THE BROOKINGS INSTITUTION

Intersections:
Renewable energy and the path to a low-carbon energy future

Wednesday, July 26, 2017

PARTICIPANTS:

Hosts:

ADRIANNA PITA

Contributors:

DAVID VICTOR
Co-Chair - Foreign Policy, Energy Security and Climate Initiative

CHRISTOPHER CLACK
Nonresident Fellow

(music)

PITA: Hello and welcome to Intersections. I'm your host Adrianna Pita, and with me today are Christopher Clack, who’s the chief executive of the grid modeling firm Vibrant Clean Energy, and formerly with the National Oceanic and Atmospheric Administration, and David Victor who is with the University of California San Diego and a nonresident fellow here at Brookings, and they're here with us today to talk about how their pursuit of zero carbon emission energy, and the role that renewable energy does and doesn't play in that pursuit. Gentlemen thank you both very much.

VICTOR: Great to be here.

CLACK: Yeah, thank you.

PITA: So there was an Onion article a couple of years ago that has the headline that “Scientists politely remind the world that clean energy technology is ready to go, whenever” and it regularly shows up any time somebody shares some article with the latest technological breakthrough. But the paper that the two of you have worked on along with several of your other colleagues gets at the point that it's not quite that simple. That while solar and wind energy and other renewables are becoming much more widely available in many countries and states in light of trying to meet the carbon reduction goals of the Paris climate agreement, they've also started to set some really high goals for incorporating large percentages of renewable energy sources into their share of electric energy. But you both and your colleagues, you wrote a paper for the Proceedings of the National Academy of Sciences that at its core differentiates between getting to zero emissions, or at least cutting as much as quickly as possible, and

pursuing a switch to 100 percent renewable energy, or again at least doing as much renewable as quickly as possible, and that pursuing zero emissions is more important than trying to pursue a 100 percent renewables. And in fact trying to pursue 100% renewables might actually get in the way of getting to zero emissions, or again, cutting as much as possible. So I'd like for you both, and maybe Chris you would like to start, to lay out for us what's at the core of that differentiation and why does pursuing renewable energy, counter-intuitively, might get in the way of cutting carbon emissions?

CLACK: Yes sure. So it gets complicated very quickly but on the base level essentially wind and solar which are the two big commercially available renewable energy sources we have today, discounting hydro because there's other issues like having enough water and things like that, are the big ones that we think we can expand dramatically across the grid. And unfortunately it still gets dark at night. And so solar definitely goes away every day and wind also has these, diagonal cycles as we call them, changes and all that collectively is called either variability or intermittency. And so we have a structure of how we use energy in the country. We just have a regular beat of drum of five work days, two days off. There's a structure to that. That's partly weather to them but also partly driven by our society. And when you add these two things together, there's a slight mismatch. And so when you're low or shallow penetrations of renewables, that mismatch can just be dealt with with the rest of the grid. We can just organize things together. But as we push the higher and higher that mismatch becomes amplified. And so what you get is what we call a divergence of matching the load. And so you end up starting to waste energy and then you also don't have to build these backup generations to fill the gaps when it's not generating electricity, and so as you get

further down this curve what we find is the cost and the difficulties start to rise exponentially are becoming much more difficult. And so as you push closer and closer to this high renewable standard closer and closer to 100 percent, we have less and less wiggle room, which means the costs go higher and higher and higher and higher. Whereas the zero emissions goal would be to use all the technologies we have to basically keep that curve level off flat in terms of the amount of cost it takes to get rid of the extra ton of carbon in the atmosphere.

VICTOR: Yeah and those other technologies in addition to renewables are nuclear power, there's a large US nuclear fleet. Big debates underway about how to keep those reactors going or not and whether to build new ones. There are technologies that allow you to use fossil fuels and then to capture some or nearly all the pollution and put it underground. Maybe even negative emission power plants, we grow biomass that capture the pollution put it underground actually that's a net negative emissions. Nobody really does that yet but those are possibilities. I think the key point here is that if the goal is to reduce emissions you have a lot of options, and that diversity creates reliability helps keep costs in line whereas if you just focus on one narrow set of options renewables, that then the costs likely go up, and then all of the issues that Chris was talking about concerning reliability, not just variation in output on a daily basis but also over the year. Right now we have about 10 percent wind and solar in the US during the peak month which is early in the year. But the difference between the peak month and the trough month is a factor of 2, so there's already just over the year in a typical year setting aside whether the year is windy or less windy than usual sunny or less sunny than usual, in a typical year there's this huge variation. And so how you keep the energy

system reliable while moving energy moving power around not just on a daily basis but on a month to month basis. That's the challenge that gets more and more difficult more and more expensive as you go a higher penetration of renewables.

PITA: People often look at trying to improve storage capacity for that when you do produce excess wind solar or finding a way to just hold on to it until you have those gap moments, might be an answer to dealing with some of that. Why is pursuing better storage capabilities not sort of the simple answer to these problems that you're discussing?

CLACK: I don’t think we shouldn't be pursuing them, I think we should be pursuing them. I think the issue is again this over inflation of what it can do. The atmosphere is a battery and wind and solar that we get from that battery is free. As soon as we have to build something to capture it, it cost energy and then if we want to store it becomes exceptionally expensive because electrons don’t like to be captured so we didn't actually capture the electrons we convert it to another form of energy and hold them, and then we convert back so there's losses involved. And the issue with it is long duration that David was alluding to, you just can't hold it for that long without losing a lot of the power. And when you start adding all these extra things to try and run the grid, we find the sums don't add up. You just can't generate enough revenue for those entities like storage to actually compete against more generation or nuclear or wind solar combined with gas. It just never works out and no matter how cheap you make storage, every incremental new bit of storage you put in, its value drops much faster than the actual cost drop could be.

VICTOR: Yeah, you know the economics and the scalability here are really important. So although we've seen a lot in the news about the reduction in cost for example batteries when you take a step back and look at actual storage deployed right now in the U.S. grid it's dominated by pumped hydro which is a really important option and there should be more of it. It's not cheap, but it's really important in grids that have a lot of renewables on them. The fraction of storage its battery is actually a tiny fraction that might grow very rapidly, but we have to remember that the whole energy system doesn't change that rapidly, and so the I'm needed to scale up that kind of solution. And what it would actually cost, how you'd finance it is really important. Chris said something in passing about the marginal value of the storage, that's crucial to the financing of all this because you need to find real people who are going to put real capital on the table to build these projects and if they think they're only going to get a return on the project every once in a while they're not going to build the needed level of storage and so that's getting the market design to a point where we actually see a big investment storage. We're still very far from that.

PITA: I want to come back to that idea of investment into various types of technologies a little bit later on. But first I wanted to ask if some of these difficulties with pursuing really high levels of renewable energy sources is sort of what's going on in Germany. Recently they've been increasing their share of solar particularly, and also wind but they've also been seeing their emissions rise. Can you explain a little bit of what's going on there?

CLACK: Yeah. So they've been increasing their renewables, but they have a lot of coal on the grid, and they've been increasing the renewables primarily by using the

rest of Europe as their battery. For want of a better word, they'll share their power with their neighbors where they have got access and buy back when they don't. Now what we're seeing is they're starting to decommission nuclear plants. And the issue is as you de-commissioned that they're not replacing it fast enough with the renewables to actually recover that emissions control that the nuclear is providing. I mean so what's stepping in is coal which is very dirty and some gas. But then they're also importing more power and if they've been posting it from Poland or the Baltic states versus say France which has very clean power, their net emissions will rise certainly unless they can replace that generation which becomes harder and harder because they're a small country and the other countries around them are now starting to want to decarbonize themselves and so they've got nowhere to run they can't use them as the storage facilities that they used to they have to now try to get this big issue that they've caused themselves.

VICTOR: Yeah I think that's exactly right. I think one of the interesting things comparing Germany the United States is that among the many differences is that in the United States natural gas is much cheaper. And so in the U.S. grid, gas is increasingly becoming the backbone and gas is displacing coal, and that's resulted in a modest reduction in emissions overall in the United States whereas in the German grid gas is more expensive, it's priced a lot of contracts and arrangements that are more closely tied to the price of oil. They don't have essentially any of the shale gas production that we have in United States and so when you look at that overall picture the German grid is more dominated by coal in particular lignite, brown coal, is actually dirty, a particularly dirty form of coal so it's not to say that coal is bad under any circumstance but if that's

the fuel that's on the margin then these variations in power output that are created by renewables they're basically made up for at the margin by more coal generation.

PITA: France has declared that they're trying to set a goal of no longer using coal at all to produce their electricity after 2022. They do produce about 75% of their energy already comes from nuclear. Are they just going to try to go all nuclear or what else are they pursuing to try and reach that?

CLACK: Well I think it is up in the air. I think there's some who want them to remove the nuclear which I feel is a mistake because they go and replace all with something else and all there is is renewables. Which makes the whole issue harder for all of Europe let alone just France. I mean even getting that last percentage to be either renewable or nuclear is a hard job but I think removing the coal is good. It's just what they replace it with and that becomes the more difficult question and has to happen rapidly if they want to reduce emissions.

VICTOR: Yeah they're in a different starting point from Germany because of the large amount of nuclear power. I would say that political opposition to nuclear power in France has grown including with the new president. Many countries announced they're going to shut reactors and then don't. My guess is that that's what's going to happen in France is the reactors are going to stay open because the scenarios of the alternatives are very very difficult indeed.

PITA: While we're talking about nuclear, you mentioned the U.S. our current nuclear fleet of reactors a lot of them, I think it's over 90 percent, are about 30 years or more old in this country. We do have a lot of people who are very leery about having

nuclear reactor near them wearing that what to do with waste which is mitigated by newer plants. But can we produce what we need from our existing fleet if we need to produce new ones, how do you do that in an environment where we're not very nuclear friendly?

VICTOR: Well so it's first of all the big threat to the U.S. nuclear fleet is especially smaller reactors, and reactors on single sites where they're competing in power markets that are dominated by natural gas. We're just talking about that and also a lot of renewables and so on those power markets prices are low and they're highly variable and that makes it harder for somebody who owns a nuclear reactor to make money and so not surprising we're seeing a number of them shot sometimes in conjunction with maintenance problems, and a lot of other problems I'm heavily involved with the decommissioning of the Center for a plant in California. So that process is underway and it's being largely driven by the market dynamics. Some people a few years ago were very enthusiastic about a nuclear renaissance in this country. That's really hard to see happen right now in the real world. Quite apart from the political opposition in some parts of the country, the economics are not there. And one of the big suppliers has just basically gone bankrupt. And so the firms that are building a few reactors right now will probably complete those reactors. But the economics and practical difficulties of getting new reactors going in this country have just gotten a lot greater.

PITA: Speaking about the financing of which energy sources get pursued in which doubt as you mentioned natural gas is incredibly cheap and that's keeping people focused on natural gas rather than nuclear rather than many other options for energy. MIT tech review it had a really interesting article recently that was talking about the

struggles that a lot of clean energy startups are facing. This one was particularly looking at Aquion Energy that was doing battery research, and they and several of their other colleagues are also doing research into storage options that would be better than the lithium ion options for storing energy. They just couldn't compete price wise. Lithium ion is super cheap the price of that has dropped. So there was not enough money to keep them afloat. Can you talk a little bit about some of the struggles in the question of the fact that we rely on market forces to try and pursue a lot of these issues and some of the investment options that are going on there?

VICTOR: Well so this is a space where there's a tremendous amount of innovation. So there are companies that are imploding but there are also companies that are thriving and so I actually don't see as much of a crisis in the clean energy investment space that I think other folks see. There's no question that the business of clean energy is much more highly regulated than other kinds of industries that Silicon Valley gets excited about, computers. I.T., so on where the regulatory barriers to entry are fewer and so the capacity to build a company in your garage and then three years later do an IPO and go buy a Gulfstream. You see that a lot in the high frequency tech world but not as much in the lower frequency more regulated worlds around energy and so some of the battery startups are finding difficulties getting markets because there aren't right now that many clean markets. That said California among other places has mandates to require the use of storage and the investment in storage and so you're starting to see niches appear here and there. And just a tremendous amount of competition. To me technologically one of the most exciting things is that lithium’s not over. The lithium play in batteries, that continues to improve radically. And so I think

some people who thought the world was going to move quickly beyond lithium have been surprised to see how robust lithium actually is.

CLACK: Yeah lithium keeps getting cheaper and now a lot of electric vehicles are being produced by lots of big manufacturing companies, car companies of course, that's going to drive down costs because they are notoriously well known for being able to make costs lower mass producing things. And so I don't think he's going to get easier in that space because are going to get very cheap and they're going to keep innovating. But again it's a diminishing portion of the energy footprint and with the market we always have to have in the back of mind, in my opinion, the emissions need to come down somehow. And if we're not thinking about that and the backbone of also the economics we're going to run into some difficulties actually being able to even achieve decarbonize full stop and so they will keep innovating and we'll keep moving forward and hopefully some will win and some will lose, that’s unfortunately markets right.

VICTOR: Maybe it's too much training in the value and brilliance of markets but whenever somebody looks for an on market solution I ask why they're looking for an on market solution. If there is any area where you want to let the market figure this out, you know I'm not a complete hansd off but with clear guidance and some incentives, it will be here because the technology is changing so quickly that the potential for error through non market solutions or regulatory mandates is that potential error is really massive.

PITA: So the two counter-example about that I would think come to my mind and make them do a lot of other people's is thinking about rural electrification in which case you know electric companies didn't necessarily want to string polls or forgot to get

transmission over longer distances, so government did the Tennessee Valley Authority or they provided really cheap loans to farmer's co-ops to make it happen. Or the moon landing of course is the other big example of times when the nation has decided that something is a priority. Getting the government to be like, all right we're not just making money off this so we'll throw a bunch of money at it until it happens. Why would this not be ok?

VICTOR: I mean there are clear market failures as well here. So the moon landing provided the social good which was getting to the moon -

PITA: A technological by product along the way.

VICTOR: And getting their tang and ourselves and right and other things. But it provides an important social good the Rural Electrification provided an important social good, so it's no question that the markets by themselves are not going to deliver everything you want so the strategy to adopt in energy is to have a set of clear market signals as well as incentives to adopt new technologies that are going to be needed. Stuart, we were just talking about carbon capture and storage CCS This is another very very important example where frankly the policy incentives have been lagging far behind. And then also for the government to make large massive investments in the early stage innovation and this is actually an area where the United States in particular has made tremendous progress in the last 10 or 15 years where not only we have been spending more money at least a bit but we've been spending a lot more effectively. Programs like Orbit E, investments in early stage innovation that then you help a company along with technology along and then eventually the marketplace picks it up. So we've actually learned a lot about doing this. This is one of my biggest concerns

regarding energy policy under the current administration is that the OMB budget cutters are so enthusiastic that the budget drafts we've seen so far are actually really harmful to some of the programs that would be the most important programs in this area.

PITA: I do have to ask you Chris you were giving another interview where you sort of alluded to one reason why state governor's states certain policy makers might be pursuing renewable energies and trying to move to more of renewable energy because it's more politically palatable if they can say we're going to create new jobs. It's a whole new burgeoning industry that is much more sellable than just talking about carbon emissions which a lot of people here as well you don't want me to run my AC is much you don't want me to drive my car I like that sounds like a negative whereas green energy sounds like a positive. Can you talk a little bit more about some of the forces at play there and what you were referring to?

CLACK: Yes it is essentially I think you know when you follow the debate through history you see that climate change wasn't really getting anywhere in terms of changing policy. So this abstract thing that doesn't seem to be affecting us but building new generators seeing them get in the ground bringing jobs to the state seeing the new influx of taxes is very visible very quickly particularly on smaller states. And so it just transitions to well we can't talk about climate, can't talk about carbon, but we can talk about renewables and we can talk about getting them on the grid and that starts with the movement. And so I think it was a good thing to do. The problem is now that we have to explain that the problems are a lot harder than just putting renewables on the grid. And unfortunately we have to explain to the public and sort of enlighten them on 10 percent is very easy for the grid to manage yourself with there's lots of variability in the

grid anyway. Besides renewables. But that's a completely different world to 50 percent and above. And so we need to be able to educate them and turn the discussion to. OK now we've got them on the grid, and we understand that they're good for jobs and for pollution and things like that but now we need to think about how do we get to the next stage of how do we get rid of the emissions. And explain to the localities that this climate change issue that seems abstract and far away isn't very far away and isn't abstract they will have detrimental effects to crops in your local vicinity water lots of different aspects of life. And that problem just gets bigger and bigger and bigger as you get further forward and trying to then get across. I keep trying to do how slow energy takes to build things. If we look at wind and solar just as one prime example all the big major development of that started in the 70s. So it's nearly 40 years ago and so it took 30 years before it really took off. And so the problem with exponential growth is you have this flatbed that you have to really zoom into to have a look before things really take off. And so we need to be able to explain that if we build something today it's going to be around in 30 years' time and that's butting up against the deadline we have to sort these issues out. And so sort of now we need to evolve as a society to sort of move the discussion on past. Now we need to get them on the grid now we need to talk about how do we keep them on the grid and how do we decarbonize the rest of the economy.

PITA: What is the danger in trying to pursue higher levels of renewable than what the grid can support right now, what's the danger and maybe aspiring to more than what we can do?

CLACK: Well first it's what I call backlash which is we have to fall back on something. And so as you push more on it gets harder and harder and humans have

this annoying tendency to fall back to despair. They don't be pragmatic about things they know we can't there's too hard to fall back into nothing. And they need to be aware of the extra burdens that they have to have with these extra renewables but also just from a practical standpoint of the resources it takes. And so I kind of sometimes feel like we have a moral objective to do it as cheaply as possible because you can say OK a 30 percent rise in the U.S., most will be able to afford that. But if you get to the developing world where the growth and energy is going to be much larger than what we're going to have they might not be able to afford that. Why would they want to pay for that when they could pay for alternatives? And so just extracting the resources from the ground just a pure, the amount of rocks, we have to use to build the wind turbines and the magnets and the solar panels is a lot of energy both in resources and actual energy. And so to do it in a lower cost way and in a more efficient way just helps everything become easier because you get these huge multiplier effects of if everyone is competing for one particular metal for wind turbines. Markets say that price is going to go up and it's going to get harder to source it. And so not only does it cost go up because of the variability question and also resources will spike up and everything else and we saw that in the early 2000s with wind we saw that big hump in prices of wind because construction booms were happening and steel was became much more expensive and that drove up prices and then not diminished need for wind or want for wind. And so we have this big lull in investment and we can't have that because we just don't have the time to do that.

VICTOR: Yeah I mean costs I think matter not just because they're important for the economy but they're also crucial for the politics. There's a long game here. You've

got to engage in a multi-decade investment to decarbonize the energy system. And if we do it in a way that generates high costs there are some places in the country that will stomach that, my state of California, maybe a few others. But what matters is the whole country and actually what it really matters because it's a global mix of pollutants is the whole planet. And so we have to keep our eyes on doing things that are going to remain politically durable and credible lest the political rollback that happens periodically that rollback basically interrupts all the progress. I worry that the zeal to have solutions that seem quick and easy and free results in adopting policies that become expensive and when they're visibly expensive then they generate their own opposition. We see some of that right now in the current administration. There's a report the Department of Energy is going to issue soon and we don't nobody knows nobody outside the department knows what it says but there's a lot of fear that that report is going to be used as a way to try and roll back some incentives for renewables because of people's concerns about costs and so I think we need to kind of keep attention to what we know and what we don't know and how do you design policies that evolve as the technologies improve?

PITA: I also wanted to ask you about carbon capture and storage or sequestration which you mentioned before, there was a report that was done by the Global Warming Policy Foundation that was looking at the costs of CCS operations and at least here in the States again with the cheap cost of natural gas right now they were saying it seems to be like CCS programs just aren't cost effective compared to natural gas. I mean there was a coal plant in Mississippi that was working on certain clean coal aspects gasification of coal and they just ended up being too expensive and they said no we're switching over all natural gas. Can you talk a little about some of those forces

at play there? If that's true in the states that are all around the world or what's going on with carbon capture?

VICTOR: So almost all the big energy models come to the conclusion that big reductions in emissions which so far we're not seeing but are necessary in order to protect the climate. Big reductions in emissions require a whole slew of technologies not just renewables not just nuclear we're talking about today but also probably CCS in one form or another. And interestingly enough the deeper the reduction of emissions the more these models tend to rely on CCS and also on a bio energy CCS system that actually has negative emissions and so that's a pretty robust result from the modeling community. And then when you go to the real world what you see is very little investment in the technology. And that's because it's early days. And so the plant that you mentioned in Mississippi the Kemper plant they're testing at scale a novel way of combusting the coal and capturing the pollution and the injection underground part is relatively more straightforward and so not surprisingly plants that do novel things have risks and there are going to be more expensive. And so I think the big problem for policy right now is that somebody who wants to go invest in one of these new power plants there isn't a credible set of policies that would allow them to go invest with confidence and not be concerned that if they try something that's new and risky which creates a public benefit of learning what works and what doesn't work that they're not going to get stuck with the cost. And I think that's now increasingly a global problem because the markets for technology are global markets. There are some countries that are better positioned right now to test some of this at scale the Chinese in particular with industrial CO2 emissions is a lot of interesting technologies gasifier based technologies in China.

There are some European policies and policy reforms trying to advance CCS that's been kind of fits and starts, but ultimately the benefits to knowing about this technology are going to be global benefits because the technologies move through global markets.

PITA: I think for my last question it’s going to be on that technology angle which is there's all these different things that people are playing with whether it's batteries whether it's CCS, and we're talking about which avenues are sort of this is too quick it's too easy. You're giving me what sounds like an easy answer, but that's not going to work. We're not going to do that. What are the next technological aspects that are going to be easier to scale, easier to implement, that people should be focusing on?

CLACK: Well we should certainly be installing more for more wind and solar. We need to be doing a lot more smartly and we're doing now. Transmission is the nettle we're going to have to grasp to deal with regardless of what we do. We need more transmission moving the electrons around. We're getting from a system where where the energy is generated is going to shift. And so that involves transmission. So investment and storage investment to the CCS needs to come online pretty quick. I'm more sort of bullish on things like power to gas and things like that more, novel things that can give us a longer term quote unquote storage that need to be invested in today for the future because if we were going to decarbonize the whole grid. There's a number of things that become very very difficult very very quickly. Aviation, cement manufacturing, steel manufacture, shipping. So there's these big sectors that we haven't talked about that need innovation and need help as long as we think about the electric sector as being. We've got some solutions we need more. But from my sort of modeling work every economy that can decarbonize from the model you have to electrify more

and so what more you have to make electricity cheap because you have to draw people in. And so those combined innovations of looking at electricity making it cheap and making it cleaner and then there's other sectors need to be innovative and talked about. And basically there's lots of new ideas that keep coming up and we need to assess them and analyze them and work with them to see which ones are win and which one failed. The issue is some of the policies we have today is very prescriptive and is very favorites of one or two technologies and that sort of blocks out innovation in other areas which makes it more difficult to find that new quote unquote miracle solution that might pop up if we're not looking for it.

VICTOR: Yeah I completely agree I think there's at least two big challenges here. One is running a portfolio that there's a tendency to focus a lot of the policy energy and investments in particular areas. But everything we know is that we don't know what's going to win. We don't know what is going the big reductions unprecedented reductions in storage costs or production from renewables or advanced nuclear reactors or CCS or some combination of all that and so we need to spread the chips around the board and then be have a policy that is nimble and can move those chips around as you find performance in one area and not another area. I think the other big challenge that Chris really put his finger on the pulse here is how to deal with the legacy system that we have right now and across the industrialized world, we have especially in cities big infrastructures that are already built the natural gas network is in particular key to this. And so some technologies work well with the existing infrastructure power and gas is a good example. And so those technologies all else equal are probably going to do better than technologies that require green build for everything because as a general rule the

green build solutions are going to be a lot more expensive for mature economies and mature infrastructures than the ones that drop in or partially drop in with existing infrastructure and that's I think both an economic point but also political point.

PITA: OK. Well gentlemen thank you both very much for helping to work through these challenges with our listeners today. I want to remind our listeners they can follow us @policypodcasts and thank you both for being here.

VICTOR: Thank you.

CLACK: Thank you very much.