

EPISODE THIRTY-SEVEN OF "ARMED WITH SCIENCE: RESEARCH AND APPLICATIONS FOR THE MODERN MILITARY," A DEPARTMENT OF DEFENSE WEBCAST MODERATOR: DR. JOHN OHAB GUEST: BARBARA MCQUISTON, SPECIAL ASSISTANT FOR ENERGY AT THE DEFENSE ADVANCED RESEARCH PROJECT AGENCY (DARPA) TIME: 2:00 P.M. EDT DATE: TUESDAY, OCTOBER 6, 2009

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ANNOUNCER: "Armed with Science: Research and Applications for the Modern Military" is a weekly webcast that discusses cutting edge science and technology and how they apply to military operations. Each week we will interview scientists, administrators and operators to educate and inform our listeners about the importance of science and technology to the modern military.

DR. OHAB: Good afternoon and welcome to Episode number 37 of "Armed with Science," Research and Applications for the Modern Military," on Tuesday, October 6, 2009. I am your host, Dr. John Ohab, at the Office of the Assistant Secretary of Defense for Public Affairs. Today's show is the first in a four-part series to celebrate Energy Awareness Month. Kicking things off is Ms. Barbara McQuiston, special assistant for energy at the Defense Advanced Research Project Agency, or DARPA. She will discuss DARPA's comprehensive research and development effort aimed at creating technologies that can lead to tactical energy independence. DARPA's goal is to generate cost-effective alternative energy technologies for the military by addressing energy generation, conservation, control, and conversion from sustainable sources.

Ms. McQuiston, thank you for taking the time to be here today on "Armed with Science." How are you?

MS. MCQUISTON: Very well, and thank you for having me.

DR. OHAB: Just a quick note to our listeners, as always: If you have an energy-related question for our guest, please Tweet it to: @armedwscience. We will be monitoring the Twitter feed and we can relay those questions to Ms. McQuiston.

National Energy Awareness Month is an effort to encourage everyone to see themselves as part of a much larger solution. The Defense Department, obviously, plays an important role, both from a utilization and solutions standpoint.

Ms. McQuiston, can you start us off by characterizing for us the Department of Defense's energy and power needs?

MS. MCQUISTON: Well, energy has always been an important point in the military. You can go back to history and look at fodder to feed the horses in the Napoleonic wars; and you can look at today, all the way to Afghanistan where energy is a key enabler and, at times, a key limitation.

So the military has run on energy. On the defense side -- (inaudible) -- just in 2008, as one of the -- the military as being one of the largest consumers of energy and oil. And in jet fuel alone, over the last 10 years the military has been a consumer of between 60-75 million barrels per year, again, as an average consumption over the last 10 years. So we have a strong reliance on energy and utilization in order to have a lot of the key technologies that we rely on in the field.

DR. OHAB: Can you tell us about DARPA's role in this? Why has DARPA taken up this particular challenge?

MS. MCQUISTON: Well, DARPA invests in science and technology that can have a real game-changing nature to the future. We look ahead and try to see where key investments now can create new opportunities for our country.

If we look at a lot of the technological changes that exist, a lot of them were brought into being by DARPA -- you can look at the Internet, you can look at GPS. A lot of these things started with, kind of, ideas here at DARPA, in initial investments all the way through to things that we use every day today. When you look at energy as being such a critical need for the military, DARPA, again, wanted to look at what we could do to change what that would look like for the future. I think Peter Drexler (sp) always said it well. I think if we looked at what he said, he said, "If you want to control the future, you need to create it." So DARPA invests in science and technology to make these changes.

When you looked the -- when we looked at energy, what we were looking at was the diversification of energy sources, and moving away from a reliance on fossil fuel to create better energy security for ourselves now and in the future.

DR. OHAB: Now, your role in DARPA's effort is as the special assistant for energy. And one of our questions over Twitter is that, if you could talk about your specific role and why it is important, particularly when there are perhaps others like the Advanced Research Projects Agency Energy, ARPA-E, that are also interested in similar issues?

MS. MCQUISTON: I think, from the DARPA standpoint, energy, especially as it relates to the military, has very specific needs and requirements. ARPA-E, and a lot of the other DOE agencies are looking at energy overall, as far as civilian use other areas of concern.

As my role with the special assistant to the director on energy, I'm looking across the portfolio of technologies that we have here at DARPA, and looking at the impact they would have in the field; and how they can leverage, as well, other activities that are going on with the agencies, not only the DOD but other agencies as well.

When I came to DARPA I was deputy director in the Defense Science Office; and then director of the Strategic Technology Office, where a lot of these energy programs were being conducted. And so now I have the chance to work with the director, across all the agency activities, and focus on energy.

DR. OHAB: Now, can you talk to us about some of the primary areas that are in need of technological development?

MS. MCQUISTON: I like to look at it in, sort of, three points: There's a lot of work in energy conservation that you can do now with a lot of the technologies that exist. But I'd say DARPA is always looking at the hard part of the problem. So we want to -- I look at what is going on in energy creation, energy conversions and energy control. We want to, sort of, push out understanding in the scientific mechanisms, like catalysts and other points of the technological base, and take advantage of these things to put real military capability into the field.

DR. OHAB: Now, some of the discussion that we've had on our Twitter account has been around algae-based fuel. Can you mention -- talk about that briefly? MS. MCQUISTON: Yes. We have several programs going on in the biofuels area. And biofuels is very important. What we're looking at in this area is the ability to create jet fuel from a diversity of sources.

So we have programs converting jet fuel from cellulose -- or woody structures; rich oils, non-food oils; and into the algae form.

Algae creates an oil that can be cracked and produced into what we call "(JP-8 ?) jet fuel" and biodiesel. Now, the military is interested in the jet fuel conversion. The two efforts that we have ongoing -- one is with General Atomics, the other is with SAIC, are putting together approaches in which to convert algae directly into jet fuel, and looking at being able to do this as a scalable and cost-effective form for the military.

DR. OHAB: We've heard on the news that certain projects are "DARPA hard." Can you tell us first what that means? And then, which of some of these areas you've mentioned would you consider to be "DARPA hard?"

MS. MCQUISTON: Again, we're -- as DARPA, we're investing in things that would have a large, high-risk, but high benefit for the future. So the things that make it "DARPA hard" are looking at what are some of these aspects that we can push out to really enable a different future?

And in the area of energy, the hard part is to identify and demonstrate ways to efficiently harness and convert the flow of energy. And there's energy all around us in abundance, and can we convert what's around us into a form of energy that can be used for the military to create tactical energy independence?

DR. OHAB: So then, if you could identify the DARPA R&D programs that you think are most promising?

MS. MCQUISTON: Biofuels definitely is a huge area. Again, jet fuel ranges between 60-74 million barrels a year for the (JP-8 ?), which runs not only the aircraft but the generators. Being able to get (JP-8 ?) from a renewable source means that you can generate (JP-8 ?) anywhere in the world independently.

And, the Congressional side, it recently directed 50 percent of the DOD consumption of aviation fuel to come from renewable stocks by 2016. And this is a huge step forward in our ability to maintain U.S. rapid-deployment strategies (with ?) renewable energy around the world. And the Air Force and the commercial aviation sector are combining -- they're sort of on a glide path in fleet-wide certification of a 50/50 blend by 2012.

But when you look at jet fuel, you want to say what sources -- what diversity of sources do you want to use to get to the conversion (or ?) jet fuel? And they're starting with the rich oils. They're, right now the Defense Energy Support Center, DESC, which purchases all of the fuel for the services, has purchased 600,000 gallons of renewable jet fuel in order to move these renewable sources into certification.

And the three performers they have are all using technology that DARPA has developed by (UOP ?), which, again, is taking, sort of, the rich oils -- things like camelina oil, what we call "waste" oils, and converting that into jet fuel.

But what we want to be able to have is not a dependency on oil, we want to be able to convert many other sources. So DARPA has advanced the state of the technology in cellulose and biowaste, to convert that into jet fuel. One of our performers is actually using what they call "black tar," from the paper industry, to convert that into jet fuel.

And, again, we're also looking at pushing out the technology to make the algae, as well, affordable and scalable; to be able to create the efficiencies that we would need to drive down the costs, so that we could actually produce jet fuel. Our target is less than \$3 a gallon. But if you increase the efficiency, as the promise of algae seems to have, we could get down to hopefully maybe under a \$1 a gallon.

Again, these are goals to look at when we're developing science and technology to put forward.

DR. OHAB: And when you're investing in these programs, there's obviously some projects that are going to yield results immediately, or

soon, and some that will be more long-term to be realized. How do you balance the short- versus the long-term?

MS. MCQUISTON: Well, DARPA is, again, looking at what could happen in the long term. But there's a lot of technologies that could spin out that make a difference right now. When we have a program in solar photovoltaics, there the goal of the program is pushing the modular level of efficiency in solar photovoltaics to 50 percent efficient.

However, today (is a ?) silicone -- solar cells that you can buy in the marketplace right now, will be 12 to 15 percent efficient, which means you need a lot of area and a lot of space to generate the power that you require. 50 percent efficient means that you can have a small amount of area and you can have solar photovoltaics powering electronics. So, along the way, as you meet -- as you make 30 percent efficiency, and you're moving to your goal of 50 percent efficiency, 30 percent is a big step. And 30 percent can actually be a point of commercialization, to go out into products and to be powering things as a portable power source.

So I think DARPA has goals that will make a huge impact in the long term. However, as we reach these goals, we are achieving a lot of milestones that become extremely important in the marketplace and in maturing the technology for today's use.

DR. OHAB: Right. And if you're successful, what advantages will DOD realize?

MS. MCQUISTON: Well, it's quite large, across the way, for the DOD in general.

In energy, we're looking at being able to make affordable, tactical energy independence and create energy security. When you're in the field, in places like Afghanistan, all your energy has to be brought in right now. What we think about is what sort of technology could you have to make yourself tactically independent so that you could generate energy from where you are?

Again, energy is in abundance all around us. We need to convert it and utilize it in smart ways, and inexpensive ways, so that we can have our military working in these harsher conditions, more remote areas, and work from a point of energy abundance.

So fuel cells, for instance, that we've developed. We developed fuel cells in what we call the "portable power program," that could last 10 times longer than batteries. They also utilize sources such as methane and propane, so you could pick up a can of propane -- that you could find anywhere in the world, and use that as your power source in order to power your electronics and communications.

So these are the sort of changes that we're looking to make in the military, and put ourselves, as well, in a better place for energy security for our nation.

DR. OHAB: The acceleration of fuel and battery technologies makes sense, I think, from a practical standpoint, but how can advancements in wind and solar power help our troops that are in-theatre?

MS. MCQUISTON: Wind and solar power, the solar photovoltaics are dependent on the solar points. But it's interesting, when you pick a lot of the diversity of energy that's around you, you cannot create a single dependency. So when you look at wind and you look at solar, these are all things that can work in concert to give you energy independence. And you also need the ability to store and manage that energy. So you want to have a number of solutions that can be used in the field to generate energy. And I think, especially if we look at bases and a lot of our military infrastructure, we can pick things that are in the environment that are plentiful, and use that in order to generate the power that we need for our military -- for our military bases, and for our forward operating bases as well.

DR. OHAB: Now, we're going to give you the "Armed with Science" official crystal ball for a moment. When you look into that crystal ball, what do you see, in terms of future achievements?

MS. MCQUISTON: I see a lot of things.

Actually, I see a lot of technologies that could make a large difference, even on energy efficiency and energy conservation:

We have programs that are looking at making transistors -- very low-power electronics that would be available not only in reducing the amount of energy that we use, and putting electronics and (components ?) with longer life, and more sustainable, but being able to overcome the thermal challenges with, right now, high-power transistors. So you would see a lot more rapid development in electronics for longer, sustainable periods.

I'd see a logistics advantage. We could create jet fuel anywhere in the world from a number of sources. That would make -- a large game-changer in places where energy and fuel is not abundant. If you looked, again, at Afghanistan, if you could be able to create jet fuel from indigenous sources, and rely on that, you'd not only be able to -- be able to source energy for our military, but you'd be able to leave an infrastructure that would be more sustainable for the country.

So, again, it's sort of changing the mind-set. Instead of having this single dependency -- fossil fuels, and conserving what we have to slow down the rate at which we consume it, moving more towards the ability to create energy, manage energy, and have a stronger point in its energy security for the future, not only for our military but for our nation as well.

DR. OHAB: One of the themes throughout our show is that, for some of these larger endeavors, it's always a team effort. What other organizations is DARPA working with in pursuit of some of these goals?

MS. MCQUISTON: Oh, this is definitely a team effort.

There is a lot of work that goes back and forth with both DD (sp) R&D and OSC (sp), as we look at the energy needs and the communities of interest, and be able to come together so that, as we -- as DARPA are able to create opportunities with our technology, these opportunities can see themselves to the field and be used.

We also look at coordinating a lot of our work, and supporting work, from other agencies, whether it's the Department of Energy or ARPA-E, so we can do complementary things and leverage each other's work. Again, the military has very unique needs and unique goals, as far as energy is concerned. But pushing ahead the science and technology is something that we have to do, as a larger community, to be able to achieve these goals.

DR. OHAB: In terms of DARPA, is this really a significant investment of resources and personnel?

MS. MCQUISTON: It is a -- it is a significant investment. We started a number of these programs back in 2005, and moved them forward quite a bit within the agency.

And when you stand back and look at a lot of things that are developed at DARPA, energy is an underlying, core competency. As we develop platforms, as we develop electronics, and all of the networks and communication technology, how can we extend and use energy, and better utilize energy is a key theme. So it's involved in everything we do.

DR. OHAB: Just one final question before we wrap-up today's program.

Sometimes the most interesting part of our interviews is learning about the guests. Would you mind telling us a little bit about your background that led up to your current position at DARPA?

MS. MCQUISTON: Yes. I come from a background in commercial products and commercial technology. And I had my own company at the time, putting technology into the market. And in many ways I was, sort of, looking at where science and technology comes together before being an every-day product.

I was interested in coming to DARPA because this is a place where I could actually be able to think of ideas, and work with people, and help them facilitate ideas in science and technology, and attract the type of investment and interest that could change things long before you would be able to establish that sort of interest in investment in the commercial side.

So this is what I would call being able to generate ideas. I mean, really DARPA gives you the chance to dream, and see those dreams come into life. So that's really what attracted me.

DR. OHAB: As we wrap-up today's program, do you have any final thoughts or comments?

MS. MCQUISTON: Yes. My final thoughts are, I hope everybody thinks of energy in new terms -- and we can think of energy "abundance," we can think of ways to accelerate our own energy use and create a better future for ourselves. DR. OHAB: Today's guest is Ms. Barbara McQuiston, special assistant for energy at the Defense Advanced Research Projects Agency, or DARPA.

Thank you again for your time this afternoon, and for kicking off our Energy Awareness Month series.

MS. MCQUISTON: Thank you.

DR. OHAB: Listeners, please tune into our next show tomorrow, Wednesday, October 7th, when we are joined by Colonel Dave Belote, commander of the 99th Air Base Wing. We'll discuss one of the Air Force's most ambitious green initiatives, the "Nellis Air Force Base Solar Array."

Completed in December, 2007, the Nellis Solar Array is comprised of more than 72,000 solar panels containing six million solar cells. The array took only three years of planning and 26 weeks to complete, and debuted as North America's largest renewable venture.

Thank you again for listening today. I am Dr. John Ohab, and you've been "scienced."

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