RISK-TAKER: Scientific innovation requires bold experimentation, says Chu, who shaped the Advanced Research Projects Agency–Energy, a Department of Energy initiative modeled on a similar agency at the Department of Defense, to fund ambitious research.

POWER AND POLITICS

With Bell Laboratories as his model, Steven Chu '70 sought change at the Department of Energy.

Interview by Karen McCally '02 (PhD)

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When President Barack Obama nominated Steven Chu '70 to become secretary of the U.S. Department of Energy in January 2009, the appointment of the 1997 Nobel laureate signaled a commitment to science and a sustainable energy policy.

In his post, which he occupied until last month, Chu delivered a focused message: that the reality of climate change, and the role of carbon emissions in producing it, is well established; that rising energy demands, particularly from China and India, are likely to cause oil prices to spike in the coming decades; and that for this combination of environmental and economic reasons, the United States must invest far more resources in developing renewable energy sources.

Chu carried out what's been called an "all of the above" strategy, stressing that fossil fuel development would remain part of the nation's energy mix, alongside renewable power resources such as solar and wind, nuclear power, and biofuels.

But behind the scenes, there's little question that his personal energies have been focused on energy innovation, particularly in the development of renewables. The department's solar energy program, a program that's existed since the department's birth in 1977, but long on the fringes of the agency's priorities, has been placed on a more solid financial and institutional foundation under Chu's leadership.

And in January, Chu addressed one of the last remaining barriers to developing an economy based fully on renewable energy, with the creation of a $120 million Critical Materials Institute to develop a stable and mass supply of the rare earth metals required to produce solar panels, wind turbines, and other elements of a renewable energy infrastructure.

Much of the new work in the department takes place under the auspices of the Advanced Research Projects Agency–Energy, or ARPA–E, an initiative to fund high-risk, but potentially high-reward, innovations in energy technology. Authorized in 2007, but not funded until 2009, ARPA–E, as it exists today, is largely Chu's creation. He's shaped it in accordance with lessons he learned as a physicist at Bell Laboratories in the 1980s. That's where Chu conducted his Nobel Prize–winning research, on using lasers to trap and cool atoms, as well as the birthplace of the transistor, communications satellites, cellular telephones, and other landmark technological innovations of the last century.

This month, Chu returns to Rochester to address the graduates of Arts, Sciences & Engineering during the University's 163rd commencement ceremonies, where he will also receive the University's George Eastman Medal. Then, he will return to teaching and research, rejoining the faculty of Stanford, where he taught from 1987 to 2008. He'll be the William R. Kenan Professor of Humanities and Sciences and will hold a joint appointment in physics and the medical school's molecular and cellular physiology department.

In March, from his office overlooking the National Mall, Chu discussed some of his work over the past four years.

What's the federal role, and the role of research universities, in shaping energy policy?

The federal government has always been the main funder of basic research in science in general, and the science and engineering related to energy. Much of the science and engineering related to energy actually starts in more fundamental research in science, and then one can realize later what its applications might be. The federal government also directs funding for projects—how to try to develop a better way of capturing the energy of the sun, for example. Much of what the federal government has funded is research in universities. This funding has a dual purpose in that it also trains graduate students, postdocs, and, increasingly, undergraduates who start to do research in these federally funded labs.

It's been written that your experience at Bell Labs has inspired much of your work as energy secretary. Is this true and if so, in what ways?

It's a model, and it's certainly the way, consciously, I set up ARPA–E. What you had at Bell Labs is a bunch of scientists who were crammed in very close quarters. You didn't just mind your own business and do your own research. You were always talking and learning about other people's work. But the most interesting part of that is, let's say you're representing your people, and you say something and I don't agree. There would be an open discussion. It keeps everybody honest. Instead of each person waiting politely to take their turn, there's an open, free discussion where everything's fair game, but it's not personal. Sometimes people ask in a not-so-nice way—there was one person at Bell Labs famous for getting up at seminars—this big, tall guy, and saying—'What the hell are you doing that kind of crap for?' This could unnerve people. What it really meant was, 'Tell us the importance of what you're doing. We just learned you succeeded. What's the fundamental importance?' You were always being challenged by your colleagues—in seminars, in discussions after seminars, at lunch tables. It was what a friend here, whom I recruited, called 'constructive confrontation.' It was a very flat organization. You were judged by the value of your ideas.

The culture in Washington is not noted for "constructive confrontation." Have you found the transition difficult?

Well, it depends on what culture you're talking about. Within ARPA–E, we created a culture of constructive confrontation. And it's the closest thing to Bell Labs that I've seen outside of Bell Labs. It is more like Bell Labs than a university. At a university, when people say, 'I have a new idea and I would like to get funding,' you write up a proposal and you'll be lucky if you get it in one year. Typically it's a year and a half, two years, before you can even start. At Bell Labs and now at ARPA–E, you go to a manager and talk about it. The manager might say, 'I don't think I believe this.' You'd say, 'Let's go work it out on the board.' Your boss can engage with you on a fine detail. But you don't get an answer in a year. You can get an answer that day or that week. And if you don't like the answer, you can appeal it up to a point.

Now in terms of political confrontation, the amazing thing is, at some level, even though they have to do the theatrics in front of the camera, some of my good allies are actually across the aisle. Much of what I've done is about science and not politics. Perhaps 98 percent of my job has nothing to do with that political sort of confrontation. Now, what the public sees, is what it sees.

How has ARPA–E helped advance solar energy?

We recruited Ramamoorthy Ramesh from the physics department at Berkeley to head ARPA–E's solar photovoltaic program. He went off and started to revitalize the program, which Arun Majumdar, the director of ARPA–E, named the SunShot program. And it turned out that a crew of four scientists transformed the solar program. All of a sudden, people from universities were coming

FUNDAMENTALS: "Much of the science and engineering related to energy actually starts in more fundamental research in science," says Chu, who has rejoined the faculty of Stanford University after four years as energy secretary.

to me, unsolicited, and saying, 'Your solar program is transformed. You're funding all the good stuff. You used to fund not-so-good stuff. It's very exciting.' One star professor at Caltech said, 'Because of this SunShot program—and now the students have noticed this—I have more applicants, I have the crème-de-la-crème pick of graduate students at Caltech who want to go in my group and work on solar, because the funding agent is making all the right decisions. So three to four in a division created that with constructive confrontation.

Now outside of that group, I have to do a lot of blocking and tackling. Behind the scenes I say, 'Don't hassle these guys.' Congressional affairs didn't want Arun to talk to Congress, for example. I said, 'No. Arun can talk to Congress. He can talk directly. Don't muzzle him.' And he turned out to be one of our best spokespeople for the program.

So that's a culture we've created within the agency. But the larger issue of how deals are not made in Congress? That part is frustrating.

You've often said that scientific innovation requires a long timeframe and tolerance for failures along the road to breakthroughs. How has failure played a role in your career as a scientist?

If you plan a program where you don't fail, that tells me instantly that you're not reaching far enough. There's a quote from Michelangelo that I like to cite. He said, "The greater danger for most of us lies not in setting our aim too high and falling short; but in setting our aim too low, and achieving our mark."

This is something I learned as a graduate student. I worked on three projects before I landed on a thesis. One could say they were incompletes or failures, but certainly incompletes. But I landed on a project and said, 'OK, this is it.' And then focused very much on that. But if you consider the overall picture, you could say, 'Well, you started this, you didn't finish; you started another thing, you didn't finish; what's going on?' Yet after I was a graduate student and a postdoc, the physics department at Berkeley wanted me to join their faculty. So I wasn't a total failure.

So how did this happen, after only one success out of four? It's because when I failed, I moved on, and I moved on quickly, number one. Number two, what I did do was of some note. And number three, when I failed, I looked at the heart of the problem and said, 'If this doesn't work, the path going forward is not going to work.'

I had a similar success rate at Bell Labs and at Stanford. At Bell Labs, there were times I would be working on a project for two or three years, and the people there would get a little anxious and say, 'Look, this could ruin your career if this thing doesn't work.' I'd say, 'it's OK, I have one or two more ideas. If that doesn't work, I'm out.'

But you have to get an inner sense of what will work and what doesn't. ®

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