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Energy Transitions – Understanding the Challenge

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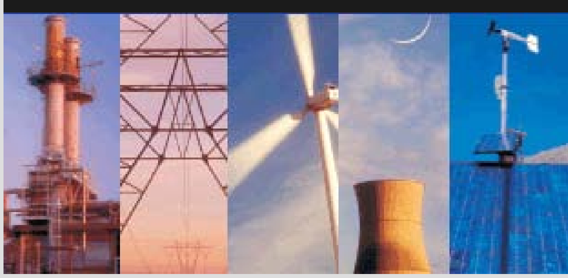

What will it really take to make a transition to a sustainable energy society? Visions of a clean, affordable, reliable, and *durable* energy future are something that most everyone can support in general. But ***how*** we get there, and ***when***, are different matters altogether. What fundamental issues do we need to understand, and what forces will drive or hinder that transition?

In a finite world, sustainability is ultimately not a choice but a mandate. The question is: how fast or slow, smooth or turbulent, the transition will be. Some say we need to move as quickly as possible—whether for environmental, economic, or national security reasons, or all the above—implying that all we lack is the political will. Others downplay the urgency and focus on the monumental difficulties of making a transition. The truth, it seems, lies somewhere in between.

To move forward, we need to resolve, or at least manage, the tension between these opposing views. On today's show, we'll explore that tension and take a "big-picture" look at the risks, challenges, *and* opportunities that humanity faces in making an energy transition.

Guests:

- **Scott W. Tinker** – director, Bureau of Economic Geology, and professor, Jackson School of Geosciences, University of Texas at Austin; chief advisor, Switch Energy Film and Education Project

- **Steven E. Koonin**– director, Center for Urban Science & Progress, New York University; former undersecretary for science, U.S. Department of Energy
- **Jesse H. Ausubel** – director and senior research associate, Program for the Human Environment, The Rockefeller University; science advisor, Alfred P. Sloan Foundation

Key Questions:

- **What are the most important factors** (opportunities, constraints, risks, benefits) that will drive or hinder a global transition to a sustainable energy economy? What realities are most important for decision-makers to understand in both defining the challenge and charting courses of action?
- **Timeframe**: What factors will most influence the timeline for such a transition?
- **Science + Technology**: What key physical and technical factors will drive or constrain the scale and speed of a transition? How important are these factors relative to other factors?
- **Economics**: What are the key economic factors that will drive or constrain a transition?
- **Behavioral/Political:** What are the behavioral and political obstacles and opportunities to accelerate an energy transition? How do they interact with technical and economic factors?

Transcript:

Jan Mueller:

This is The Energy Exchange, conversations about how energy connects to the economy, national security, and sustainability, helping you to understand a changing world. Thanks for joining us. I'm Jan Mueller.

On today's show, what will it really take to make a transition to a sustainable energy society? Visions of a clean, affordable, reliable, and durable energy future are something that most everyone can support in general, but how we get there, and when, are different matters altogether.

What fundamental issues do we need to understand, and what forces will drive or hinder that transition? In a finite world, sustainability is ultimately not a choice, but a mandate. The question is, how fast or slow, smooth or turbulent, the transition will be. Some say we need to move as quickly as possible, whether for environmental, economic, or national security reasons, or all of the above, implying that all we lack is the political will. Others downplay the urgency, focus on the monumental difficulties of making a transition. The truth, it seems, lies somewhere in between.

To move forward, we need to resolve, or at least manage, the tension between these opposing views. On today's show, we'll explore that tension, and take a big picture look at the risks, challenges, and opportunities that humanity faces in making an energy transition.

With me to address these issues, we have three outstanding guests that I'm very pleased to have on the show today.

Scott Tinker is the director the Bureau of Economic Geology and a professor in the Jackson School of Geosciences at the University of Texas at Austin, and a chief advisor with the Switch Energy Film and Education Project.

Steven Koonin is the Director for the Center for Urban Science and Progress at New York University, and also a former Undersecretary for Science at the US Department of Energy.

Jesse Ausubel is the Director and Senior Research Associate at the Program for the Human Environment at The Rockefeller University, and also a science advisor with the Alfred P. Sloan Foundation.

We have Scott, who is a geologist, and Steve, who is a physicist, and Jesse, an ecologist and environmental scientist. All of you are featured in a 2012 film called Switch, which as the name implies, is all about this very issue of making an energy transition. Scott plays the role of traveling host, and Steve and Jesse are amongst several experts who contributed to the film. Scott, if you would, tell us a little bit about the film, and the project, and what you and director Harry Lynch were aiming to accomplish, and was there a theme or message that you arrived at after making the film?

Scott Tinker:

Sure. Thanks, Jan, and I'm glad to be here with Steve and Jesse. Harry and I decided to set out and make an objective balance film that looked at global energy. We didn't think something like that was really out there. We interviewed over 50 experts, and Steve and Jesse were prominent amongst those. Over 20 site visits, the best sites in the world, 11 countries, and we agreed that we would feature energy in the film. We weren't going to put somebody against somebody else to try to make somebody look smart and somebody look dumb, and we weren't going to pick one energy winner over another. We were going to go to the best places and show energy in its best light, and in doing so, look at some of the challenges and the pros of each form of energy.

We think we accomplished that pretty well. We are in over 700 universities and schools now, and past 10 million viewers, so Switch continues to roll along. It was a remarkable experience. It's been a lot of fun, and I think it has helped us set an objective balanced conversation that goes on.

As we worked our way through it, we looked at the foundational energies of coal for making electricity, and oil for transportation, and those remain prominent in the energy world. We looked at some of the alternatives to those, and there are very many good options, but there are challenges with those as well.

We came back and said, "What can really scale and meet some of the environmental challenges as well?" Without prescribing, we did conclude that nuclear and natural gas certainly have a large role to play globally, as that transition begins to happen. That's how the film played out, and again, I look forward to this conversation with Jesse and Steve. I think it's a very important one.

Jan Mueller:

The one takeaway that I had after watching the film, Scott, was there are reasons that fossil fuels dominate our energy mix, and have for a long time, and how they've been the foundation for the modern economy, and our 150 years of prosperity since the Industrial Revolution began. I'd love to hear all of your takes on what's unique about fossil fuels, and how making the transition to something else, there may not be something exactly like what we've experienced thus far in terms of energy and fossil fuels.

Scott Tinker:

Yeah. I'll certainly start and be very brief. I tend to think of energy security with four pillars. Is it affordable, is it available, is it reliable, and is it sustainable? There are components to each of those with no energy meeting all of them. The reason that coal has been so important and remains so, it is affordable, it is available, and it is reliable, and that's why we continue to use it globally, and it's helping to lift many undeveloped and developing nations out of poverty.

Oil, in many ways, is the same thing. It's certainly available. There's a large oil resource. It's reliable, remarkable fuel, dense, and powers machines with very little residue or emission other than C02, and very difficult to replace as a result of that. It's affordable today. Here we sit in 2016 with oil priced down two thirds from what it was not long ago, but it certainly has a volatile price, and that introduces all sorts of challenges as you look globally. Again, for transportation and electricity, these are and were the big two.

Steve Koonin:

This is Steve. Maybe as the physicist, it's appropriate to invoke just physical properties. The energy density of fossil fuels and particularly oil is astounding. When you're pumping gasoline at the pump, you're wielding about 15 megawatts of power. You should compare that with perhaps 50 kilowatts of power that you would put into an electric vehicle by charging it up. The energy density for transportation is particularly important as we think about fossil fuels.

Scott Tinker:

Steve, you said 50 kilowatts and 15 megawatts.

Steve Koonin:

That's correct.

Scott Tinker:

For people who don't think in those terms, that's a multiple of what?

Steve Koonin:

That's a multiple of about 200 and something. Okay? The electric car is more efficient, but nevertheless not 200 times more efficient.

Jan Mueller:

If I can mention this, Steve, you used to work for BP before you were with the Department of Energy.

Steve Koonin:

Yes, I was for five years the chief scientist for the oil company BP, and was there to help them think about and move toward alternative and renewable energy sources.

Jan Mueller:

That sounds like an interesting position to be in. How did that go?

Steve Koonin:

It was very interesting. One of the takeaways for me, I had spent 30 years in academia before moving into the private sector for a while. I think for anyone who really wants to understand energy as a scholar, or as a citizen, that private sector perspective is extraordinarily important. 90% of the US energy sector is in private hands, and that means it's about profit. It's about regulation. It's about betting very large sums of money on multi-decade time scales, and unless you understand that perspective, it's very difficult to imagine getting industry to move.

Jan Mueller:

Understood. Jesse Ausubel, you look at energy through the lens of ecological systems, and also you've talked about the footprint of our energy system, and how the next energy system needs to have a smaller footprint as opposed to a larger footprint. Give us your perspective on where we've been in terms of both fossil fuels, in terms of their environmental impacts, and where we need to go moving forward.

Jesse Ausubel:

Thanks Jan. Let me give a very basic point of view from life sciences. We need to think of the energy system as a continuously evolving system. Our theme is energy transitions, and in fact, the energy system is always in transition. It's always evolving. One needs to see it, in that sense, really as a kind of living organism. The wood and hay were the lead sources of primary energy until 1800, 1830. Then coal came along, and was the lead source for 100 years, and then oil came along and became the leader in about 1920, 1930, and now natural gas is becoming the lead source. That's just on the supply side.

Then of course, there's our reusing heat. About 125 years ago, Edison came along and electricity came into the game. There are the different ways you can use energy, and there are all the end use devices, and these are always changing. We fed hay to horses. Then we feed oil to cars. Maybe we'll feed electricity to Maglev trains in the future. The system is continuously evolving, a few percent per year. It's a very big system, as Steve and Scott have suggested. The idea of revolutions, I think, is usually mistaken, because when you have very large objects, they tend to change gradually, and that's what the energy system has been doing for 10,000 years. We've documented a lot of that over the last 300 years.

There's been a gradual decarbonization of the system, with the shift from the most carbon intensive fuels, namely wood and biomass, to coal, to oil, to gas. All of these are hydrocarbons, a blend of carbon and hydrogen. We have been moving gradually from the system relying on carbon to a system where hydrogen, the lighter and cleaner element, is the source. There's really nothing exceptional about the year 2016, and we are living with this living, evolving energy system.

Jan Mueller:

You say nothing's special about 2016, but looking backwards, we went from oil to natural gas. Natural gas wasn't liquid, but it was a pretty nice thing. The energy density wasn't as great, but we kept finding oil, so we kept adding these new sources that were still pretty awesome. We kept coal and we kept oil. Now to keep growing the energy supply, we're having to find unconventional fuels and we're adding … Renewables are not replacing fossil fuels at this point. They're just adding to supply, and they're not quite as useful, so what do all three of you think… Is there anything special about where we are right now? Are we at some kind of threshold? Are things changing? Are we in a different reality?

Jesse Ausubel:

I would say renewables were here before. People used water, and every river and stream in France was dammed by the year 1400, 1450, and destroyed most of the life in the rivers, the fish and so forth. Of course, sailors used wind and so forth. People abandoned renewables, so-called renewables, because they were unreliable, and they didn't scale up well. But they're not new, they're old, and it's also important to realize that renewables, in many cases, are exhaustible. Wood, for example, is much more exhaustible than coal or oil. The non-renewables are incredibly abundant, which is part of the reason that we have the debates we now have. The question is not, is there enough oil, or is there enough gas. The debate is, are the side effects of using very large amounts of coal, or oil, or gas with present technologies, are the side effects unacceptable? I think the vocabulary of renewable and nonrenewable often confuses us.

Steve Koonin:

There are some externalities, if you like, that are changing and make the present decade and the next couple of decades more unusual than previous decades. One is the accelerating development and hence demand for energy from most of the world. In the developed world, such as the US, other OECD countries, energy demand is really quite stable, growing very modestly, but you have surging energy demand due to development for the other six billion people on the planet. That's one.

The second is that technology is evolving rapidly, particularly information technologies, but also materials, and we can see that there are different ways of creating, storing, transmitting, using energy than we might not have imagined 30 or 40 years ago.

The third thing is that we can start to imagine and in some cases see human influences on the environment as a result of our energy use. I think all of those together conspire to make this and the next decade or two somewhat unusual in the history of the energy system.

Scott Tinker:

I would add to those excellent points a couple thoughts. Population matters. It is growing at a rate of about a billion people every 15 years or so. We're adding to the planet. That is forecast to plateau mid-century, around 10 or 11 billion people. The benefit of energy to humanity can't be underestimated. It lifts humanity from poverty, access to affordable, available, reliable energy.

It also does other things. It allows you to have clothing, and shelter, and light, and be able to start to read and get educated, which leads towards other benefits such as better health systems, lower population growth rates, and other kinds of things that are often not fully described when we're thinking about the benefits of energy. Today, in the world, 85% of the energy in the world comes from oil, natural gas, and coal.

Ironically, perhaps, those trends, just in percentage terms, not in actual units of use, because those are all increasing with population, just in percentage terms, oil has been coming down. It peaked in 1979, just under 50% of the total energy mix. It's down in the low 30s today, and continues to decrease. Natural gas has remained essentially flat for the last 25 years, around 23 or 24%. The irony is coal, around 28% 25 years ago. It's around 31% of the mix today. It actually was dipping, but it has increased, and again, the reason for that is it provides electrons to developing nations that are needed for the benefits that I just described. That is a great challenge.

Infrastructure was mentioned. China sold five million cars a decade ago. Last year, well over 20 million cars. That's more than the US, so they've gone from a third of the US to 1.3 or 5 times the US in a decade. These cars will be on the road a long time. They're mostly gasoline and diesel. Coal power plants last 60, 70, 80 years, et cetera, large scale infrastructure. The challenge is really how to make better environmentally and in other ways, the energy systems that we have, which have done and are continuing to do many good things for humanity.

The other piece of that is, and I'll talk about this in simple terms, affordable, available, reliable energy is good for economies. Healthy economies, in very simple terms, allow for investment in lots of things, and one of those is the environment. I talk often about the three E waltz, the waltz between energy, the environment, and the economy, and truly do fundamentally believe that those have to stay in some sort of a balance. Physical environments often are not well treated when you have a very unhealthy economy, so this is a balance that we have to always think about, and I think Steve in his roles in DOE, and Jesse, and a lot of the brilliant things he's written through the years have dealt with this and made some really, I think, fundamental suggestions about how it would move forward.

Jesse Ausubel:

We've spoken mostly about the supply side, and Steve and Scott have hinted that we need to expect a lot more demand growth, but I think we need to think very hard about that. The overall efficiency of the system remains very low, and there are fresh opportunities to create more efficient systems. One of my favorite examples is what's happening with cars, car sharing, smart cars, self-driving cars. The average car in the US or anywhere in the world is used less than an hour a day, and there are a lot of them. We may need many fewer vehicles in the future.

If the future model is much more car sharing, I'll say self-driving, Google, or Uber cars that are used, let's say, just five or six hours a day, then we'll need … We won't need 20 million new cars. We'll need less steel. We'll need less oil. We'll need less rubber. The cars can be metabolized faster and replaced each year by more efficient ones. People no longer get lost because of GPS, so all the gas that's been wasted on people being lost can be eliminated. There are lots of opportunities, I would say, as a result of adding more information into the system, in buildings in the transport system, to really continue lifting efficiency.

It seems to me we need to very careful to extrapolate the history of demand growth from the countries like the US to the rest of the world. There will be some more population growth, but the demand side may surprise people, and I think a lot of what we've seen in the last decade, or since 2008 or so globally, has to do with surprises in terms of soft demand for many products, other than information products. I think we just need to be careful about that, and if the demand growth was much more moderate, then of course our ability to do smart things on the supply side, the options grow.

Jan Mueller:

If I could just briefly recap, we've been talking about how energy has been important for everything. It's brought a lot of good to a lot of people, and we're trying to bring it to more people. We've wasted a lot of energy, but there's opportunities to be more efficient, and how we satisfy the people outside the developed world, for their economic benefit is the big question mark.

We're going to take a short break. When we come back, we'll talk about what some of those scenarios might look like. We talked about the environmental impacts, but we can also talk about the economic risks and opportunities of the transition. We'll be right back.

We're back, talking about energy transitions with Scott Tinker of the Bureau of Economic Geology at the University of Texas, Steven Koonin with the Center for Urban Science and Progress at New York University, and Jesse Ausubel with the Program for the Human Environment at The Rockefeller University.

Before the break, we were talking about how demand and how people will use energy in other countries besides the United States, that they may or may not take the same path and demand may not be everything that we project it to be, in terms of continual growth and similar expectations. Jesse, you work a lot on looking at things from a behavioral standpoint. Could you elaborate on that?

Jesse Ausubel:

The shared economy is a phrase we're all becoming accustomed to, and I think it's a very interesting one, whether it's companies like AirBnB, which mean that maybe we don't need to build as many new hotels as some of the hotel companies have thought, or again, car sharing. Maybe we don't need as many cars.

There's this broader trend. I'll put it in an even broader perspective. There are four great resources, natural resources like water and energy, labor, information, and machines. In the 20th century and before that, the master resources were the natural resources and the human labor. In the 21st century, I think the master resources are now information and capital, the machines.

There's a real question. How many workers do we need, and how much oil do we need, or coal? I think the infusion of information into agriculture, precision agriculture, into all kinds of systems, into transportation, it's dramatically affecting the stuff that we need, the demand side. Steve is the leader of a center which is looking at cities in this way.

Jan Mueller:

Steve, he teed you up very nicely. Why don't you talk about what you guys are up to.

Steve Koonin:

Yeah, thanks, Jesse, for the segway. We started four years ago a center at New York University called CUSP, the Center for Urban Science and Progress, whose goal it is is to use data, big data resources, to fully understand large cities. In the US, 80% of us live in urban areas, and so understanding cities with the goal of improving them is something that should be high on the agenda. New technologies, the digitization of records, machine learning, the proliferation of censures let us understand cities in ways we never could before.

Some of our work is concerned with energy, of course, and that's a very important function in cities, but others are concerned with the delivery of social services, environmental quality, and so on. With respect to energy, you can substitute information for energy, as Jesse said, whether it's in the way buildings are operated in order to reduce energy consumption, the way in which they're designed. The way in which vehicles are routed is a very important use of information technologies. There is this flowering of urban science and its applications now going on in the US about how we can use new information to better understand and improve cities.

Scott Tinker:

It's interesting too, if you look at this concept of efficiency and at the end of the film, we showed a [trend] line of global demand. What we didn't talk about was that I had shown less global energy consumption than pretty much anybody who does these things in the world, because I think we're going to continue to build a lot of efficiency into our systems. If you look at that US, we're on energy growth trend pre-1973 that was at one slope. If that had continued about half a percent less than GDP growth, we would be consuming about 180 quads a year, 180 quadrillion BTUs a year of energy today. We are consuming today less than 100.

The US can do much better, but let's not underplay the amount of efficiency that's been built into the system already. Along the lines of the kinds of things Steve and Jesse are talking about, but we can do much better, so in developed nations, energy per capita is flat largely, and decreasing in some, and certainly in terms of energy per unit of GDP produced, the ratios are much better than they are in developing nations, which I hope we're correct in saying that they can accelerate themselves towards that.

As the old saying goes, the Stone Age didn't end for lack of stones, and I think Jesse Ausubel does a very nice job of explaining most of major global commodities in the world are really not a function of limited supply. What happens is, we start to replace those with other things when they get too expensive.

On that thought, the oil, the shale oil and shale gas, as the prices come down, there is discussion about, will Saudi Arabia's activities leading OPEC cause the shale oil producers to go out of business? Some of them will, some that were high cost producers, but what happens with price fall is, cost comes down, and cost comes down dramatically, so you're seeing that.

The other thing that happens is technology continues to improve and march along, so that you can extract more resource from a set of rocks than you could five years ago. That dynamic between cost, and price, and technology is very real, and as long as there is demand for that energy form, we tend to produce it.

It's really not a limit of supply. It's really a function of demand, and I think that's a very important piece of the conversation.

Steve Koonin:

This is Steve. I want to talk about, just for a minute, the potential for efficiency to reduce demand. It's very interesting if you look at energy use of various countries as they develop, and what you see is that in the early stages of development, all countries follow an almost universal path of energy use until they get rich enough, up to about $25 or $30,000 GDP per capita. China's at about that inflection point, India not really yet there, and a good fraction of the world still to get there. That universal rise of energy with increasing wealth has got to do with concrete, steel, roads, just building stuff.

Once you get rich enough, then society's choices about infrastructure, behavior, climate, mix of activities, can lead to relatively low energy economies or very high energy economies. Europe, for example, uses half the energy per capita that the US does, but that's a conscious choices about what the developed state looks like. The real question is going to be, what do China, India, Africa look like 30 or 40 years from now, after they've developed?

Jesse Ausubel:

I think part of the answer to that is in looking at young people around the world today. This past summer I was struck by the number of people standing naked on the beach talking into their cell phones. It seems like the world is just heading in that direction where what people want to consume is digital. They want images. They want communications. They don't even care if they have a bathing suit or shorts….

Steve, you're right, that people of course do want basic shelter, and so forth, but it's the information century, and people … I think the expressed preference of people in recent years is for Facebook, and Apple, and Google. That's what people are consuming, in the same way that in 1900 or 1920, people were getting all the extra electricity or all the extra BTUs that they could. In 2016, it's bytes and bandwidth that people want, and I think that's true in much of the world.

Again, we need to be very careful not to assume that the rest of the world will live like America.

Steve Koonin:

Right, although to paraphrase I think the Bible, men cannot live by bytes alone.

Jan Mueller:

A modern version of the Bible. Steve, I'd like to get back a little bit to your center, and the urban part of your name. You're in New York City. My New York friends like to tell me how low their carbon footprint is just by living in New York City, and the rest of the world is urbanizing as well. What we've been talking about is how behavior and different lifestyles may naturally, by choice and necessity perhaps, lead to a lower energy lifestyle, and a lower energy society, but there are also special challenges in dealing with energy in an urban environment.

Steve Koonin:

Yeah, so buildings use a significant fraction of the energy in New York City. The construction of the buildings, of course, changes only on multi-decade scales. The operation of the buildings is a very important factor in determining heat and light. For example, the classic New York scenario is that the building heater's turned on and the apartment windows are open in order to keep the apartment at a comfortable temperature. That's an information control problem that can be solved, but there are societal problems, or societal aspects, that make it hard to change those.

For example, there's what's called the principle agent disconnect, where I might be a renter of an apartment, and I pay the utility bills, but the landlord maintains the infrastructure if you like, and has no incentive to improve the infrastructure directly, because I'm paying the bills. Another is the risk aversion to investing in more efficient systems, whether it's because of technology or uncertain payback in the future. Frankly, in some cases, it's just that the small cost of energy is a factor in landlords' or tenants' thinking.

I'll give you an example. The numbers I'll quote are rough, but they illustrate the point. Per square foot of office space in Manhattan, the personnel costs, the person occupying the office, are $300 per square foot per year. The rental costs, the building costs, are $30 per square foot per year, and the lighting cost, the energy that it costs to deliver the lighting in that office, is $3 per square foot per year. If you're a business person, lighting as an economic driver to improve the efficiency is way down on the bottom of your list.

Scott Tinker:

Steve, I'll add into that that I speak a lot to power companies these days, and power utilities, and public power producers, and co-ops, and things. The model for their price structures is a big discussion topic. It needs to adapt and change as we become more efficient, we use less per capita. We begin to share, as Jesse has described. The amount we need drops, and not a great business model when you go to your board each year and say, "Hey. We're gonna produce less again next year."

They have to begin to work out, and that's a combination of governments, and industry, and academics, and NGOs thinking. I call that the radical middle, not many people there, but thinking together on how to create the kinds of price structures that allow companies who provide electrons to still exist, make a profit, in an ever-decreasing world, if you will, in terms of energy consumption.

Jesse Ausubel:

Yeah, this is a huge issue. Farmers need profitable crops, and it's been very hard, and in the US, Canada, Europe of course, we live with these enormous subsidies to agriculture in order to maintain the farm economy. Energy has been a very profitable industry. It's paid a lot of taxes. It's supported a lot of the rest of society in that sense.

The question of how to create profitable energy enterprises in the future is a big one, because as Scott says, if there's really a lot of demand destruction, and there are a lot of requirements to behave in certain ways, that means that the revenue to the industry is going to have to come through a lot of taxation and subsidies, that the industry won't be self-supporting.

Steve Koonin:

There is another dynamic as we think about the transition, particularly in traded commodities like oil and increasingly natural gas. If the demand for oil or gas is going down because the world is transitioning away from those fuels, then the prices will drop, and will make the alternatives less financially attractive. That needs to be managed carefully by regulation, by standards, and as Jesse was just saying, perhaps by subsidies.

Jesse Ausubel:

Of course, one of the real problems is that energy makes people go crazy in some way, in terms of public policy. If we look back on decades and generations of energy policy, there have been a lot of really lunatic ideas, whether it was nuclear powered airplanes in the 1950s, or the Clean Air Act in 1970 had some good aspects, but it also required a certain kind of review of new sources that led to the super-annuation of very bad old coal power plants. The Carter administration forbid interstate transport of natural gas, and we've had this insane ethanol diversion over the last 25 years. On an area of land in the US, the size of Illinois or Iowa, is used as pasture for cars.

The history of public policy with regard to energy is really not good, has at least as many bad ideas and failures, and lots of willingness to lie, and distort, so we have to be really careful about invoking public policy.

Scott Tinker:

Jesse, there's a modern example of that. There's several, but in Germany particularly, where they have moratory on hydraulic fracturing, and moratory on nuclear, post-Fukushima. As a result, they're taking physical delivery of coal from our Powder River Basin on trains to barges back to trains to Germany, where they mix it with their lignite and burn it. Their C02 emissions in a very green-thinking economy have actually increased. I say don't judge intentions, but please evaluate outcomes, because some of these ideas, although well intended, often fail miserably.

The one thing I want to say about Steve's point, and it's an interesting one to think about, as costs come down, yeah, perhaps government thinking and incentives, or a variety of other mechanisms, but another thing to think about is as costs come down because of demand destruction for coal, and oil, and natural gas, it means they will last longer. If we could use some of that cost destruction to clean them up further, and they're actually doing remarkable things already, but they can go further, but they could afford to have quite a bit of cleanup cost put on them and still be very competitive. If we're able to accomplish that, the environmental goals, is it coal, and oil, and natural gas that are evil, or is their environmental impact?

I think the thing that surprised me most, and I would encourage listeners to take a look at … I got to share the stage last summer with Stewart Brand, and Stewart is the original environmentalist, the Whole Earth catalogue, and he's written a book called Whole Earth Discipline. Its subtext is why dense cities, nuclear power, and transgenic crops are necessary, and this has shocked the world, that an environmentalist with his credentials is saying, "Look, the denser we are in cities, the less we use per person, more nature." Nuclear power, very dense, efficient, high capacity factors, affordable once it's built. Transgenic crops, et cetera, being able to feed people with less land, more nature.

I think a lot of the people who have spent quite a bit of time thinking about this are not trying to necessarily continue with the mantra that these things are bad by definition. We got to look at the outcomes we are intending, and if they can be accomplished, let's accomplish that.

Jesse Ausubel:

As Steve suggested earlier, the cities are great friends of the environment in general. The average New Yorker uses about the same amount of energy as the average Japanese person. Going back to Jan's original question about what is the vision of a good energy system, it may be one with very large, dense, very smart information-rich cities. It isn't one with each of us having a ranch in Texas with a windmill.

Steve Koonin:

Yes, although, just to counter again, to illustrate the point that energy is a complicated, nuanced business. Everybody thinks they understand it, but actually very few people do. One of the reasons that New York City energy consumption is low is that there isn't much manufacturing anymore in the city, and we bring in a lot of energy, and hence a lot of carbon, by importing goods, or electricity, into the city from other parts of the country. Good, careful accounting of the energy is a difficult thing to do, but is probably important as we think about the country as a whole, or the globe as whole.

Scott Tinker:

Another example of well-intended policy, and maybe Paris will counter that, but certainly the first big one, the Kyoto Protocol, post-Kyoto, C02 emissions globally increased. Although the developed nations flattened, and the ones that were participating, and the developing didn't participate, and there was a kink, a literal kink, as the C02 emissions increased.

This is exactly Steve's point. You can't blame China for increased C02 emissions. I bet every one of us has a least one thing made in China, or more, and so the demand for products that are affordable and reliable is a global demand. The emissions are a result of that. You just can't export that problem to some other country and wash your hands, and say, "Hey. We're clean." In fact, this has to be solved globally.

Jesse Ausubel:

The information economy requires perfect power. Google or Facebook can't live with outages, so the system has to be ultra-reliable. If you're in an airport and trying to get on an airplane using a boarding pass on a cell phone, it's just no good to say, "Oh, well, the system is down. Come back in an hour."

Steve Koonin:

Let me come back to Scott's point about this being a global issue, both in terms of goods, energy, environment at least for climate issues. I often ask people the question, suppose you were in charge of China, and you were the leader. You were subject to all of the constraints that the current leader has, the political constraints and so on, but you care deeply about these environmental issues. What would you do? I've not had anybody give me a good answer, other than the current trajectory.

Jan Mueller:

Okay. We're going to take a short break, and I think that's ultimately the question, and we'll dive into that in our final segment. We'll be right back.

We're back, talking with Jesse Ausubel of the Rockefeller University, Steve Koonin of New York University, and Scott Tinker of the University of Texas about energy transitions, what it's going to take.

Before the break, we were talking about how government does and doesn't help in many of these cases. We'll talk more about the federal role, but we didn't talk very much about the scale of the challenge and the timeline of the challenge, and I want to give you guys an opportunity to comment. There is the climate timeline that dominates the public discussion, but then there's the reality of what this going to take, and I'd love to hear your thoughts.

Right now, we're using in the developed world many times more energy than individuals are in the less developed world. Will we be able to bring them up to our scale of energy use? Will we be going down to their energy scale? Will we be meeting somewhere in the middle? Scott, what are your thoughts?

Scott Tinker:

Scale is really the issue, and Jesse mentioned earlier that you see people naked on a beach with a cell phone today, and that is maybe all they need. If there was no energy, they'd be hungry and naked, without a cell phone. This is the challenge. Energy underpins everything in the modern world, and the scale of demand, it's just hard to describe. I'm very optimistic that developing nations are and will continue to come down per capita, and even in the aggregate, and that the developed nations will be able to do that.

Developing nations and undeveloped will be able to grow to where they need to be and not have to go to the heights that we were in terms of aggregate consumption. It takes energy, however, to do things, so there's going to be some consumption there.

It's a huge challenge, and this is I think one of the things that's probably not well understood, is that there is a need for energy that's industrial scale, let me say, as well as a greater opportunity for distributed energy. No doubt that we can have solar panels on rooftops, and micro wind turbines, and geothermal systems that provide heating and cooling via the heat pump thought to homes and small businesses, et cetera. Particularly in parts of the world where there is very little energy or none today, that would be the way to start.

The challenge, of course, with industrial scale renewable energy, if you want to use that term to describe solar, wind, or even waves and tides, perhaps biofuels and even hydro, although many of those aren't wholly renewable, if you think about rainfall, and you think about drought, and you think about other things that affect those.

If we're going to go to scale with those, they remain sources that are not always on, if you will. The sun comes and goes. Something called night, and clouds, and the wind changes as well. You have to have reliability in that system, and that requires industrial scale, or base load, or backup systems, if you will. This mix is critical. I think it's one that we're getting our heads around, but there's still plenty of work to be done. It's going to vary. The challenge here is it's going to vary by geography. What I mean by that is, you can't have, in the US for example, a single solution.

You can't have a single solution for each state. You may have good wind in the desert southwest, and sun in Texas deserts out west, and wind in Texas and other places up the central US, whereas you don't have those resources in other parts of the country, and the same with oil and gas, et cetera. As tempting as it is, these things have to be managed by geographical regions using the resources that you have, so that you don't have to move the energy too far.

There's politics in this. Let's not kid ourselves. If you look at a map of the United States and lay down where these various sources of energy are, it's remarkable that oil, and natural gas, and coal, and wind to some degree, are largely red states, and red counties, and wind, and solar, and other things are blue. I'm not saying that correlation is causation, but I think you got to understand the politics that certain forms of current energy tend to vote one way, and others vote a different way, and there's a need to get votes. You tend to support the voter base that you have, and try to move the systems that way. There's a political component that weaves its way in and throughout all the physical, supply, and economic issues, and environmental issues we've been describing already, and that tends to make it even a little bit more complex.

Jan Mueller:

Politics, obviously, is very important, and it gets a lot of the attention, but you were talking about how on the business side and on the use side, there are a lot of trends that are very positive. I think the question still is, will it be enough? Does it need acceleration? What can we do to, in a way that makes economic sense, move there as deliberately as possible?

Steve Koonin:

It's good to look to the science, to understand at least the climate driver. Almost 200 countries met in Paris in December, with the stated goal of stabilizing the climate, and the science behind that says that if you want to stabilize human influences on the climate, not reduce, but just stabilize, we need to go to zero fossil fuels in the next 60 years, globally. Zero. That gives some estimate of the time scale the transition needs to happen, if you want to protect the climate, as people say.

It also gives some sense of the scale. In the US, for example, we replace, or we add, about 1% of generating capacity every year. Most of those additions in the last years have been in gas, some in wind and solar despite the strong growth in wind and solar. Time scales are not that rapid, and we're not moving in the right direction fast enough.

Jesse Ausubel:

The sector that most excites me for the next ten to 25 years is mobility. If Henry Ford had lived not only through the Model T and the Model A, but if he had still been alive in the year 2010, he wouldn't have been very surprised by the vehicles he saw. He might’ve been impressed by windshields that don’t shatter and so forth, but the basic vehicles didn’t change very much for 100 years.

Now, for the first time in a century or so, the mechanisms of mobility really seem to be in play. We have fuel cells running on hydrogen. We have claims, not yet really substantiated, but claims of better batteries. There really could be lots of changes, and of course, the market, the really exclusive market, the only market for oil anymore is for cars and mobility, and secondarily for aviation, jet fuel kerosene.

It’s really possible that engines and motors could change a lot, and they could run on compressed natural gas. They could run on hydrogen. The hydrogen could be stripped from methane with the carbon captured and sequestered. It could be manufactured by high temperature gas reactors in Idaho, or in China. There’s a whole set of possibilities now. There are a billion cars in the world, so the whole system won’t … Again, it’s going to change a few percent per year, but basically, it’s been a pretty stable … Mobility’s been pretty stable, and in this next period, I would say maybe the area really to watch is what changes in vehicles on land, and maybe in the air as well.

Scott Tinker:

Jesse, interesting on that. A study just came out from Berkeley. It showed electric vehicles, and it was looking at their emissions relative to internal combustion engines. It showed that you’ll get a decrease in emissions from vehicles nationwide, and it varies by state depending on the source of the fuel for charging them. What it also went on to show though, which was the interesting part, is battery efficiency, and you mentioned there’s claims of better batteries, and I heard Elon Musk speak recently, and he makes those claims very strongly, but he’s motivated to do so, that when they put in the battery efficiency component related to temperature, it turns out there are about ten to 15 northern states that have fuel mixes that are more fossil-based, and cold affects the battery life and efficiency, where the actual emissions from the electric vehicles in their system went up compared to combustion engines.

There were a bunch of states where it went down, and some that were sort of mixed. I think this is a classic example of intention, thinking, and then the real consequences out of the back end as you start to deploy it scale, and you got to always keep in mind, just like the Germany example earlier with C02 emissions going up, you have to keep in mind, what is the end goal there as we make changes from one type of thing to another, to make sure that if it’s an environmental driver, then we got to make sure that it actually happens.

I tend to be a guy that thinks … I may be unique in this, but I actually think markets aren’t dumb. I think markets actually do a reasonable, if not slow, job of moving things to where they need to be.

I think the reason Henry Ford wouldn’t be surprised is because his basic design was a pretty darn good one.

Steve Koonin:

Scott, I think you got to be careful. There are other benefits beyond greenhouse gas emissions to electrifying transport, if it can be done economically. You have the local pollution issues. You have noise. You have a much greater stability of the fuel, electricity prices are much more stable than gasoline prices, and so there may be other benefits. In fact, if you wanted to reduce greenhouse gases, transport is not the place you would start. Transport accounts for 20% globally of greenhouse gas emissions related to energy, and only 14% of total greenhouse gas emissions. Transportation, there are other reasons for wanting to improve transportation, and I agree with Jesse. Electrification, connectivity, and autonomy are the exciting things going on in vehicles right now.

Scott Tinker:

To kind of play devil's advocate for a minute, the other thing we'd have to do as we do that, though, is make sure we understand the amount of mining that would have to go on. We'd kind of shove that over to China as well, for rare earth elements. As they're weekly disseminated, you have to move lots of tons to get a little bit, and so as you start to build the cations and ions in these batteries that are going to be needed at scale, and what you do with the big housings that you can refurbish or re-use. We're not disagreeing. When you go to scale with anything, there are benefits, and there are costs. You got to manage all of those as you make those changes.

Jesse Ausubel:

My personal bet would be on fuel cells rather than the batteries, but my main point, and I was not focusing on the climate issue, but rather trying to think of which sectors of the energy economy might change most rapidly in the next generation or so. I think it is this integration of the car sharing, self-driving cars, changes in propulsion, this whole suite of things where if it's, let's say, 2040 or 2050, and we've looked back today, it may be that the area of mobility is the one … Electric power generation, basic electric power generation may still be mainly natural gas and nuclear. The executive of today, visiting a plant in 2040 or 2050, it'll be a bit more efficient and so forth, but maybe not radically different.

The mobility system could shift a lot, and I think the companies, whether it's Toyota, or Honda, or Uber, and Google, and Apple, that whole area is vibrating.

Steve Koonin:

I agree, Jesse.

Jan Mueller:

In general, there's a lot of things going on in mobility, in terms of batteries, and fuel cells, and changes in lifestyles, but if you put that all together, it's still going to be very difficult to replace the amount of energy that we're using in transportation now or if we replicated it elsewhere. It seems it's hard to avoid getting to the point where we can have all this innovation in those specific areas, but it's not going to be a replacement of the system, the transportation system, that we have now. Whether it's an energy constraint, or a capital constraint, or just a time and human organization constraint, we're talking about a future of less energy and perhaps fewer cars.

Jesse Ausubel:

But greater mobility. People will have more transport services, while using a reduced amount of natural resources. That's exactly what we want.

Steve Koonin:

I think it depends on circumstances, Jesse. For you and me, you're exactly right. I might drive a car in New York City once a week at most. Mostly it's public transport, and taxis or Uber, but you talk to people who live in Santa Fe and go several times a year or more to the Bay Area, as one of my friends does. He'll say, "I can't do that on an electric car."

Jesse Ausubel:

Maybe a fuel cell will do it.

Steve Koonin:

Maybe, or maybe just changes in lifestyle.

Jesse Ausubel:

Yes. Yeah, again, it may be that … Yes. It may be the self-driving fuel cell car which knows exactly where to get its hydrogen and so forth.

Steve Koonin:

Right.

Jan Mueller:

We’re getting close to our end of our time, and as a way of wrapping things up, we’ve talked a lot about the specific areas of opportunity, and positive trends, as well as nuts still left to crack. Rather than picking the winners and losers, which government or anyone else doesn’t do very well, but it’s just creating the conditions for more innovation, more experimentation, more trial and error, more companies, and people, and brain power involved in this problem, as well as dollars in terms of investment.

Not every investment’s going to pay off, but we need to make some bets on paving the way to a more sustainable, lower energy, lower impact future that ultimately is as satisfying, if not more satisfying, than what we have today.

I’d love to hear your thoughts on both what the private sector and individual communities can be doing, and feel free to elaborate on what government should and should not be doing in this area. Given a lot of this has to do with behavior, Jesse, why don’t you go first.

Jesse Ausubel:

More bytes, not more kilowatts. Precision medicine, precision agriculture, precision energy. It’s the infiltration of intelligence everywhere in the system, and this is true for India, or China, or New York City. I think that’s the key. I don’t think we need to invent altogether new forms of propulsion. It’s not a matter of fusion or these kinds of things. I think it’s a matter of really informaticizing the energy sector in the same way we’re trying to do that with agriculture, and with medicine and many other sectors.

Jan Mueller:

Well said. Steve, what are your thoughts?

Steve Koonin:

Let me first give a government informed perspective, and then turn to the private sector. The government is the principle agent of energy innovation at the very beginning of the innovation chain. It does the basic science, and the materials. Biosciences might be appropriate for biofuels, and some of the underlying technologies for the informatics that Jesse was mentioning. However, it can only go so far.

One of the things we talk about is the valley of death between the development of a technology and its demonstration at scale. We need more of that. Scott knows this from direct experience, carbon capture and storage plan is one or more billion dollars to demonstrate at full scale, and the government needs to be able to make that happen, either through its own funding, or co-sharing with the private sector.

More research at the head end, and then the ability to do large scale demonstrations, and FAIL as appropriate at the demonstration end. In the private sector, the companies respond to economics and regulation. I like to say they're almost like sharks–economics regulation, that's all they do, and you need to have a predictable regulatory environment. Yesterday's Supreme Court stay on the Clean Power Plan is an example of the kind of instability in regulation that is plaguing the system right now.

The second thing is the ability to make money. Unless things are arranged so that a company can make money by providing energy services, whether it's supply, or demand, or both, it's just not going to happen.

Jan Mueller:

Scott?

Scott Tinker:

Yeah, and for me, it's education. Two little girls came up to us at the high school soccer game. They were probably fifth grade. We thought we were going to be buying some Girl Scout cookies last week, and one had a little notepad, and she said, "You're the Switch guy," and she wanted my autograph, so I reminded my wife how famous I am.

The irony of all that is, her whole fifth grade class was watching Switch. I got an email just yesterday from a high school teacher in Highlands Park, Colorado, and they had done a whole unit around Switch. I'm not pitching Switch, but what they are doing is starting to educate themselves about energy, and they're using energy in their STEM classes now. We have a woefully undereducated public, even in our developed nations, with regard to energy. We simply don't understand it, and what it provides, and what it takes to do that.

I feel I completely agree with both Jesse and Steve, and I just say that the better educated the public becomes, the more likely these things are to happen in way that makes good sense.

Jan Mueller:

Okay, and I applaud those efforts, and that is, in essence, what we're trying to do here with The Energy Exchange in our small way. I very much appreciate you contributing to that effort today.

[End]

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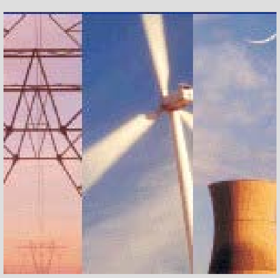

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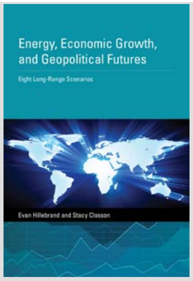

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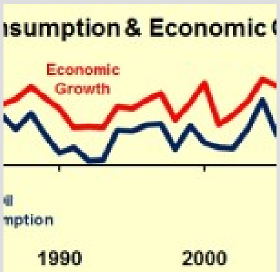

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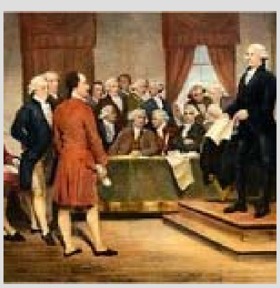

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