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Q&A

ENERGY POTENTIAL

Stanford University's Sally Benson long ago became involved with research about carbon capture and storage. The technology, still unperfected, is crucial if America's vast coal reserves are to continue to be used without producing atmospheric greenhouse gases. ¶ Benson, right, now director of Stanford's Precourt Institute for Energy — a hub for many of Stanford's 200 faculty members involved in energy studies — agreed to an interview with Allen Best during the recent Vail Global Energy Forum about disruptive technologies, the boom in oil and gas production, and the need to rapidly reduce greenhouse gas emissions.

Allen Best: In the world of energy, what is the most feel-good story that you see?

Sally Benson: The really rapid growth of solar PV (photovoltaic). It's extraordinary. It's all around the world. In California, which I watch very closely, it's amazing that in the middle of the day we are producing 7 gigawatts of renewable energy out of a total load of 25 gigawatts. Of that renewable energy, about 80 percent is PV on a typical day. Who would have guessed? And it's getting very cheap.

Q. Why has PV solar done so well?

A. It's a combination of things. There were some government policies primarily driven by Germany, which provided this very lucrative payments to home and business owners for green-energy production. That created demand. The Chinese responded with excellent supply-side management, learning by doing, and advantages of scale in building some big, big factories. There were also technological improvements.

Q. You talk about something happening here in Colorado influenced by things happening in two other continents. Is that the story of energy altogether?

A. Since the advent of liquid fuels, energy has always been a global story. Now we see this in PV and in batteries. We are all connected.

We are on the cusp of a real revolution in batteries much like we saw with solar photovoltaics beginning about 10 years ago. Batteries are poised to undergo dramatic improvements in energy density and in terms of the cycle life: How many times can you charge and discharge it?

There must be thousands of scientists at universities and industrial labs working as fast as they can, because there's a big prize. This next generation of battery technology will be very profitable, because there will be demand both for transportation and for storing of electricity from renewables.

Q. What are the implications of improved battery storage to our electrical system?

A. Right now the sun shines in the middle of the day, six or seven hours, and the wind, of course, is even less predictable. The modern electricity system operates on demand. We turn on the light switch, we expect to see light.

In the short run, having batteries will also help with things like power quality. By putting good storage with the right kind of inverters, you can actually help stabilize the grid. But with storage, we could use solar energy at night. The harder problem is seasonal energy storage, and that's a nut we haven't yet cracked.

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Q. The National Renewable Energy Laboratory in Golden says that we have figured out a lot about renewable energy, and now it's a task of integrating it, which is what they're doing at the new Energy Systems Integration Facility.

A. It's a matter of figuring out how to deliver it in a way that provides all the same services and benefits. The way we produce energy today, it's completely controlled by us. When you want to turn on the electricity, you turn it on. Our electrical supply from coal and natural gas plants is completely dispatchable.

With renewable energy, it comes and it goes. So figuring out how to take advantage of that in a way that delivers the same services that we're used to will require a lot of integration of what is called demand response.

Q. Most people would say that the oil and gas boom in the United States is a good thing. Are there downsides?

A. There's no doubt that it's beneficial to the United States if we don't have to import so much oil, because when we do we're just sending money overseas, sending jobs overseas.

I think that for natural gas, to the extent that it can be used as a substitute for coal, that's certainly beneficial for reduced air pollution. And if we don't have much methane leaking, that's good for greenhouse gas reduction. Methane is a very potent greenhouse gas — over 30 times more potent that carbon dioxide. If it is leaking at a rate of 3 percent or more, the greenhouse gas benefits you realize from burning it, as compared to coal, go away.

It's also a good thing if we have enough natural gas to export to other countries, particularly in Asia, that are very reliant on coal and have great air pollution problems. Gas would be vastly preferable to burning coal.

On the downside, with oil half the price of what it was, we know consumers tend to buy cars that are not nearly as fuel-efficient. When you buy a car with low miles per gallon, you are locked into a decade or more of inefficiency. There's a long tail in terms of impacts.

Q. Do you think we can get a strong handle on the fugitive emission of methane from production and transport of natural gas?

A. I think so. A number of studies have shown that most of the emissions of methane comes not from many little leaks but instead from a few large sources. These are things such as valves left open as a result of human error. They are very fixable. With excellent monitoring, this is a very solvable problem.

The distribution system, including the maze of delivery pipes, is a lot harder problem. In some places, we don't even know where the gas distribution lines are located, because they were installed before good records were kept. The benefits of updating this infrastructure are huge, because of the potential for natural gas explosions, as have already occurred in many places across the country.

Q. Two years ago at this conference, you said that we have received an unexpected blessing in the form of natural gas production and that we'd better not waste it. What did you mean by that?

A. Natural gas provides us the unique opportunity for two things. One, it will make it easier to add a lot more renew-ables, because of the ability of rapid-start gas turbines (to ramp up when renewables drop).

There are other uses of natural gas, including for light-duty transportation. There's may be a financial benefit, but in in terms of the greenhouse gases, it's worse than gasoline.

The other thing is we make chemicals from natural gas. The chemical industry is an important one. We can make all kinds of fantastic materials. As we move into the future, we will see a materials revolution that will allow us to make things that are more recyclable, lighter and stronger.

Q. If we are to continue to burn coal, we must figure out a way to capture carbon from emissions and sequester it and, more importantly, do it at scale and on a global scale. Are you optimistic that we will get there? What will it take?

A. We're finally seeing carbon capture and storage deployed by coal-fired plants. There's now a plant in Saskatchewan, Canada, and another plant, in Kemper County, Mississippi, should be on line next year. By 2020, we will have doubled the amount of sequestration from about 14 million tons a year to just about 30. That's a good thing, because we need a baseline of experience. And understanding the science of C02 storage has advanced tremendously.

The hard part is that it's it still expensive. Carbon capture and storage is always going to be a more expensive way to produce electricity than burning natural gas using high-efficiency combined-cycle turbines. Nuclear power suffers from the same problem. Unless we have a high price on carbon emissions, it's hard to make the economic case for C02 capture and storage.

We still can do much to decarbonize our electrical supply by expanding the deployment of lower-cost renewables.

But once we get past 30 to 50 percent reduction (in greenhouse gas emissions), we will absolutely need things like capture and storage if we are going to continue using fossil fuels. That includes natural gas.

Q. How much time do we have to decarbonize our economy?

A. We need to start now and make significant progress. We know with certainty that any delay makes the problem harder and harder as we go into the future.

This is a multi-decadal problem, but by 2050 we need to have made significant progress in terms of global emissions reductions, on the order of 50 percent. By the end of the century we need an energy system with no emissions. Many studies now suggest the need for negative emissions. The faster we can act and create real meaningful emissions reductions, the less we will have to rely upon more extreme negative-emissions technologies.

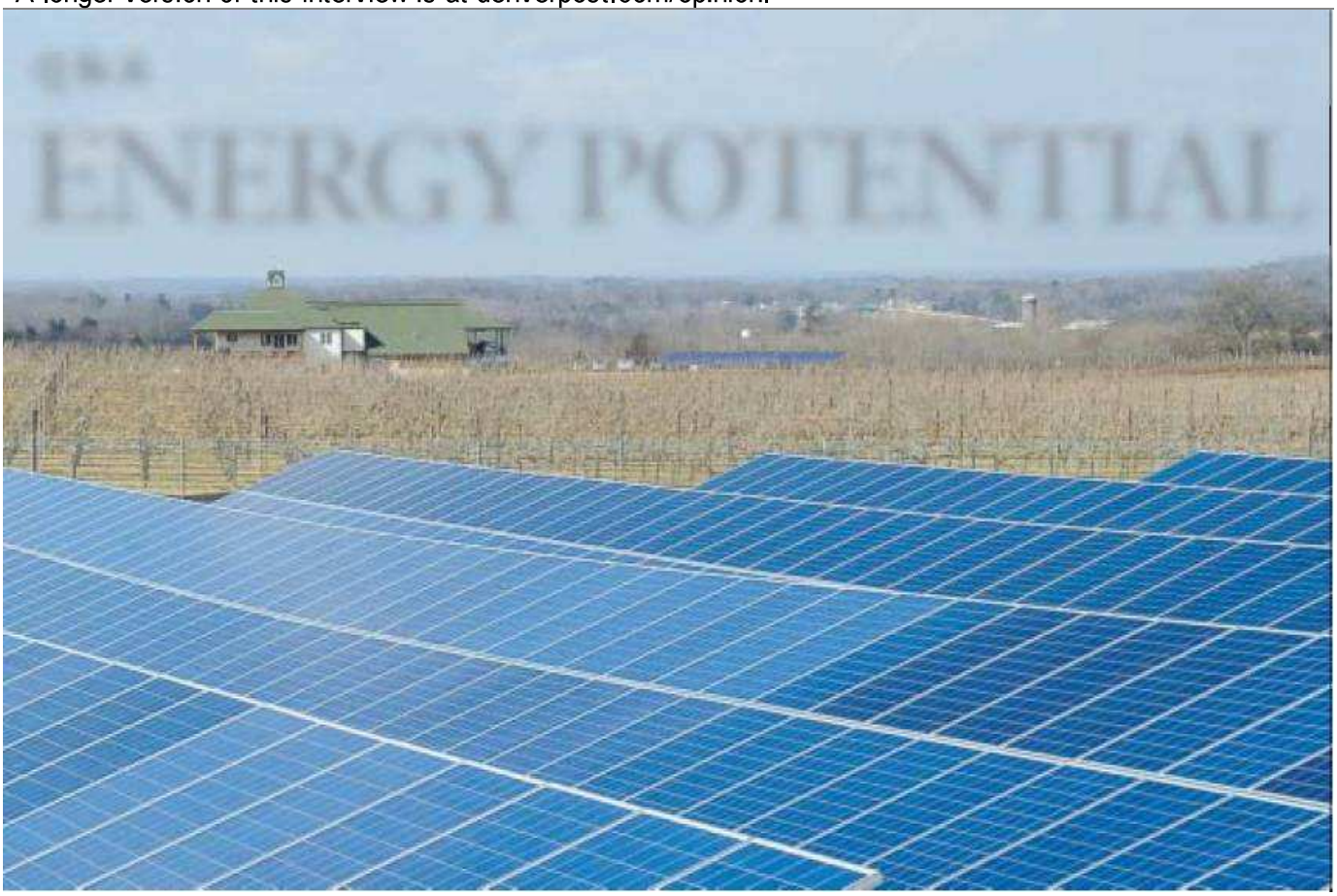
We will not solve this problem in 10 or 20 years. If it was just the United States, Europe and Japan, wealthy countries with energy systems where energy demands are probably going to be flat or, if we're effective in our

efficiency, we could have declining demand.

But those are the richest regions in the world.

It's an ironic situation that the major economies will need to use less energy and decarbonize quickly, while at the same time, other parts of the world will need to use more energy and emit more greenhouse gases into the atmosphere. That's a hard thing to grasp — we're doing one thing and they're doing another — but that's what will happen and what needs to happen.

A longer version of this interview is at denverpost.com/opinion.



These solar panels in Mocksville, N.C., will generate 430,000 kilowatts of electricity, enough to power 50 homes.

Bruce Chapman, Winston-Salem Journal

Allen Best of Arvada publishes an online newsmagazine found at mountaintownnews.net. This interview was edited for length and clarity.