance from the sun that's getting the same amount of radiated heat. Why are we warmer? It's because of greenhouse gases and thank you, the human species wouldn't have come into being without those greenhouse gases making it nice and

warm for us. But when we increase the amount, then it's bound to get warmer and it's almost as simple as that.

Nate Hagens (00:16:06):

And yet how many people really understand that of the 8 billion humans, a few million? I don't know.

Sir David King (00:16:17):

You're quite right to ask the question. Needless to say, I've been talking about this for a long time and I've traveled the world, many, many countries of the world making these speeches. The Climate Crisis advisory group that I chair, which is a global group, 16 members from 11 countries, CCAG, do visit our website. You'll find we've produced 18 reports in three years, and those reports will tell you why we're having extreme weather events. We can explain these in some detail now because of our understanding. I think we need to really get the idea that this is a very sophisticated field. For example, Nate, what was the temperature at the surface of the earth over the last million years and how do we find out? Now it's very, very clever because if you go to a region of the world where snow has been falling year upon year and very little melting has happened, the snow that fell a million years ago is down at the bottom of the heap and at the top is last year's snowfall.

(00:17:35):

And if I drill down and take a core of ice, which is exactly what is done. Here, we have in Cambridge, the British Antarctic survey, they've got all these freezers full of these cores, and in the core you can analyze what the snowfall looked like 600,000 years ago, 800,000, et cetera. You can analyze it because captured in the cause is the amount of carbon dioxide that was in the atmosphere at that time because there are bubbles of air captured in the snow, in the ice that's compacted as further snow falls. Now it doesn't go all the way back that way because the sheer weight of the ice does actually force the bottom layer to slip away into the sea. You can go back about a million years that way, but then you can do ocean cores and you get, again, information going far further back millions of years ago that is actually very, very detailed and the information is obtained from many different parts of the world so we can compare how these different experiments are conducted and how they agree with each other.

Nate Hagens (00:18:51):

Right now we're at 420 something parts per million. How does that compare to the past few million years and what about our temperature during that same timescale?

Sir David King (00:19:06):

We've had a series of ice ages and warm periods over that time, about seven of these ice ages, warm periods. The ice ages are relatively long and the warm period, and we are in a warm period now is relatively short. And we might've expected to come out of the warm period because carbon dioxide takeup would increase and that means the amount left in the atmosphere would be reduced and so it would get colder.

(00:19:41):

If we go back in time, the cold periods lasting maybe 50,000, 70,000 years and then the warm periods much shorter, 10 to 20,000 years. We know about all these cycles of warm and cold and we can also see how much carbon dioxide there was in the atmosphere, how much methane was in the atmosphere in the past. And we can also see whether there's a correlation between the level of greenhouse gases and the temperature into the past. And the correlation is pretty good. I'm not going to say it's exact because there are other things that cause these big, big changes.

Nate Hagens (00:20:29):

And how do we know that these connected temperature patterns and CO2 that are highly correlated, that CO2 two is what led the temperature increase and not vice versa?

Sir David King (00:20:44):

Such a good question because correlation doesn't mean that it was actually delivered by that force. It could be a complete feedback that is driving that. And of course there is feedback involved. It's not a direct correlation, and there are times when it looks as if it goes out of kilter. The situation is rather more complex than I'm able to explain here and now. But certainly if we look at the past periods, there is a point in the world's past when we had what an author by the name of Gabriel Walker called "Snowball Earth," the title of her book. It's brilliant. And this is all the evidence showing that at one point the ice at the two poles became so prevalent that it almost met at the equator. Now the almost is quite important because that water left in the sunlight around that region meant that there was still life in the oceans and we are derived from that life.

(00:21:53):

And then finally it recedes. Now this big positive feedback if they're causing that snowball is not described by what I've just been saying. At the moment, and this is really important, we know that in the North Pole region, ice has been melting more rapidly than the climate scientists were predicting based on what I was describing to you. And here's the feedback effect.

(00:22:25):

First of all, when there's a fire on land, we've just the biggest fire in Europe on record in northeastern Greece with a big natural forest destroyed and all of the habitat in that forest. If the wind is blowing towards the Arctic, taking all of that black soot stuff over there and it settles onto the snow, the black snow absorbs sunlight. Whereas of course, the white snow reflects it back into space. What we call this the albedo effect, as the albedo is changed, we see that the ice melts much more rapidly because of this big absorption of sunlight that wasn't occurring before, not included in the calculations because it's so difficult to know how much black ice would form.

(00:23:18):

And then underneath the arctic ice as distinct from the Antarctic is a blue sea. It's the Arctic Sea around the North Pole. And as that blue sea becomes exposed, even small regions of blue sea exposed to sunlight, of course that blue sea soaks up sunlight even more rapidly. It's a great sink of heat and the air above the blue sea gets warmer. And that's really why we are now seeing the Arctic Circle region as a whole, which is a large region, is heating up at 4.3 times the rate of the rest of the planet. And this has been happening for the past 15 years because of these feedback effects.

Nate Hagens (00:24:06):

And can you explain why we often hear the word "tipping points" in climate science and why they're so important and unpredictable?

Sir David King (00:24:16):

And that really is a good moment to explain this because what we are seeing in the Arctic Circle region is a tipping point in which we are losing ice more rapidly because of these feedback effects. But then there are follow-up tipping points. For example, Greenland sitting in the Arctic Sea is now exposed to the warm air during the three polar summer months and is losing ice quite rapidly. Now, when I say quite rapidly, it's speeding up year on year as more and more of the blue sea is exposed to sunlight

year on year. And the result of that is if all of the ice melts and it looks as if it's beginning to melt irreversibly, if all of that melts, sea levels globally will rise by seven and a half meters by 24 feet, and that's a global average sea level rise. That's an enormous feedback.

(00:25:15):

The second big feedback, there are three, is what happens over the landmass. Around the Arctic Sea is land, whether we're looking at northern Scandinavia, Northern Canada, Alaska, all of that land is covered in ice and it's virtually permanently covered in ice. And we call that permafrost. And that permafrost contains a vast amount of methane, and methane per molecule is about 120 times more effective as a greenhouse gas than carbon dioxide. Now the methane is now beginning to evolve explosively. Now again, not predicted by the scientific community that would happen in that way. In Northern Siberia, we now have photographic visual evidence and evidence from satellites of these enormous explosions yielding very large deep holes in the ice. I talk in meters, maybe 50 meters diameter and 60, 70 meters deep. That's methane being explosively released with water vapor, with a bit of Earth, but not much Earth. It's mainly water vapor and methane.

(00:26:38):

Now, it's not happening enough now to make a big difference. Most of the methane is emitted from leakage from gas, oil, and coal recovery. Most of it is emitted also from farming. Whether you are growing rice or whether you've got livestock, especially beef, a vast amount of methane comes from that. And I think those are two big feedback effects that are real tipping points. And then there's a third one, and we are all experiencing it right now. Around the North Pole region, there's a circular wind, goes anti-clockwise around the North Pole, a jet stream, and that jet stream is essentially pretty circular. It waves up and down, but it's essentially, in the past, pretty circular. But because of what I've just been describing, the warm air above the North Pole during those polar summer months, that warm air circulates around here. But there was cold air there before. That warm air displaces the cold air down. Now the jet stream was our means of keeping cold air in the North Pole region and warm air from the tropics down below. It's a real separator of cold and warm.

(00:28:05):

And what's happening now is that we get such big distortions in the jet stream. So for example, Climate Crisis Advisory Group did an analysis of the very hot summer down the west coast of America in 2021. It's been repeated, but in 2021, what we show very,

very clearly is that the jet stream got locked in down the west coast of America. So that warm air from the equator was coming right up to Canada, right? So it was coming right up because of this distortion of the jet stream, and then the Center of America cold air going right down. In that year, Texas, Dallas, Texas experienced the temperature of minus 16 degrees centigrade. So what you're looking at is extreme weather events occurring literally around the planet driven by what I've just been describing.

Nate Hagens (00:29:04):

It's so refreshing to have a real climate scientist on the program. I could spend a whole two hours just asking you these questions, but I really want to get into the heart of your work. But I'm just personally curious about the mechanics of all this stuff. First, let me conclude this introductory section by asking you how much uncertainty is there currently really in the field of climate science, and where does this uncertainty apply to? Because there was a consortium of scientists, 2000 scientists came out a couple months ago saying, "The science of climate is not settled, and C02 is not a big deal." And that sows confusion with people that are unsure about what's really going on. So where is the current state of climate science?

Sir David King (00:30:02):

The current state of climate science is very well represented by the Intergovernmental Panel on Climate Change. Thousands of scientists literally from every country in the world are represented by that international panel set up right back in the beginnings, 1988, the beginnings of the United Nations Framework Convention. And what we do fully understand is what I've been explaining to you, and I don't think you'll see a report that questions the overall understanding. Now, of course, the origin of the phrase the butterfly effect refers to the idea that a butterfly flapping its wings in China could lead to storms in America. How could you possibly predict that one butterfly could do that? And weather is a very difficult thing to predict accurately. It really is very difficult, and climate scientists are fully aware of this, and have to be very careful about specifying the range over which they're making predictions.

(00:31:16):

It's not going to be possible to say, "Next year, the weather will be this in this part of the world," et cetera. However, predictions are proving to be good as long as these feedback effects that I've just described are taken into account, and predictions. So for

example, we've got in Western Europe, a very, very detailed prediction made for the weather out to the end of the century. And it was made back in 2002 when here in the British Meteorological Office, we managed to get access to the world's biggest computer in Japan, and do these calculations as accurately as the science was able to make it. And predicted what the weather would look like in Central Europe, and even focus down on the three summer months of Central Europe what the weather would look like out to the end of the century. Now, the summer temperatures in Central Europe are about twice as high as the global average, and the reason is big masses of land tend to heat up more than oceans.

(00:32:27):

There's more energy exchange with oceans. And so this is happening, and we were able to say that the most extreme summer that we'd ever had on record in Central Europe in 2003 was predicted by this model a year ahead. But it wasn't predicted precisely that it would be 2003. It might've been 2004, 5, but we could see from the bouncing predictions that these extreme summers would reach the level that was reached in 2003 when it's estimated that in Central Europe something like 70,000 people died of heat stress. Now I'm talking about an advanced part of the world where heat stress is not that common. Today, we've had extreme hot weather around Europe over the past summer, and it's just receding now actually. And again, if you look at the predictions from that model 2002, it's there within the error margins of the prediction.

(00:33:36):

And that prediction was saying, "Central Europe will see temperature rises up to five, six degrees centigrade above the pre-industrial level by the end of the century if we continue emitting greenhouse gases at the rate we're emitting them at now," right? So that's a very, very clear message because where we are today at just over two degrees centigrade in Central Europe summer temperatures above the norm, it's already very, very severe. We've had another very severe year for deaths from heat stress.

Nate Hagens (00:34:17):

Not to mention the Indian subcontinent, and Australia, and other places. Okay, I have so many questions, Sir David. How about giving us a summary of the current state of climate and ocean impact? Thank you for the introduction bringing us to this point. What impacts are largely built in, and can you paint a science informed picture of a distribution of the midpoint, not the best case, not the worst case, what that looks like

on our current trajectory the next 20, 30, 40 years? What are the impacts we're looking at that are largely built in, and what we face?

Sir David King (00:35:05):

Those extreme weather events I've just been referring to can only get more extreme as we go forward in time. So I think that we're simply living in a new phase where the weather systems of the world are in transition, and I've already indicated driven largely by what's happened in the Arctic Circle region. Now I'm saying this because the Arctic Circle region has had such a big impact, and so we can make these predictions, but greenhouse gas levels at this level today, the impact, for example in India, I don't believe that we're going to avoid a catastrophe with over a million people dying in that country at some point when there's an extreme hot weather. Now, I know that people in India are used to much higher temperatures than most of us, and they have customized themselves to that just as the Inuit and Sami people on the permafrost have customized themselves to living at much lower temperatures, minus 10, minus 15.

(00:36:13):

But there's no way that a human being can survive with a temperature of 45 degrees centigrade for a couple of weeks if they have no access to air conditioning. And air conditioning is a solution, but it doesn't help farming. So there's real, real problems there. And of course for many, many people in that part of the world, there's no air conditioning for them. So I think these enormous disasters are very much around the corner. And 2030, it could well get bad. Now, we've also, I mentioned sea level rise, and Britain is an island nation. The reason why I was able to get all party agreement in Britain back in 2008 on climate change when we'd literally tied every future government into actions on climate change at that point was because we are an island country. And I was able to talk about rising sea levels, and what the impact would be.

(00:37:22):

Yes, we've got a Thames Barrier to protect London. We can divert water into floodplains around that part of the country, but that only operates up to a certain level of sea level rise. I'm talking to you from Cambridge, which will be effectively underwater by the end of the century if we just look at where we're going now. Let me take you to Vietnam. Vietnam is a very flat country, and the reason is that this enormous river coming down from China, from the eastern part of the world, coming

down to the sea has created a great big delta. And that great big delta is Vietnam. So it's all silt that's been brought down by the river. And in that delta, you've got the world's biggest rice paddy fields, third-biggest rice producer in the world. Now we all depend on Vietnam, Indonesia, China for rice.

(00:38:25):

All of those rice paddy fields, southeast China, Indonesia are very close to sea level. But Vietnam prediction is that by mid-century that 90% of the land mass of Vietnam will be under seawater at least once a year. Now, once it's under seawater, rice production is going to be very, very difficult to continue.

Nate Hagens (00:38:49):

And it's worse than that, right? Because even before that happens, the saltwater will wick underground and salinate the soil.

Sir David King (00:38:58):

No, you're quite right. The problem with salination is very well known, and the Philippines has a Rice Research Institute, which has been working very, very hard to produce rice species that are able to withstand salinated water. It's quite difficult to actually get the rice as productive as the foodstuff, as the rice that we have now.

Nate Hagens (00:39:25):

We are seeing right now, second half of the year, 2023, we're seeing extreme weather events. How much of this is due to this El Niño in coming months? And will what we see this summer and winter go back and mean revert to the prior trend? Or is it possible that we are in some sort of a phase shift? Or is there a lot of uncertainty about that question?

Sir David King (00:39:53):

So, just a very quick explanation. The Pacific Ocean soaks up a very large amount of heat, and particularly during a La Niña period, and it soaks up enough heat that we get a cooling of the whole planet. And then the heat is reemitted into the atmosphere, and that's the El Niño. So we go from La Niña to an El Niño, and it's come about already, and much more quickly than we anticipated. You might know that for example, Antarctica has lost a vast amount of sea ice just in this year, and in the previous years, very little sea ice was lost, previous 10 years. So suddenly it's lost a lot.

There is, I believe more of an El Niño effect than the effects I've been describing. But the El Niño effect sits on top of this overall temperature rise due to greenhouse gases. So the El Niño effect always makes it much more extreme.

(00:41:01):

So it is very likely that I would say it's almost a certainty that in the coming year, as the El Niño takes over, we're going to see a temperature rise in excess of 1.5 degrees centigrade for the whole planet on average. And that was the number that we agreed in Paris that we should try to avoid exceeding. So I think your question is such a good one. Yes, there's already an influence of El Niño coming through now, and yet we have not seen the full spread of that, and we won't see it until next year.

Nate Hagens (00:41:40):

But then will there be mean revert reversion after that?

Sir David King (00:41:44):

Almost certainly there'll be a reversion.

Nate Hagens (00:41:46):

Here's a question that I don't know the answer to, which is why it's a question. What about a future El Grand Niño when the ocean can't absorb any more CO2 and out gasses it in a major heating event? Is that possible? Is that in the models? Is there a historical analog for that?

Sir David King (00:42:10):

It is possible, but let me take you back a much longer period of time to 20 million years ago when most of our atmosphere was carbon dioxide, and we wouldn't have species living on oxygen as we do if that was the case today. And the carbon dioxide levels have been pulled down by creating insoluble carbonates, which dropped to the floor of the ocean. Now, at the same time as this happened, the amount of carbonates built up the floor of the ocean in many parts of the world. And there's where our continents emerge, so the continents sitting on these carbonate formations. In Italy, there's hills called the Dolomite hills. And those Dolomite hills have the same species, same amount of magnesium, calcium, lithium as in the ocean, right? And we're pretty confident that they were formed as the crust of the ocean came above the ocean

itself. So the ocean has an enormous capacity for storing carbon dioxide as these insoluble carbonates.

(00:43:32):

Now that is over a long period of time. We're now talking about much shorter periods of time. So I am just feeding in the oceans have enormous capacity, and while we may not have a comfortable future for humanity, nevertheless, the planet will continue in a form that won't be very different far into the future, but there's going to be a very uncomfortable transition. Now, I don't know if I've answered your question because I think it remains a very good one. There is a limit as to how much carbon dioxide can be taken up into the ocean. It's converted to carbon acid in the ocean by action with water, and then that carbon acid reacts with the salts, whether they are calcium salts or whatever, some of them soluble, some of them not soluble. And I think this is critically important for the biomass of the oceans. I think we maybe need to have a discussion about that because I'm as concerned about climate change as I am about biodiversity. Literally many of the deep oceans are literally deserts compared with where they were 400 years ago. And we can discuss why that is.

Nate Hagens (00:44:59):

I had a recent Reality Roundtable discussion with three ocean scientists on that, and they're all very, very concerned. I'll send you the link. It was.

Sir David King (00:45:11):

Thank you.

Nate Hagens (00:45:11):

Yeah, there's climate change, but then there's also the biodiversity, and other impacts. So before I get into your work, one last question. This is more of a psychology political question. You've been aware of this, and working on it since 1988, you said, and James Hansen and others. Since then, we see all of the convening of parties, and the CO2 marches unimpeded. It seems to me that society builds antibodies to new predictions and awareness of the deleterious effects of climate. Here we are in 2023. We're spiking in temperatures. We're seeing these fires, and floods, and other things. And yet, it's not 90% of us are on board with this. There's half of society is still disagreeing that this is reality. Maybe if they agreed with the prescriptions, more of them would agree, but is this going to continue?

(00:46:18):

Naturally, as a scientist, I would think that as more evidence comes out that things are this way, more people would agree, "Oh my gosh. We have a problem." But it seems the opposite is happening. As more evidence comes out, people dig in their heels and disagree that this is the situation. What are your thoughts on that?

Sir David King (00:46:38):

So Nate, I think we need to understand the power of the fossil fuel lobby, particularly in the United States. The lobby system in the United States, we all know about from guns where the population at large is all for better legislation on control of what guns individuals can purchase, and how they purchase them, and so on. But that doesn't make any difference the lobby is so powerful. The lobby on cigarettes has been extremely powerful. And once again, we now see Philip Morris coming out saying, "We've got to deal with these people who are against vapes." And vapes have become a major problem in many parts of the world because young people are pulling in nicotine into their lungs from vapes, very young people thinking it's a safe way to operate, and yet they become hooked.

(00:47:36):

And this is the way the cigarette manufacturing industry works. With climate change, I don't know how many senators and congressmen have received funds from the fossil fuel lobby, but the money that lobby puts into the anti-climate science brigade is enormous. I'm talking about billions of dollars over the years. So there is no equivalent organization with that money spreading what is actually happening in the world, rather than people defending what they consider to be their vested interest, and not caring about what happens to the world.

Nate Hagens (00:48:22):

So do you, in your international experience, all over the world with different conferences, is the United States propaganda machine especially egregious, and other countries are more on board with the climate reality we face?

Sir David King (00:48:39):

Yes. There was an interesting poll done by Pew in the United States, but an international poll in which they asked everyone, "Do you take climate change seriously as a serious threat?" And the answer yes came from every non-English speaking

language country in the world. English-speaking language countries, the answer was more like the 50/50 you've been describing. It's not 50/50 in Britain. I can assure you it's much more like 80/20 people believing in climate change. But nevertheless, the power of that fossil fuel lobby can be demonstrated because people quote what's happening in America in their newspapers.

Nate Hagens (00:49:27):

Well, it's also a little bit of cognitive dissonance, right? Because the United States has burned more fossil hydrocarbons and carbon than any other country in history. And so it might stand to reason that 50% of our population don't want to admit that that is a problem, and that we're in the driver's seat of creating that problem.

Sir David King (00:49:51):

I think that's right. We could go on discussing this for some time, but I think the main point is, let me say it this way. If in 1992 at Rio, the American presidents, subsequent presidents had decided to put their shoulder behind action on climate change, we would not be where we are today. In other words, the United States, the great hegemon of the world, led the world, for example, on The Montreal Protocol, and could easily have done the same on climate change. Why not? Because of the great vested interest we've just been discussing.

Nate Hagens (00:50:31):

But the vested interests, Sir, are beyond the fossil fuel companies. The vested interest is economic growth, which is dependent on extraction not only of fossil carbon, but copper, and minerals, and neodymium, and all kinds of things. So underpinning this discussion is climate is the most egregious and worrisome symptom of ecological overshoot. And that is a discussion that, you were the chief science advisor to the UK. I doubt you were sitting around a table talking about overshoot because it's so complex. And I don't think we have the political ability to deal with such a thing. What are your thoughts on that?

Sir David King (00:51:19):

No, I fully agree with you, and let me just take this broader picture that you're raising now. I do believe that we have been operating an economic system, the free market system, which has penetrated the whole planet. And as a result, a very large number of people have been taken out of poverty. And a large number of people are getting

education. A large number of people are living healthier, better lives. And I don't want to gainsay that, but I do not think that this system is fit for purpose in the next part of this century, meaning that system gives no value to our ecosystems whatsoever. We can destroy the ecosystems because they're there. They're free. We can pollute the atmosphere. We can do whatever we want unless legislation is introduced. So governments can cope with some of this by legislation. But there's another big issue, and we talk about vested interests, and these are very real problems.

(00:52:27):

If a very tiny proportion of our population can acquire so much wealth, and this is a fairly new phenomenon, post 1980, can acquire so much wealth that they can control a few people, control the news media of the world, when a very small number of people have the wealth to buy up the major news outlets, et cetera, that is not democratic. What we end up with is a system where true democracy is very difficult to maintain. So my view is we need a complete transition away from this economic model to a model which does deal with diversity. We need diversity, but we also need equality. We need to see the people around the world are able to live decently, are able to live well, and we have enough wealth in the world to do that, but we don't have the capability of delivering.

Nate Hagens (00:53:31):

So how do we integrate equality and wellbeing for those humans alive today around the world, 8 billion, and future generations, while also paying attention to the natural resource limitations of the sink capacity of our oceans, our biosphere, et cetera? Can those things be optimized at the same time, or what are your thoughts on that?

Sir David King (00:53:57):

So what we have to accept, I believe, is that super consumerism, which is what the free market system produces, in other words, you might be perfectly happy with the way you lived 20, 30 years ago, but as everyone acquires what seems to be deemed better and better things, you acquire more and more, super consumerism is the way GDP growth occurs. It's everyone consuming more, and more, and more. Otherwise, GDP growth would stop. We don't need super consumerism. I often visit the Greek islands, and one of these islands, the name of it is Icaria. I don't want everyone to travel there. It's a small island, but has the longest living people in the world on average, so well

over 90 and many, many of them over a hundred age. They live on and on, and it's not a sophisticated lifestyle, but it's a community that helps each other.

(00:55:05):

It's a community of a kind that frankly in our world, I think has disappeared. Now, I'm not suggesting that we can repeat what's happening in Icaria around the world. We have very, very big cities, and we've got to manage life in those cities, and that is an immediate problem. But as we move into the more distant future tens of years ahead, we need to make sure that we move away from a consumer driven society to a society in which human wellbeing and ecosystem wellbeing are treated with equal importance. We somehow need to take the lesson from what is happening today that our ecosystems provide us with our ability to live and survive. And yet, we seem to have ignored that. For the past many hundreds of years, we've developed a system that put no value on ecosystems.

Nate Hagens (00:56:05):

Here, here. I keep promising I'm going to get to your work, but one last question. So you, I think from 2000 to 2007 thereabouts, were the Chief Science Advisor to the UK government. So that was 20 years ago. Do you think that what's happening in the world now and the emotive visible effects from climate, if those would've happened when you were in that position, would things have been easier for you? Do we need to see the smoking gun before we can actually do things?

Sir David King (00:56:46):

So I'm just going to say a little bit about that time when I was Chief Scientific Advisor working with Tony Blair over the period eight years from 2000 to 2007. And the last period was with Gordon Brown, two prime ministers. And in that time, all party agreement on climate change, I think we had six votes against in the 630 member House of Commons, right? Every single one of all parties. And as Chief Scientific advisor, I am regarded as a civil servant. And so I wasn't party pre, I was seen to be available to every head of whatever party we had. And I did brief all of them. And then I gave a talk on their invitation to both houses of Parliament, which was extremely well attended, in which I said, "Frankly, I don't see how Britain can survive beyond 2070, 2080, if we don't manage this climate crisis and set out what we needed to do."

(00:57:52):

Now, Britain under Blair, frankly took a global lead on this. He thought he had a very good relationship with George Bush Jr. But George Bush Jr's team, and for example, we were in the chair of a G8 meeting held in Carnegie in Scotland, and the American team said, the other seven nations get your agreed statement for the end of the meeting together, and then we'll look at it. And they red lined every sentence that meant action on climate change that came from the United States President.

(00:58:31):

So what I'm saying is that the only country where we were getting opposition to what we were proposing was the United States but we couldn't act without the United States. And I would say today, if I translate what I was trying to do then, and by the way, I became the representative of our foreign secretary on climate change negotiations. So I also worked with two other prime ministers, both of them conservatives, and I carried that through in four years in the run-up to Paris. I had 165 climate attachés in our embassies around the world. Every ambassador knew that Britain treated this as the most important issue on our table. And Prime Minister Cameron made available to us for negotiations, a sum of unbelievable £9.2 billion to help those negotiations.

(00:59:36):

Now what I'm saying there is the British government understood at that time the nature of this global challenge and was prepared to back it with money. All of these climate attachés in embassies, people well-trained in climate change. It was astonishing. And I have to say I was a bit amazed that we had so much support.

(00:59:58):

Now, I think we have gone backwards. If you ask me which country is in the lead on climate change now, it's certainly not Britain. Since 1990, Britain has reduced its emissions, domestic emissions by 48%. That's not a small amount. We have reduced our, so that was all through that period I've just been discussing because we had to have to improve our negotiations, a domestic policy that made other countries believe that the problem was really tough. And that's why we were putting this amount of money in so people could see that we were taking it very seriously. We were only emitting 2% of the world's carbon dioxide.

(01:00:42):

And one option would be, frankly what I think our current prime minister might believe that that's a small sum so why don't we just keep emitting and let the others deal with

it, let the United States and China deal with it. That's a nonsense position. What we have to do is all pull together. This is a global problem. We have a massive enemy and we all have to stand and work on it together.

(01:01:09):

And my bottom line now is, and I'm working hard on trying to achieve this, United States and China have to provide the leadership. If the United States and China actually came up with a plan to manage the situation as it is today, I do believe the rest of the world would fall into place. Now that's not exactly good to be saying at a time when people in the United States and Britain are throwing whatever they got their hands on at the Chinese. We need to find common ground and work on this together.

Nate Hagens (01:01:54):

I agree. Thank you for all that. I didn't know that about Tony Blair and George Bush. I mean, this is a global problem and I don't know how our species can coordinate at that level. But let me get to the heart of your work, Sir David. I've read up on what you're doing. You've outlined your strategy for a climate response with what you call the three Rs, reduce emissions, remove greenhouse gases from the atmosphere and repair the damage. Can you give us a brief outline of these three?

Sir David King (01:02:32):

Absolutely. I'm delighted to have that question. I think the point I want to make is that we, the Climate Crisis Advisory Group, have tried to put forward a comprehensive strategy for managing the problem from where we are today, not from where we were back in 1992, but from where we are today. And by the way, we're now talking about four Rs. We've add a fourth hour, which is resilience. Climate change is with us, and we need to learn to be resilient. So let me take you through four Rs, and this might take more than a single breath.

(01:03:09):

The first R is reduce emissions deeply and rapidly. Today we're emitting 50 billion tons a year of greenhouse gas into the atmosphere. 40 billion of that is carbon dioxide and the rest is methane and NOx, but all expressed as carbon dioxide equivalent. I've already said methane per molecule is much more effective, 120 times more effective than carbon dioxide. So if we look at 50 billion tons a year and we continue doing that, let alone increasing it, which is what we are doing year-on-year still, I think there

are signs that it's going to decrease at least peak and decrease and fairly soon. I can say a few words about that. But the main point is unless we can reduce our emissions, whatever else we try and do, we are cooked. I don't think there's a possibility for us to continue if we're going to keep adding greenhouse gases into the atmosphere.

(01:04:13):

Now the second R is to remove excess greenhouse gases that are already there. Now what I'm saying is today at over 500 parts per million of carbon dioxide plus methane, we are already seeing the Arctic Circle region melting. We're already seeing Antarctica losing its sea ice. We're already seeing extreme weather events, rising sea levels, et cetera. So in other words, the current level of greenhouse gases is such that this will continue for quite a few decades into the future. Of course, if we hit net zero tomorrow, the rate of reduction in greenhouse gases in the atmosphere will slowly bring it down. But the rate of reduction is very slow, particularly for carbon dioxide. Methane has a shorter lifetime. So we have to learn how to remove greenhouse gases. What's the objective?

(01:05:17):

For a safe world, and here I fully agree with Jim Hansen, the American NASA scientist who's now at Columbia. Jim has been working on this for a very long time and he's been saying for a long time, 350 parts per million is the maximum we should have if we want to save future for humanity and we're at now 500. Now, I believe he's right. So we need to learn how to take billions of tons of greenhouse gases out of the atmosphere at low cost and at no damage to the planet as we move forward. Two big challenges. And you're going to say, how the hell will you do that?

Nate Hagens (01:06:02):

Well, first I was going to ask, I didn't know that the 350 also included the methane and NOx and CO2 equivalents. So on just the CO2, it would have to be less than 350 maybe.

Sir David King (01:06:15):

Yes, and I've had that discussion with Jim, and Jim is saying, no, no, don't talk about it like that. It's CO2. Yeah. I don't believe that's right.

Nate Hagens (01:06:25):

He's scheduled to come on the show, but he's waiting for his paper to make it through peer review. His paper is, depressing does not even begin to describe the adjectives. Please carry on.

Sir David King (01:06:41):

All right, so I set up a center for climate repair at Cambridge University, and it's not doing all the work that I think needs to be done. We're acting as a hub to stimulate the work to be done around the world. And the Center for Climate Repair at Cambridge is looking at each of these four Rs and seeing what in detail needs to be done. We're not interested in looking at a project for removal of greenhouse gases if when it's all scaled up, it can remove less than a billion tons of greenhouse gases a year. We must be looking towards 3, 4, 5, 10 billion tons per year for each of them.

Nate Hagens (01:07:22):

And what are the things that can do that potentially?

Sir David King (01:07:25):

Right. So now I'm just going to give you my favorite project, which is we call it molecular biomass regeneration. Sorry, marine biomass regeneration and marine biomass regeneration, which I initiated from Cambridge. But we have four other institutions working with us, University of Southern California, the University in Honolulu, Hawaii, University of Cape Town, and the Marine Studies Institute of Goa. And each of them has a research vessel, at least one research vessel. Some of them have more than one. And so this consortium is working on the business of greenhouse gas removal at scale, but as well at restocking the marine system of the world, the deep oceans with fish, marine animals as well, mammals, and also crustacean. And so what we have with this project is an understanding based on the work of a German scientist, Smetacek. And he published papers from 10 years ago. This is a recent discovery, but I love it. He found if you film a pod of blue whales coming up to the surface of the ocean, the film suddenly gets cloudy as the whales approach the surface. Now we're aware of watching them from the air that they're taking in a vast amount of air. But what's this cloudiness? They're relieving themselves. Any mammal that is 300 to 500 meters below the surface of the sea has their orifices jammed shut by the high pressure. So when they come up, it's not only for air, it's also to relieve themselves. Now what that means is all this fertile material is put into the surface of the ocean, which receives sunlight. And the result of that is that within a week, you

might have an enormous area, thousands of square kilometers of sea covered with green material.

Nate Hagens (01:09:42):

Just from the blue whales defecating.

Sir David King (01:09:46):

Yes, yes.

Nate Hagens (01:09:48):

Okay. And that green material is drawing in CO2 from the atmosphere as it grows.

Sir David King (01:09:54):

Drawing in CO2, but perhaps more importantly, it's essentially phytoplankton. There's zooplankton as well. And the zooplankton includes krill, which is the food of the whales where the krill goes down 300 to 500 meters down, which is why the whales are down there. So it becomes a biosystem at the surface of the ocean equivalent to an ocean, a land-based forest. And the result of this is if you have a large enough area, you might get a quarter of a billion fish there. Why? Because fish eggs, the sea is full of fish eggs, even though it's almost devoid of fish. But an average fish lays a hundred thousand to 200,000 eggs a year. So what you have is a lot of eggs. And when the larvae hatch, they die unless there's phytoplankton. Every kind of fish needs phytoplankton. Bingo. They all live in that phytoplankton area. So this is a way of restocking the oceans, but I believe a little more than that.

Nate Hagens (01:11:04):

Well, hold on. Isn't the answer, we need orders of magnitude more blue whales then?

Sir David King (01:11:09):

Yes, exactly. And you've come to my point.

Nate Hagens (01:11:12):

But how does that happen?

Sir David King (01:11:13):

That happens because this is a process by which you increase the krill population as well. And at the moment, there's a very good krill population around the Southern Ocean, around the Antarctic and also around the Arctic, but not many other parts of the world. The Arabian Sea has a fair bit. Not many other parts of the world have enough krill to sustain a large population. The blue whales are now down to probably less than 1% of the population they were at 400 years ago. That was our first oil discovery. Humanity's first oil discovery was that these whales that live down below the surfaces of the sea where it's very cold, have a large amount of blubber to sustain themselves and that was our first oil. And so we stripped the seas of whales, and the result is that we were taking out this circular process that the whales were essentially responsible for.

Nate Hagens (01:12:15):

So whales were our historic, a big part of our carbon sink as it were?

Sir David King (01:12:21):

That's another point. So yes, they were a big part of the carbon sink, but I'm also saying they were part of creating this food stuff for the fish larvae to create this great population. If we look at the stories of sailors from 400 years ago, they knew wherever they were traveling in the ocean, they would catch fish. It's not quite like that today.

(01:12:48):

So I think the point I'm making is this is an amazing potential for restoring biomass to the oceans, but at the same time taking up vast amounts of carbon. I do believe, but the figures are very difficult to put big numbers on, I mean to put proper numbers on because it's such a difficult calculation. We need to be doing the work at sea, which is what we are doing. How much carbon dioxide do I think we could capture if we were to put this artificial whale poo, if I can use that phrase on the surface of the oceans, and let's suppose we did it to two to 3% of the deep ocean surface. How much carbon dioxide are we likely to fully sequester? Probably minimally 3 billion tons a year, maybe maximally 12 billion, 13 billion tons a year. So there's no other way of capturing that amount of carbon dioxide and sequestering it.

(01:13:51):

So I do believe that we might have to continue doing this for 40, 50 years, at which point we've got the whale population back up. And as you were saying, we leave the

whales to do it, but we need to increase the baleen whales or the ones with this blubber. We need to increase their population dramatically.

Nate Hagens (01:14:14):

And how do we do that?

Sir David King (01:14:16):

By exactly what I'm saying. Can I just tell you another little story about whales? The Southern Ocean is cold water at whatever depths you're at. It's not exactly my favorite place to swim in. And when the female blue whales are pregnant, they know that they can't have their babies down there because the babies don't have blubber when they're born and they would die. So they've learnt to go up to the east coast of Africa. I'm from South Africa and I have been down to a place called the Wilderness to watch these wonderful blue whales coming up. I didn't know they were coming up there to have their babies in warm water, but there's not much krill there. And so the mothers have to time their return so that they've still got enough blubber themselves to withstand the cold water in the Southern Ocean, but their youngsters have built up blubber as well. So it's quite an interesting little story.

Nate Hagens (01:15:25):

We just don't know how everything is connected, do we?

Sir David King (01:15:27):

Yes.

Nate Hagens (01:15:28):

And at the last moment when things are disappearing, we're finally figuring out the importance of the other species as part of Earth's ecosystem just at the last moment. And it's both beautiful and horribly tragic at the same time. Is there no other way in your research that we could remove large amounts of carbon? I've heard that using regenerative agricultural methods might be able to increase the soil carbon content from 1% to two or 3%, things like that. Is there anything promising in that area?

Sir David King (01:16:09):

Yes, a vast number of different things are emerging. And really there are a large number of people doing research into these areas. So for example, I was just in New

York for Climate Week a couple of weeks ago and met up with a wonderful group from Denmark. And what they told me about was what was happening in Greenland. Greenland has this vast amount of ice. Greenland is about the size of Mexico. It's a vast island, and it's got nearly two miles of ice all over it. It's been percolating from the ocean of snow over many, many hundreds of thousands of years. And the result of the mass of the ice is that blocks of it will shift away towards the ocean. So it slides down towards the ocean. And where a big block of ice slides down towards the ocean, the larval material, the geological system underneath the ice is crushed to a very fine powder.

(01:17:28):

This is really important because this is a very, very important source of the nutrients required not only in our land masses for farming, but the nutrients required in the ocean. I'm very interested in this so we can use this as our artificial wealth. So the real question is whether we can transform farming practices to use this material. How much material do they have there? And it's all in fine powder form. It's just ready to be used. So it's not going to cost a great amount of energy to grind it down. The answer is not billions of tons, but trillions of tons. They've got a vast amount and we could possibly transform the farming system of the world using this resource.

Nate Hagens (01:18:22):

And how do you get your artificial whale poo from where it's generated to where it would be in the oceans, and how much energy and CO2 would that create in the process? I mean, big questions, but you're aiming at a huge solution.

Sir David King (01:18:41):

Yes. So this is why we've got these research vessels out in the ocean doing these experiments, and we need to raise more money because that is the only slow factor we've got. But the main point is that the work is proceeding well along the following mechanism. In Goa, there's a very large rice factory, one of the biggest rice factories in the world. And what do they have as a throwaway product from producing rice? They have rice husks, and our team in Goa decided to try and use the rice husks as floats, right? So each of these tiny little husks floats on the surface of the ocean. Now they have to bake it. It's not a high temperature, just bake it a little bit and you now have something that floats on the surface of the ocean.

(01:19:36):

Using a biological glue lignin, they can put the lignin on one side of the rice husks and then add our material, our fertilizer material onto that. That means the rice husks are keeping the material in the surface of the ocean for longer, and that's in the sunlight, and it becomes extremely efficient. Actually, it turns out the rice husks also dissolves slowly into the ocean and add further nutrients. So we're winning all the way around. So how would we do this over two to 3% of the world's ocean surface? That's a vast area.

(01:20:16):

Now we've got easy maps of the shipping in the world. If you go to Google, you can see where every ship is in the ocean right now and how they're moving. If we had a fraction of that large number of ships depositing these rice husks loaded with fertilizer into the surfaces of the ocean, I believe we can do it. But there's another way to manage this.

(01:20:41):

When we first start work, we plan to be working around small island states, particularly in the Pacific, but in the Indian Ocean as well, and possibly the Atlantic Tristan da Cunha, where the fish stock around the island has become diminished. And yet, for example, if we take Tonga, the GDP of Tonga depends on selling tuna to the rest of the world, mainly to the United States. That's their GDP. And it's falling and has been falling for the last 20, 30 years, year-on-year. So we will get permission from the heads of these governments, I know this, to work in their extended economic zone into the ocean that's about a radius of 1000 kilometer from their beachfront into the ocean. That's ideal because these Pacific Island islands are formed by volcanic action from the floor of the ocean so it's deep water all around, and we will only do this work in deep water. So it gives us a means of a stepping stone into working at full scale.

Nate Hagens (01:21:55):

I have so many questions for you. This is just so fascinating. It's not where I expected the conversation to go. Let me ask you a non-scientific question, but a political and economic one. If we, humanity recognize our place in history and what is happening to this blue-green Earth due to our economic metabolism, if we're able to somehow bridge that governance and cooperation with the minds and people around the planet, we are going to need to allocate some of our existing surplus to regenerating and healing the natural world. In other words, someone's going to have to pay for this. It's not going to generate GDP in the way that we have come to think of it. But

governments and business and philanthropy right now are following this business as usual GDP model. And somehow to regenerate our biosphere into a healthy state, there's going to have to be like a tax or a re-giving back to the Earth. Do you agree with that? And do you think that's possible?

Sir David King (01:23:13):

Essentially, I do agree with it, but let me just put in this little caveat. In Britain, how did we reduce our emissions by 48% to today? It didn't happen easily. So basically what we said was we've got all these utilities producing electricity, and every utility was told they had to use a certain percentage of renewable energy for their energy they sold to their customers, and that percentage would increase every two years. And they were told in advance how this would be, and there was a system of penalizing them if they didn't manage to achieve that.

(01:23:53):

Now, what this meant was the renewable energy systems that we were using, solar and wind were much more expensive than fossil fuel energy,

(01:24:03):

but it was starting off at a few percent. It didn't add much to how much the customers were paying for their electricity, I don't think anyone even noticed. But the result of that was, and we pushed it. We were then in the European Union, and you know why I'm saying that. And the result of this was, as other countries in Europe picked up on this, Germany, France, Italy, it went up, Scandinavia, they all began to do the same thing one way or another, subsidizing renewable energy, which was more expensive. And the market kept expanding, and here's the beautiful thing about the market. As it expands, the price collapses, and the price for any one of these forms of energy, light emitting diodes are now popular right around the world, because they are cheap, much cheaper in producing light for us at night than the old hot filament bulbs.

(01:25:04):

And so, what we have is seen something no economist predicted, which is interesting in itself, that the cost of photovoltaics has come down a factor of a hundred, the cost of wind turbine energy has come down massively. So here in the UK, we have wind turbines offshore, and a vast amount of our electricity is coming from offshore wind. North Sea, the wind blows most of the time. There's only a couple of days in the winter when it doesn't blow, but otherwise it's blowing. You ask any sailor, they will tell you that. And the result is, we can get the world's most efficient wind turbines into the

North Sea, because we deliver them by the same shipping that was used for North Sea oil and gas recovery. We can deliver extremely long wind turbine blades, 110 meters long. Very difficult over land to do that.

Nate Hagens (01:26:02):

So that itself is a huge discussion. But wrapping that into our prior one, the UK is 2% of global emissions. So the climate doesn't care about the UK, the climate doesn't care about anything actually, it just responds to biogeochemical forcings. And globally, even with the expansion of solar and wind growing very rapidly and their cost coming down rapidly, we are hitting all time highs of coal extraction this year, because of India, and China, and elsewhere. So getting cheap energy is really not reducing our CO2, it's adding to the entire energy hungry super organism, which is humanity.

Sir David King (01:26:50):

Not quite that way. The International Energy Agency, which is based in Paris, but it's truly international, produced a detailed analysis of the uptake of renewable energy systems around the world. What percentage would you say around the world is now from renewable energy? You'd never guess 32% of electricity produced in the world. I can take you to Texas, where more than 50% of electricity in Texas is produced by wind turbines.

Nate Hagens (01:27:25):

But electricity is only around 20% of global energy use.

Sir David King (01:27:29):

Correct. That is correct. Right, so I'm just making the point about electricity, but it also applies to every other form of new technology that's emerging. It starts off expensive, but as the volume in the marketplace goes up, the price goes shooting down, and then you start beating. It is now cheaper in the UK, even with storage problems, to produce electricity from renewable sources than from any form of fossil fuel.

Nate Hagens (01:28:00):

Let's skip ahead to three or four side points here, and let me ask you a core question. If humans had abundant low cost, renewable energy or energy of any type, would that solve our climate, and overshoot, and biodiversity, and plastics, and endocrine disrupting, and ocean issues?

Sir David King (01:28:24):

No.

Nate Hagens (01:28:24):

Or would it have to be accompanied by a change in objective, a change in consciousness, and a change in governance?

Sir David King (01:28:31):

Absolutely. We need to understand the principles of an ecological civilization, giving as much attention to the wellbeing of our ecosystems as we give to our own wellbeing. I don't think there's any other way. Now you may be interested, because you mentioned China's consumption of coal, India's consumption of coal. Can I say a few words about China, because I've been there many, many times. China is producing more photovoltaics, more wind turbines, more nuclear power, and also more hydropower than the rest of the world put together. But they have a large population. And what I've only recently understood, and this is a report that the climate crisis advisory group produced just a few months ago, is that in China, since the year 2000, about 800 to 850 million people have been taken out of poverty, and are now living the life of middle class citizens. That's one heck of an achievement.

(01:29:39):

So the Chinese government, since 2012, really committed themselves to the whole business of reducing dependence on fossil fuels. You will know that their electric vehicle on the road level is now higher than the rest of the world by a mile, right? So most cars being sold in China are now electric. What they didn't understand initially was that, as that middle class emerges, they're going to use more and more energy. And they could not meet that energy demand with the new renewable sector, even though they were investing so heavily in it. And that's really why their dependence on coal has gone up, it hasn't come down. Now, I do believe it's going to come down. As you may know, their economy is no longer expanding. And frankly, I don't know whether that's deliberate, but it may be in keeping with what you and I have been saying.

Nate Hagens (01:30:38):

Here's a question that I worry about and you're particularly well-placed to speculate on it. I think as the climate continues on the trend that we've seen, that in the coming

decades it will be undeniable to the leaders of the countries around the world that we have a major planet scale problem. And so geoengineering of the volitional type, I mean we're doing geoengineering now by transferring the buried carbon into the atmosphere, and getting dopamine in the middle. But I think geoengineering will become prevalent and maybe not every country, but some places will do it. And I worry that as a creative problem solving species, that in some cases the cure may be worse than disease, that we do manage to reduce CO2 by a few parts per million, but in doing that creates some other damage that we haven't considered. What are your thoughts on all that?

Sir David King (01:31:58):

Yeah, I think this is a very, very important part of the whole question. So the first thing is, please don't shut down on experiments. We need more experiments to see that whatever is rolled out to scale, as it becomes necessary, we roll it out to scale on the basis of as much information as we can gather. And let me now say, I'm working, with my colleagues here, on Marine Cloud brightening, that is creating white cloud cover. We possibly have a mechanism for putting white cloud cover over the Arctic Sea region during the three polar summer months, and that would reflect sunlight away, and keep the ice that's formed during the winter over the Arctic Sea. And we'd have to do that every year for the next 50 years perhaps. But that in itself needs a lot of experimentation to make sure that there's no negative consequences.

(01:32:56):

But here's the alternative, and this has been talked about quite frequently, which is putting aerosols into the stratosphere. And the use of aerosols, sulfates for example, into the stratosphere we know will work, because when there's a volcanic eruption, it does do just that. It puts these sulfates and little particles up into the stratosphere and it cools the planet, because it keeps the sunshine away from the planet's surface. However, if we put sulfates into the stratosphere, we've just got to remember it's not too many years ago, 1980, that we agreed the Montreal Protocol, not to destroy the stratosphere by removing ozone and creating this great big ozone depletion layer, the ozone hall, which people in New Zealand and Australia were more aware of than anywhere else, because it was largely settled around the Antarctic. And so what we need to understand, is that any country that has the ability to put sulfates into the stratosphere, and many, many countries have rockets now and they could do it, would be able to do this unilaterally.

(01:34:16):

Now, I would be all in favor of a moratorium on rolling any of these things out, until there has been enough experimental verification and agreement amongst nations, that this is what was the only way forward. I'm against putting sulfates into the stratosphere, because I fear that once again, we'll all get cancer from the loss of the… The ozone in the stratosphere keeps the ultraviolet, the high energy sunlight, away from our skin and protects us from cancer. So I think there are sound reasons why you're asking such a good question. The scientific community has to prove seed with caution.

Nate Hagens (01:35:04):

Oh my gosh, you're one of the few guests that I can ask any of these complex scientific questions, and you have knowledge on it. I don't want to spend our time asking about the effect of global dimming, the fact that if we did manage to stop all carbon burning, that there would be a phase where the masking effect of our current particulate emissions would make climate worse. Well, I will ask you that, but what do you think about that briefly?

Sir David King (01:35:35):

So we have been burning a lot of coal that contained a large amount of sulfur, and the sulfur dioxide has been a major factor in keeping the planet cooler for just the reasons we've been discussing. Now, we have cleaned up our act on that, we know that sulfur dioxide in the lower atmosphere is pretty bad for us. And so we keep the sulfur out of the coal and we are still burning coal, but we claim that it's clean coal. I say claim, because it still produces carbon dioxide. But the point is, that if we completely eliminate sulfur dioxide in that way getting into the atmosphere, we are going to see even more warming than we are currently experiencing. And already that is a factor in the rate of warming now.

Nate Hagens (01:36:30):

Here's my ultimate worry about geoengineering, is I think we need more people asking what if neoclassical economics is wrong? And the continuity of large long-term projects is subject to energetic receding horizons and political discontinuities. And as soon as we stop this geoengineering, when we run out of money or cooperation, then there's an abrupt spike, or a termination shock, because species can't adapt. And I

don't think you have an answer to that, I'm just throwing that out there as something I worry about.

Sir David King (01:37:08):

Yeah, I think these are the things we all worry about. It's not an irrational worry. The state of the world is such that, we know our civilization has never had to face up to a challenge of this kind before. And I'm talking about the thousands of years of our civilization. One of the interesting things about the way discussions take place in the United Nations Framework Convention on Climate Change Meetings, nobody discusses what happens beyond 2100.

Nate Hagens (01:37:48):

Right, as if the world stopped existing in 2100.

Sir David King (01:37:52):

Yes, and we don't care what happens after that. And yet I've said, I love going to Greece, and one reason is, because we can see ruins that go back thousands of years in Greece from human civilization, and some of them the most beautiful statues, et cetera, that you could possibly imagine. So we can go back in our history many thousands of years. Why would we on Earth be happy with another 70 years only?

Nate Hagens (01:38:22):

Yeah, we don't think about it much, but I mean, 2100 is closer to today than World War II is, and we have movies about World War II all the time, and things like that. Yeah, so how do we begin to create a coordinated global effort, especially at times when there's Israel, Palestine, Ukraine, Russia, NATO, and financial and economic geopolitical issues? Shout louder to ours and our politicians' mental structures. I mean, I know you're a scientist, but you've worked with politicians in your career. How do we even begin to coordinate this globally other than more education and activism, et cetera?

Sir David King (01:39:06):

So I'm just going to interpose. Yes, I'm a scientist, but over the last 20 years I've been working in diplomacy as well, the negotiation process, and I am very proud of the fact that the American Association for the Advancement of Science gave me an award last year. It's probably the award I'm most proud of, for science diplomacy.

(01:39:29):

And so, I have got used to talking to politicians literally around the world. In the two years run up to Cop 21 in Paris in 2015, I visited 96 countries officially. That was one-on-one negotiations, effectively Britain with that country. I had deep pockets, so often Minister of Finance was there, and they'd listened. They listened because Britain was really doing what it could to manage its domestic emissions, but they also listened because we were offering money. So it was really quite an eyeopener, that getting an agreement in Paris, I didn't even have to go to Paris. I knew there was going to be an agreement from all the countries that I'd got agreement from. As long as Obama was there to sign, and then the Chinese would sign, they said, "We will only sign if the United States signs," then we knew everyone else was going to fall into place.

(01:40:37):

Now that's why I'm saying the key answer to your question in the current political structure, is the importance of China and the United States playing the global leadership role. Yes, bring in the European Union. And by the way, that's not going to be difficult at all. European Union as a whole is also right on top of managing climate change. So I think, let's say those three power groups, but don't leave out the rest of the world, but that all would happen if the great hegemons of the world actually lead the way.

(01:41:14):

Now, I'm using the current structure, political structure, in my answer to your question, but you asked a much, much deeper question, which is, and how do we change our economic system? Now for me, I've just brought onto the, actually I'm not sure I can say, climate crisis advisory group, an economist who is somebody I admire enormously, and she works in London, and I've been looking for a male/female balance, and this helps. But she is amazing, and she's an economist who is trying to answer the very question you're asking, how do we switch from the current economic system of the world? Even China's operating the same system. How do we switch from that, to the system that is fit for purpose in the world that we're talking about, in terms of biosecurity, as well as in terms of climate change, and the future of civilization?

Nate Hagens (01:42:20):

Sounds a lot like Kate Raworth. So this has been so fantastic, and I want to be sensitive to your time. I kind of, in lieu of asking ChatGPT questions about the world, I wish we had a chat Sir David King, because you have opinions and deep scholarship

on these things. I'm going to have to have you back on a deeper dive on some of these things. But let me ask you, Sir, some closing questions that I ask all my guests. You've thought about, and are obviously a engaged citizen and macro observer, on the human problematic as a career choice. Do you have any personal advice to viewers of this program at this time of global ecological disruption, and civil upheaval, and anxiety? Because it does seem to be a lot, and I think many people watching this program agree with almost everything you've said, but what do we do as individuals? What advice do you have to the listeners?

Sir David King (01:43:30):

Now, of course, every individual has got a different personal history and a different position in society, and if I was talking to a group of global heads of governments, I would say something very different. So it does depend on what your background is, but all of us can spend a bit of time to think about the state of the world and the direction of travel that will suit ourselves, but also our children and our grandchildren. I'm of an age where I have four grandchildren, so I really care about that longer distance future. But also, think about different people in the world. And the group of people that I think we need to focus on much more radically are the indigenous people of the world. I've become friends with some people who are members of the Sami, people who live on the permafrost in Northern Europe, and represent also the Inuit people on the other side.

(01:44:36):

And these people live basically with reindeer, and the reindeer provide them with so much of their ability to live, whether it's leather hides or whatever, and they have actually a sophisticated lifestyle, but quite simple. You need fish, you break a hole in the ice and you fish there. And that lifestyle is now being dramatically altered. I spoke to one of my colleagues who lives in Northern Siberia, name of Tero Mustonen, he's a climate scientist on the permafrost. Spoke to him in April 2021, "What's the temperature there?" We're just chatting.

(01:45:18):

He said, "It's damn cold. It's -30 degrees centigrade."

(01:45:22):

I said, "Oh."

(01:45:24):

He said, "No, it would normally be -10, -15. This is extraordinary cold, but we know how to manage it." I spoke to him the same year at the end of July when this hot period had arrived, he said, "You better be sitting down. The temperature here is now +32."

(01:45:42):

You imagine the lifestyle of those people who depend on their historical knowledge of living on the permafrost, and the permafrost exploding around them. I mean, I was brought up in South Africa. The people of the Kalahari are probably one of the longest living indigenous people of the world. They live on a near desert. It does rain there every five years or so. But they live there and they know how to live there. If any one of us was dropped into the Kalahari, I doubt that we would stay alive for very long at all, but they know how to do it. So indigenous people live relatively simple lives, but are extremely smart at managing their own affairs. We need much more respect for those people.

Nate Hagens (01:46:37):

I've been to the Kalahari and Okavango, and it was probably the most memorable trip of my life.

Sir David King (01:46:43):

Oh, right.

Nate Hagens (01:46:44):

So what about the young people? You say you have four grandchildren. What about the young people listening to this and coming to terms with the climate, and the economy, and the cultural change? What advice do you have for young humans?

Sir David King (01:47:01):

So each one of us when we're growing up, are developing ideas of what we are going to contribute to our own lives, and to the world as we move forward in time. That's a normal human operation as we learn to live in this world of ours. And I would just say open your eyes to the direction of travel, just not the next few months, but the next few years, decades, you are going to probably be alive at the end of this century. You need to look at what that will look like, and what is the right lifestyle to live, in a world that is endangered in the way it is. I do think for everyone, it's a question of understanding the challenges and then working out from where I'm sitting, how can I

best operate to not only manage the challenges for humanity, but for myself and my family?

Nate Hagens (01:48:01):

If you could wave a magic wand and there was no personal recourse to your decision, what is one thing you would do to improve human and planetary futures?

Sir David King (01:48:13):

Whoa, whoa. You've now asked me the most difficult question of all, because you asked me for one thing, and am I allowed to say that the four Rs are all accepted as a way forward for humanity, and our eco civilization?

Nate Hagens (01:48:32):

Sir David King, this has been a very interesting and wide-ranging conversation. To be honest or to be blunt, I think we just scratched the surface of your artificial whale poop, regrowing whale populations and marine cloud brightening. I think this was a fantastic introduction, but I would love to have you back in a few months to take a deep dive on those initiatives from a scientific perspective if you'd be willing, because I think we're headed in that direction and we need to have broader awareness of those things.

Sir David King (01:49:11):

Nate, can I just say thank you very much for spending this amount of time with me, because I appreciate that you reach a significant number of people, and if we can get these messages out, we're doing exactly the right things. I'm congratulating you on what you're doing.

Nate Hagens (01:49:30):

This is the conversation of our time and the human history as we converge on the world's largest problems, and this is it. To be continued. Thank you for your lifetime of work on these important issues.

Sir David King (01:49:43):

Thank you.

Nate Hagens (01:49:45):

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