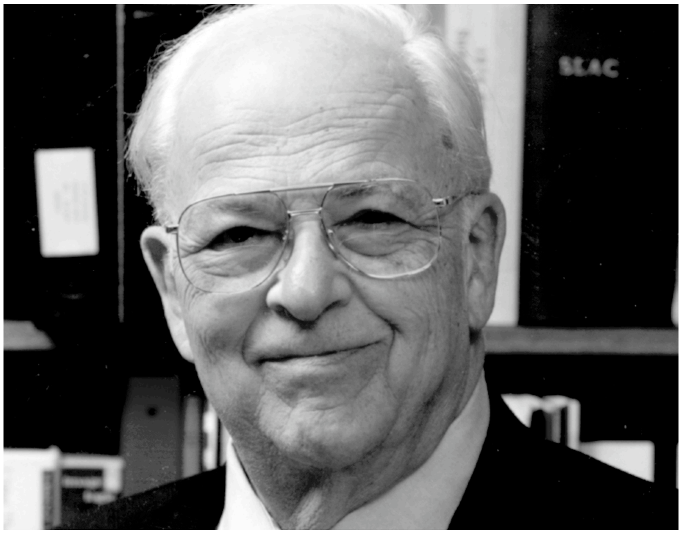
Q&A: Burton Richter



Many of the issues of concern to the FAS founders exist today. Burton Richter received the Nobel Prize in Physics (1976) and the E. O. Lawrence Medal of the Department of Energy (1976). This long time supporter of FAS was interviewed and supplied his answers to FAS questions via email.

Learn more about Burton Richter by visiting: http://www-group.slac.stanford.edu/do/people/richter.html

The California Council on Science and Technology (CCST) released "California's Energy Future - Powering California with Nuclear Energy," a report that recommends building 30 new nuclear power plants to provide 2/3 of Califonia's electricity by 2050. Following the devastating earthquake and tsunami that led to the Fukushima Daiichi accident, only 11 of Japan's 54 reactors were online as of September 19, 2011; Germany plans to close all nuclear power reactors by 2022; Switzerland plans to shut down 5 reactors by 2034; and Italy recently rejected to return to nuclear power. Have your recommendations changed? If so, how?

The nuclear energy report is part of a larger effort commissioned by the California Energy Commission. The study takes a comprehensive look at how to achieve the state's goal of reducing greenhouse gas emissions in 2050 to a level of 20 percent of the emissions in 1990. It uses the state's own assumptions on population and economic growth, estimates what energy efficiency methods can do, and then finds that the goal cannot be met with technology now in the pipeline. Further, even adding new technology including large-scale carbon capture and storage, it cannot be met with renewables alone, which has surprised many. The full report (California's Energy Future - The View to 2050) recommends a balanced portfolio with nuclear supplying 31 percent of electricity, not 67 percent. The larger number was one of many exercises that had different technologies leading. All the reports are available at www.ccst.us.

As to Fukushima, the first lesson to be learned by all is that regulators have to be truly independent of promoters. The United States learned that lesson for nuclear energy years ago and our Nuclear Regulatory Commission became independent in 1974. The Japanese recently decided to make their regulators independent, and India announced it would do so two weeks after Fukushima. The United States should address this issue in other, non-nuclear areas. The BP oil disaster in the Gulf of Mexico is an example of what can happen when our regulators, promoters and those regulated have too cozy a relationship.

Lessons from Fukushima are still being learned as more information becomes available. The NRC has completed its first round study and from that has come some initial recommendations that will soon be put into effect. It is clear now, for example, that reactors have to be able to function in conditions when no external power is available (called station blackout) for longer than has been assumed up to now. It was eleven days before electricity from outside was restored at Fukushima. The United States will certainly require more than three days worth of fuel for emergency generators. Also, consequences of simultaneous disasters will have to be reexamined.

From what we know now, the reactors at Fukushima came through the earthquake fine but the tsunami flooded the emergency generators and knocked them off, precipitating the loss of cooling that those generators were designed to prevent.

My recommendations for California, indeed for the world, have not changed. Nuclear electricity is clean and safer than that from most other sources. Infrequent big problems are more feared than frequent smaller ones. Every study I have seen finds coal, gas, and oil responsible for more health problems than nuclear when averaged over a long period. What I think will happen to the nuclear renaissance is a pause in the expansion of nuclear while the lessons from Fukushima are absorbed. The big expansion was always going to be in Asia and that will continue to be the case. The need for more electricity is acute if they are to meet their development goals and other sources are too dirty or too expensive or too hard to come by. As far as Germany is concerned, this has happened before when nuclear was to be phased out only to have the phase-out phased out to meet environmental goals. It is ironic that Germany as they shut down reactors (if they really do so) will get more nuclear-generated electricity from France and coal-generated electricity from Poland.

The polarization of U.S. politics grows worse. In July 2009, you authored a letter, signed by 33 fellow Nobel laureates, to the Obama administration in support of the Clean Energy Technology Fund, which would provide $150 billion over 10 years for research and development into energy technologies. With a skittish economic recovery and contentious debate to reduce the U.S. deficit, do you still support this scale of federal investment in energy research? How would you advise the United States in terms of its investment in energy technology?

It is not at all clear that the country is as polarized as is Washington. The polls tell us that Democrats, Republicans, and Independents all seem to scorn Congress for the absurdities of the maneuvering over the debt limit. The 2012 election will tell us all if we are heading to revenue enhancement as part of deficit reduction. I do still support investment in advanced technology and energy R&D, and our legislators would too if they would only open their eyes. If they did they would see the rest of the world gaining on us in R&D. Part of this is natural. China and India, like Japan and Korea before them, have entered a stage of rapid economic development. First their manufacturing expanded and now their science and technology base, both short term and long term, is expanding as well. But if we slow down as they speed up our long-term leadership will be lost. A long-term view is needed, and in Washington long term seems to be defined as the time to the next presidential election. Fortunately that is not too far away.

As you did for the May 2011 report "California's Energy Future - The View to 2050," could you look a generation ahead to what energy policy should become art the national level? How would you define U.S. energy objectives to create a coherent long-term energy policy? How would you prioritize the steps to transform the U.S. energy system?

Because I was Director of a DOE lab for many years as well as a President of the American Physical Society, I have had lots of opportunity to see how the government really works. If something big is to be done, and changing the energy system of the country is very big, an army of lobbyists on all sides of the issues mobilizes. If something is not only big but controversial it is easy to find all sorts of excuses for doing nothing and it takes something major to get action. From this experience I have derived Richter's Four Laws of Government Inertia:

1st Law: The future is hard to predict because it hasn't happened yet.
This one is an excuse for inaction because we do not know enough yet.

2nd Law: No matter how good a solution is, some will demand we wait for a better one.
This is what some environmental organizations use to block sensible proposals like incentivizing the switch from coal to natural gas for electricity generation. If we did that we would decrease greenhouse gas emissions by 25 percent. It is opposed because it does not eliminate all emissions from electricity generation.

3rd Law: Short-term pain is a deterrent to action no matter how much good that action will do in the long-term.
This is the one that blocks things like cap and trade or carbon emission fees. You can always find a lobbyist to explain why hurting their clients hurts the nation (and maybe campaign contributions).

4th Law: The largest subsidies go to the least effective technologies.
This one keeps things like subsidies for corn ethanol going.

My 2010 book *Beyond Smoke and Mirrors: Climate and Energy in the 21st Century* looked at energy policy mainly from the perspective of climate change. I have come to the conclusion that I should have chosen a wider base, and if I do a second edition I will broaden the discussion to what I have begun to call Energy in Three Dimensions. These are our economy, our national security and our environment (and environment can include more than just climate change). Looked at this way, some things become obviously good from more than one perspective. CAFÉ standards for cars and light trucks are going to go to 54 miles per gallon, roughly double today's. If I could make it happen today, I would reduce oil imports by six million barrels of oil a day, saving the economy half a billion dollars per day, reducing our balance of payments deficit, reducing risk of disruptions from the Middle East, and cutting greenhouse gas emissions as well. If I electrify light vehicles, I improve their energy efficiency and reduce gasoline use further. If I switch from coal to natural gas for electricity generation I reduce mercury emission, bronchitis, smog, and greenhouse gas emissions. Looked at from multiple dimensions, one can broaden an alliance for action and perhaps get things done.

As to government policy, I am not a fan of prescriptive programs like renewable portfolio standards, low carbon fuel standards and the like. Government policy should have two important parts. One is to tell industry what has to be done, not how to do it. CAFE standards are an example. The EPA defines a goal and manufacturers can do it with better engines, hybrids, electric drive, or whatever works. California's low carbon fuel standard is an example of the wrong approach. It says that by 2020 the fuel you use must emit less greenhouse gas by 10 percent compared to today. The new CAFE standard does far more for far less cost.

The other government role is to fund the longer term basic and applied work needed to take possible new technologies to the point of understanding their real usefulness and their potential to be scaled up enough to make a national impact. That can be done at both small scale and large scale. For example, the battery technology in the Chevy Volt plug-in hybrid came out of a research program at MIT funded by the DOE. It did not cost much on the scale of government-funded R&D to reach the point where General Motors picked it up and brought it along to the scale necessary for car production. Fusion energy is a very much more expensive program and here many countries are joined in a multi-billion dollar effort to see if it can be made to work.

I think of myself as a pragmatist, not a perfectionist. I want to move us in the necessary direction and am quite happy to do it incrementally. For example, I would like to see revenue neutral carbon tax like that put into effect by a conservative government in Canada's province of British Columbia. Why revenue neutral? Because I think it can gather support from all sides of the debate. Cap and trade may have a better theoretical basis, but to gather support in the House, so much had to be given away as to make it unworkable. Why better CAFE standards – because they can be justified from more than one dimension. I am happy to be impure and effective rather than pure and ineffective. It is a long time to the end of the century, and no one knows what technologies the scientists and engineers just now being born will bring to reality. Bring things along as they develop and do not fall victim to Richter's second law.

The Energy Star ratings system introduced a "Most Efficient" standard. How will this new label influence energy efficiency? What more should the EPA and DOE be doing to increase efficiency in appliances?

When I led the group that produced the APS energy efficiency report in 2008 (http://www.aps.org/energyefficiencyreport/) we found that DOE was not setting standards for all the products they were allowed to. I have not kept up with what has been happening, but I hope it includes rating more products.

Another of our findings was that there was no real understanding of why consumers did not buy the things that saved them the most money, and we recommended some social science research was in order. I think that has begun and perhaps the "Most Efficient" rating comes from that.

The new "Most Efficient" rating is very useful if it is properly advertised. In looking at the clothes washers and TVs (42 inch), I found that the number two in both cases cost only 60 percent of number one.

There is great debate over energy policy and climate change. Interest groups and industry often control the message and presentation of information. How can FAS improve the understanding of energy technology and policies by a wider, general public?

You should be asking people younger than I. The virtual world has changed the way people communicate and get information. People like Prof. Jeremy Bailenson who directs Stanford's Human Interactions Lab have impressed me with how different today's world of communications is from what I grew up with.

What issues should FAS tackle in the next 65 years?

FAS was born about 65 years ago (different name, same initials) to deal with nuclear weapons and the threat of Armageddon. While the nuclear weapon problem is still with us, large-scale nuclear war is much less likely now. Today's problems include climate, developing countries, population growth, natural resources, etc. FAS might do well to broaden its horizons including perspectives from more disciplines. Sixty-five years is a long time given the rapid evolution in science, technology, and, above all, society. FAS should evolve alongside the things it reports on.

What is your advice to students entering the fields of biology, mathematics and physics today?

Science has evolved a long way from what it was when I entered MIT as a freshman in the September of 1948. I arrived not sure if I wanted to go into chemistry or physics. At MIT then the first year was the same for the science majors and I quickly settled on physics. I had arrived with a notion that I wanted to understand how the universe worked, and physics seemed to be a much more likely road to that goal. In the summer between my sophomore and junior years I persuaded one of the faculty, Prof. Francis Bitter to let me work in his lab. Over the next two years I moved from being a pair of hands to some real research. My bachelor's thesis was the first measurement of the quadratic Zeeman Effect in hydrogen. The first advice I would give to students is to get into research as soon as possible.

I began graduate school with Bitter's group, but as time went on I found that I was not as interested in the area he was exploring than in what is now called Elementary Particle Physics (which has evolved a long way too). I was one of the fortunate few with a fellowship rather than a research-assistantship (first from DuPont and then from the NSF). That meant that the support was mine and to move I did not require anyone's permission because the support money was mine. Bitter helped me to move on for which I am forever grateful. The second bit of advice I would give is to grab a fellowship over an assistantship any time. If you come with your own money you are a hot property. Given the huge increase in cost of an undergraduate education, I am not sure that life is as simple as in my day.

As to advice on what to do, one question has been bothering me for years, and if I were starting over, I think I would go after its solution. How is it that for certain problems, facial recognition for example, the human brain can do the job as fast as a computer even though the computer has a cycle time more than a million times faster than the brain where the time cycle is determined by chemistry not transistors? This is much more a physics and mathematics question than a biology one. We know how neurons communicate and what they communicate with, but we have not a clue on how things are organized. I think this is more a physics and mathematics question than a biology one, but expertise in all three would be useful. I hope I am still around to read how the system that does this job really works. ■

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