

"Energy: Attainable Independence?"

Dr. Paul Sullivan

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Dr. Sullivan: Good morning, Air Force.

He mentioned Iraq. I'm also working on an energy security study of Iraq proper, not how Iraq energy affects the rest of the world but the energy situation within Iraq. And if any of you have been there, you know what I'm talking about. The lights going out, the oil being smuggled, the kerosene disappearing, the Mafia's making millions of dollars off of the backs of the poor people of the country, and the insurgents making a lot of money from smuggling. Quite a lot. Also there are quite a number of gasoline stations in certain bordering areas of the country that really shouldn't be there, but they're used to smuggle gasoline into other countries.

But anyway, on to this subject. I'm assuming all of you know what that picture is. That's a tanker refueling. Now could you ever think of an aircraft being energy independent? This thing is going all over the place.

No. Unless, of course, you had all the energy being produced inside of the aircraft itself. It's not possible. In many ways, that's analogous to the United States. And we'll get into that.

First, I have to start with these caveats. All these opinions are mine alone and do not represent those of NDU, Georgetown, or anyone else. All right. Now I can speak my mind. At NDU and some other places I'm known for a certain degree of controversy. The way to get to the truth of matters is not necessarily to tow the line, because sometimes towing the line isn't exactly the right way to go -- particularly when we're looking at very complicated issues like what we face today with regard to energy security.

If we're talking about energy security, well why don't we talk about food independence? How many of you only drink American beer? Oh, I don't see any hands. How many of you only drink American coffee? Brazilian? Okay, why don't we look at food independence as an example of independence of any product? Or lamb from the Aussies, and the Kiwis. Anyone been into Whole Foods and purchased that \$20 a pound

stuff from New Zealand? Probably not. You go down to the local Harris Teeter and get it for \$7. [Laughter].

Financial independence. Could we have fueled our development in the last 10-15 years without money from the Chinese and the Saudis and the Japanese and the Taiwanese? The answer is no.

Another side of this is -- what is going on here? I'll have to wing it if this goes like this for the rest.

Autos and auto parts. Think of the Cash for Clunkers program. How many American cars were turned in for Japanese cars? Actually, most of the cars turned in were American cars and most of the cars purchased were Japanese cars.

Trade is important. Trade in goods and services and also trade in energy. Now when you do your Christmas shopping or shopping for whatever holiday that you celebrate for the children, try to find a toy that is not made in China. And then look at the toys that are made in the United States and take a look at the costs.

To put this into perspective, the first quarter of 2008 when the price of oil started to zoom up. Can everyone read that? That black part of the chart is imports of energy products into the United States. The red part is imports of everything from China. That'll give you some sense of how important energy imports were during that time. But energy imports relative to anything else changes rapidly. There is a lot of variability here.

Taking a look at the yellow line here. This is non-oil deficits in trade. And look at the oil deficit creep up and actually take over. This is total deficit. How important oil is to our overall trade balance is extreme.

Now this is kind of a small chart, but I'm assuming even the folks in the back, given that you're all in the Air Force, can see this clearly. [Laughter].

The great recession. That's what we have right now. And by the way, folks. It's not over with. Read the newspapers; they'll tell you that. The politicians will tell you that. We have another long way to go on this.

Look at what happened to our imports in 2008-2009. See how that drops. Export drops. And also, if you take a look at the chart on the bottom, oil demand dropped. So we have price variability, cost variability, and also demand variability.

Right now the price of oil is relatively low compared to what it might be, even in the near future, because of low investments in new fields, and exploration. Much less than what should be happening. And also, much of the cheap oil is gone. We have to go into very deep-water oil fields. We have to go back to old oil fields, and we have to rely on some interesting partners. I didn't push that forward by the way.

Now the value of imports into the country, like I told you, is highly variable. Here we are. It goes through 2008, the oil price collapse. Go down to 2009. So the problem of energy independence can change day to day.

What does it mean? What is the price of oil today? What is it tomorrow? What will it be next week?

I always get questions whenever I got to a conference. Dr. Sullivan, tell me -- nudge, nudge -- what's the price of oil next week? And I just tell them I don't even know what it's going to be the next minute or the next half an hour, because there are speculators, there's the weather, there are political events, there are military events, all kinds of other things that can affect the price of oil.

Speaking of the price of oil having gone forward on its own, this is a history of it. Take a look at all those years where it was pretty calm and then we get the '73 oil shocks. That's that first bump up. And then the Iranian Revolution, second bump up. And everything starts to vibrate after that. It kind of looks like an EKG for a heart attack. [Laughter].

Now to you get to 2008-2009; that's when you have all these speculators getting into it, and people talking about peak oil, and everyone getting wound up about where's the next barrel of oil going to come from.

People are concerned. It's a very tight market. Psychologically, it's pretty wound up.

What would happen, let's say, to the price of oil if the Iranians tested one of their submarine missiles in the Straits of Hormuz? You could see the price of oil changing by about ten dollars very rapidly. How would that affect the countries that are oil importers? Possibly quite drastically.

So this is pretty much the picture of oil markets. But these folks are lucky because they're actually on a track.

Oil markets are not on a track. They're also lucky because if they have taken this rollercoaster before, they know when the next up and downs are going to happen.

In this market, you don't.

The number one user of energy, the number one using constituency in the entire world is DoD. And within the DoD, the number one user of energy, particularly oil-based fuels is the Air Force. You need fuel to fly those airplanes and many of the other things that you do.

So this affects your budgets. It affects your planning. It affects your strategizing, but also your planning and strategizing affect the price of oil. So it's recursive.

Now if we could produce the same amount of energy inside of our country, completely autarchic, importing nothing, and produce it more cheaply, more efficiently, more securely, and with less volatility, well then let's do it.

Why don't we do it? Because the alternatives to oil are few and far between. What oil has going for it is a very dense BTU count per barrel. And you need to find an alternative to that. And you have to find it inside of the country. It's going to cost us a lot to do that.

Is that cost worth it? That's the question. The short answer to all this is not yet and probably never.

Energy independence, in many ways, is a myth that distorts what we really need to do, which is to focus on energy security and building diplomatic relations and economic relations and technological relations and educational relations worldwide. Coalitions. Energy coalitions.

Does it make sense to be energy independent as one of your major goals? Are you willing to trade off other goals in order to get there?

Does energy independence improve our national security interests? Consider the following: Let's say in two years we decide to import no more oil from outside the country. Drastic step. But this is a thinking experiment.

The Canadians would not be happy, because we get most of our oil from Canada. Mexico is number two. They would be unhappy, and think about how the Mexican economy would be hammered.

And then go on to Venezuela. Well, strategically that's a complex issue and Hugo Chavez isn't exactly our friend these days. He's more friendly with Mr. Ahmadinejad of Iran, so let's put that aside for a moment.

Now let's take a look at Nigeria; number four on the charts. Then Saudi Arabia and Iraq. Are we willing to not import oil anymore from Iraq? Wouldn't that seem kind of counter strategic to what we're trying to do?

As many oil-importing countries move toward a post-oil age, and that's what's going to be happening in the next 50 to 100 years -- We're moving into a post-oil age. The oil-exporting countries have to adjust. And if they don't adjust properly, if you think it's unstable in the Gulf now, look out.

Also, when we're looking at energy security it's not just oil. Look at all the stuff we have to consider. Sunlight, biomass, hydropower, wind. I'm not going to read all this stuff, but there are many different sources of energy that we could take a look at that exist within our country, exist in Canada and Mexico, exist in the oceans, exist in space.

Yes, there are actually people looking into zapping energy down to here. I don't figure it. I haven't figured that one out yet. And it seems a bit odd to me still, but there may be a way of sending energy down from space through microwave. Okay, I know that sounds spacey, but let's leave that aside.

You also have electricity from anything. You can produce electricity from a tomato. I worked at the Oakridge National Laboratory for many years, many years ago, and there was a fellow who had an office right near me who figured out a way to make a tomato battery. You can make electricity from the sun, from the wind.

You can make electricity the following way: An updraft tower. The Australians are doing this. What's the difference in the temperature between the surface in the hot part of Australia and one kilometer above? Significant. You take advantage of the difference in temperature. You have a big funnel like a chimney with numerous wind vanes at the bottom of that chimney, and you can produce enough electricity for two million people using no fuel but the difference in the temperature that exists. Absolutely astonishing.

And there are downdraft towers. You're all Air Force. You know how this works with [Brunuy's] Law. Well think of certain laws related to having a fireplace working. That's what it is. It's a huge fireplace, and you produce massive amounts of electricity.

All right. Town gas. It used to be from coal. Now we can produce energy from garbage. Drive up toward Baltimore. There's something called Bresco. They put a pile of garbage into a big vat, burn the stuff, boil water. The water turns into steam, turns the turbine, produces electricity for about 60,000 households. Think of all the garbage on Air Force bases that could be used to produce electricity. It's astonishing what's out there.

What do you do with the garbage? You throw it into a landfill. What happens when it's in the landfill? It produces methane. Capture the methane, you can use the methane to produce cooking gas, heating gas, and cooling gas. Lots of things out there.

But where are we now in the United States? Seventy-eight percent of our energy use is fossil fuels. Natural gas; we're doing okay. Actually, our imports of natural gas are declining. We're finding new natural gas and coal seams and other nonconventional sources.

The sources of natural gas for us in the future will be nonconventional. We can also produce natural gas from other things.

Now take a look at the renewable energy. There's hydroelectric at the bottom. Wood; anyone who lives in the countryside, you know what I'm talking about. How do you heat the house? You throw wood inside of the furnace and there you go.

Biofuels. I think the corn to ethanol program is probably economically -- again, remember that caveat -- one of the dumbest programs I've ever heard about. It makes no sense. Energetically, you put more energy in to get less energy out. Economically, it has increased the price of corn. We have about 30,000 products related to corn. Just about everything in the economy is affected by the increase in the price. And also it hurts motorboat engines. Anyone who uses a motorboat, don't leave that stuff in your engine over the winter. All right. It helps the economies of the countryside, yes, but there may be other ways of doing this.

All right, this machine seems to have a mind of its own, so let's be creative here.

If we're looking at imports of energy, it's much more than our exports. Most of what we export is electricity in different areas, to Canada, down to Mexico.

Natural gas; we actually export natural gas to Mexico even though Mexico has a pile of it. They just haven't developed their fields yet.

But look at what most of the imports are. Petroleum. Natural gas; see that dip down. That dip down at the end is probably going to continue. The other is mostly electricity or ethanol fuels.

We did have, or we do have an example in the past when we were able to reduce our demand for petroleum. The oil shocks in the 1970s. Looking around, probably many of you weren't around driving cars at that time; some of you were. Long lines, but also we had price controls. We had demand controls. We had laws to apply to industry. The next factory that you build has to not be used with oil. And we actually focused on cutting down our oil imports; we really succeeded at that.

As the price of oil went down again, look what happened. The 1980s, 1988, it went right back up again. And that's about when the Humvee hit the markets, which is in many ways an energy absurdity. I'll get more to that as we go on.

Our population is about 4.6 percent of the world's population. Our energy production is 15 percent. We are the largest producer of energy in the world, by far. When you normalize the energy into BTUs, British Thermal Units, which is the equivalent of one of those wooden matches being burned all the way down to the end, what we actually produce in terms of quadrillions of those. We are the largest energy producer, but we're by far the largest energy consumer and even more by far the largest oil importer.

Transportation is the key. Transportation is what you folks do. It's the key to getting to greater energy security and a little bit better interdependence. Look at that for transportation.

There is an example of a B-2 bomber that is flown on butanol from coal. There are possibilities of having mixed energies used within one aircraft, and an engine inside the aircraft that can be switched from one fuel to the other pretty rapidly. This is just developing. It's probably going to end up to be very expensive, but you get this up to

industrial scale, you get economies of scale moving, and this could really be something in the future.

But is that really going to help us? Temporarily. Temporarily. How many of you know a fellow named Mike Amini? Excellent person. He has been working on this for years, and he has really made some progress.

What we're going to need within the Air Force, within DoD, which is going to be one of the vanguards of this change, is epic transformations in the way we transport things. Epic.

The aircraft of 30 years from now may not look anything like the ones we have now; at least the cutting edge ones. And the cars most certainly will not. Think of a carbon fiber car, how much lighter that is, how much safer that is, how much less fuel it uses.

In the typical automobile, about 95 percent of the gasoline you put into it goes to moving the vehicle, not moving the cargo and the passengers. And if you're talking about the typical Humvee driver, usually a petite woman of about 95 pounds with one bag of groceries from the local Harris Teeter -- [laughter] -- 97 percent of the gasoline that goes into that tank goes to pushing the Humvee, not her and the cargo.

And every time you hit the brake, you waste energy. You accelerate, you stop. You accelerate, you stop. What about getting that energy from the brake? There are people working on that.

The biggest source of energy in the United States right now is improved efficiency in the use of energy. We are the Saudi Arabia of waste when it comes to energy. Absolutely the Saudi Arabia of waste.

Every year, if you take a look at electricity, production, automobiles, other transport, houses, how many of you think you have an energetically efficient house? I don't see any hands. How many of you have been in a building whether it be Air Force or whatever building in the middle of wintertime and the heating is way up and the windows are open? You know what I'm talking about. Think of all that waste. Now save it by just being more efficient.

The biggest source of oil in this country right now is Detroit. It's not like they have oil underground, but if they use their brainpower and the brainpower throughout this

country and through these coalitions I talked about, you could find multiple billions, tens of billions of gallons of gasoline, barrels of oil, by just simply making better cars, lighter cars, more efficient cars, smaller engines.

Think of the air conditioning systems in cars. Many of these air conditioning systems are made for a small house. What's the point of that?

And also, if we change the way we drove; accelerate, stop, accelerate stop -- But in Washington that's about all you can do.

So we have negative watts as well. Use that electricity more efficiently. Negative gallons. Negative BTUs. We should be focusing on these, not on offshore drilling necessarily, because I'll show you later the offshore drilling will probably give us three years. Each year, we use about 7.6 to 8.0 billion barrels. Offshore in the non-used fields today, it's about 18 billion barrels open that we know about. A lot of it is not accessible.

So let's not kid ourselves that if we just drill that we will solve this problem. Solving this problem is more focusing on the difference between this Humvee and Vegas and this hypercar being developed by Amory Lovins out in Colorado, which uses much less metal. It produces electricity that can be put back into the grid, can recharge batteries in the car as you're driving along. And it is very lightweight and safer.

Most people think the heavier the car, the safer. Not necessarily. The F-1 racers are made out of what? Light carbon fiber. That's how those folks can get out of accidents without too many injuries.

Weir had a huge debate on average fuel economy standards. I really don't think that's much of a debate, and I don't think it's much of a step forward. This is baby steps, baby steps indeed, in a world where we have to make bold changes and bold decisions and quickly.

The lobbyists had run this, and the American people have to take charge, because it's their future. Sixty miles per gallon; it's doable. Three hundred miles a gallon; it's doable, so why not do it?

So do we just waste petroleum? No, there's electricity. We put all this fuel in, mostly coal and natural gas, our own. And once it reaches the house, about 20 percent of it is left.

Now how many of you, if you were running a base and you had let's say a hundred million dollars and then only twenty-two million dollars actually went to running the base, would keep your jobs? Zero. Think of the waste.

The reason why this has happened is because energy has been cheap for so long. In many other parts of the world, energy is expensive. We started complaining about \$4 a gallon a year and a half ago. I'm sure many of you have been to places like Cyprus and the UK and Norway and even Turkey where it's \$12 a gallon. Imagine the complaints.

But also imagine the complaints that if someday we're in the situation where we're importing 97 percent of our petroleum and we haven't made the changes that are needed. Where will we be then? How flexible will our foreign policies be then? Not very.

We have some relationships with people in the world who export oil to us that, let's put it this way, are questionable. And we would not have those relationships if it were not for our need for oil.

Now let's take a look at the typical American light bulb. We put all this stuff into the power plant, a hundred units; coal, natural gas mostly; nuclear, for example. Out comes two units at the end. Now we go from a hundred to two.

I tested the temperature near one of my light bulbs the other day. It was 180 degrees. The light bulbs in this country produce more heat than light, much like the debate on energy independence. [Laughter].

So they talk about electric cars as being green. This is the future. Everyone has their silver bullet. Right? You hear about the wind people saying it's wind, and the solar people say it's solar, and the nuclear people demand that it's nuclear. Of course they have the clout to say that. And then the oil people say there's no problem with peak oil, and the natural gas people and T. Boone Pickens say it's natural gas, that's our future.

What our future is, is a lot like investment. Would you invest everything in one stock, particularly after what happened recently? You diversify. You have a portfolio. The answer to our energy security and greater independence is to have a mixture of production of energy and fuels to produce that energy. That will change over time. We have to be flexible. We have to build in flexibility to our networks.

Most of our electricity is coal and dirty coal. There are environmental impacts from that. Nuclear may have a resurgence. Natural gas may have an even further resurgence. But we have to take a look at our choices. We have to take a hard look at what we're going to be doing. And DoD can be a big part of this.

There's the waste. This is being conservative. And I'm a professor at NDU, so I guess by definition I'm conservative. Sixty-six percent just out of the production, transmission, and distribution. Once it gets into your houses...

Anyone have an old refrigerator? Put your hand on top of it and feel the heat coming out of there. What about a toaster? That's got to be one of the most absurd ways of cooking bread. [Laughter]. You don't want to put your hands on top of that because the electricity that goes into that goes mostly to producing heat that goes right out. There has got to be a better way of doing things.

Transportation; 71 percent of it is lost. Industry; 20 percent of it is lost. Residence, commercial; 20 percent of it is lost.

Overall I know this is really complicated. Just focus way to the right; this is small print and all that. The dark gray is how much energy we actually end up using, and the light gray is how much energy we throw away every year in this country. And we're talking about 57.07 quadrillion wooden matches we throw away. Does that make sense?

The biggest source of increased energy independence is cutting waste. The biggest waste can be found in electricity production and transportation. Have you heard any of the people on the Hill, or in the White House, pointing this out? It's all drill baby drill and let's not import oil, whereas we should be focusing on the way we do things and change the way we do things. And it's not that complicated.

Think of the following: Put a pile of oh, let's say \$50 to \$100 billion in a furnace and burn it. That's what we're talking about. Burn it.

Anybody ever been to one of the Federal Reserve Banks and they have the chopped up dollars? Well you can think of it that way. Chopping it up. Where are we going with that?

Now let's get back to oil. Where do we get this stuff

from? It's wasted, but we need it anyway. Right?

This ship right here is the Sirius Star, the Saudi ship that was hijacked by the Somali pirates. The Saudis were not happy about that. We're talking about 2.5 million barrels of oil. Certain recent events might have something to do with what happened there, but also the price of oil shot up because of people in a rusty fishing boat that left from a rusty stinking trawler, took over a \$300 million ship full of oil. Talk about risk.

Now let's say someone had a bad idea and just got a shotgun and started shooting at a pipeline, like what happened in Alaska a few years ago. Somebody had a little too much Yukon Jack. He was angry, and he started shooting at the pipeline.

Or even more egregious, what has been happening in Iraq where they're blowing up pipelines, they're blowing up pumping stations, they're going after the energy infrastructure. Could that happen here? Don't fool yourself. Think of Houston Port. Anyone been there? Turn, turn, turn, turn. RPG. Problem.

Suez Canal, Straits of Hormuz, the Bosphorus in Turkey, the Malacca Straits, the Panama Canal. You name it. There are lots of choke points, which could really cause damage in this country because of our reliance on imported oil.

Where do we get it from? Canada, Saudi Arabia, Mexico, like I was saying earlier, and of course I'm saying thank you to all those folks there. Most of our oil is from the Western Hemisphere. The argument that we should stop importing oil because we want to put the Saudi sheiks into bankruptcy simply does not hold water.

Oil is an international commodity, and if we don't buy it from the Saudis, you had better believe there will be VLCCs and ULCCs, Ultra Large Container Carriers, moving as quickly as they can from Japan and China and Singapore and Taiwan and the EU to take that oil.

And by the way, sanctioning of oil is a nonsensical concept. I'll give you an example. We're not importing any Iranian oil, but are we importing Mercedes and Volkswagens and French food and those little Austin minis and all this stuff? How do you think they make that stuff? From oil; some of it which would come from Iran.

So actually, in virtual terms we are importing Iranian oil every time we import from a country that imports Iranian

oil. So is this sanctioning anyone? No, this is not thinking about it.

You have to follow it through the chain. Energy is a chain upon chain of supplies. You folks know about that probably better than I do. And it's a system within systems.

Where is most of the oil? It's right there. All the known commercially available reserves in the world can be found in that upside down horseshoe, which in the Arab world is good luck.

Many of the countries outside of here where we import oil from will be peaking or have already peaked, like Norway, like the UK, like Mexico, like Nigeria will in 10-20 years, like Angola will in 10 years. And we will have to focus more and more on the Gulf. Where would that leave us in this somewhat volatile region? We will need to become more involved, not less.

Think of how many tours you've had. Now think of the tours of the next generations.

Who owns most of the oil? The argument in Washington and elsewhere is Big Oil. Let's tax the Big Oil. Well Big Oil is actually tiny oil. Most of the oil is owned by Middle Eastern national oil companies, and the largest oil company on earth is Saudi Aramco.

And then you have Latin American national oil companies like PEMEX and Pedevezo of Venezuela. Then the Russian national oil companies and the African national oil companies and the Asian national oil companies and the European national oil companies, and then there's poor Exxon Mobil with one percent of the reserves. And they could be knocked out of any of these countries. And there's Chevron and Conoco. Look at Shell. That's big oil? At 0.5 percent? The big bubba on the block is Saudi Aramco. That's a country in and of itself.

So we either change the way we do things or we focus more on the Persian Gulf. Alternative; Russia markets, and that could be problematic in itself.

We could turn to heavier oils found in Canada, Madagascar, Venezuela, but then we'd be importing oil anyway, just a different kind of oil. A more expensive oil. You have to re-refine the oil.

Most of our refineries cannot use heavy oils or bitumen

sands. And the bitumen sands in Canada have to be refined two and three times in order to make them effective. It's very expensive, and it's also environmentally damaging.

So we have a lot of this heavy oil and extra-heavy oil. Let's say the sands in Madagascar. I suppose most of you don't think of Madagascar and oil at the same time. Anyone notice there was a coup d'état there recently? I wonder what that had to do with something underground. Ah, let's forget about that though. Things like that don't happen.

Oil sands of bitumen. This is in Canada. Now take a look at where most of this stuff is. Canada, Russia and the former Russian republics, and Venezuela. So where does this leave us, the people who argued for going to heavy oils and oil sands? What it leaves us is importing more, and possibly importing more from even more uncertain places, except for our good friends in Canada and most of the oil from the Canadians that we get, and most of the natural gas we get from the Canadians, is from the province of Alberta, about 60 percent. Thank you, Alberta. Good hockey team too. All right.

And we have oil shales. One of the arguments in our country is let's use a lot of oil shale. Well part of the problem with using oil shale in this country is you need water to extract it. And the places where the oil shale can be found, and it's multiple billions of equivalent oil barrels out in the West. In the Midwest there's not enough water. Actually, their water's scarce and they have to compete with farmers for the water.

So we either figure out a different way of extracting it, or we think about a different way of producing energy. Also, oil shale will not solve the environmental issues that we have to face.

And those of you who are interested in the strategic aspects of those environmental issues, take a look at a video and a report out of the Center for Naval Analysis written by, I believe, about 20 four- and five-star officers from the Air Force, Marines, and elsewhere, looking at the strategic aspect of global climate change. Particularly focus on the speech by General Zinni when he talks about the strategic ambiguities that we would face.

Now look at all that unrecoverable stuff. Most oil wells have only about 50-70 percent at best that can be recovered, given even the best technologies we have available now.

We could go to coal to liquids. I know the Air Force is looking at that. I've had a couple of students work on that at NDU.

When it comes to coal, we are the Saudi Arabia of coal. We've got a pile of it. It could be 150 years. It could be 200 years. It depends on how we use it.

And we can turn that coal into fuel for aircraft and other things. It's going to be expensive. You're going to have to build new plants. It's going to take a long time to implement it, but there are options there. It depends on the security issues that we're facing whether it's worth it.

We could look into natural gas as well. Not a lot of transportation is from natural gas. But of all places; Cairo, Egypt, where I used to live for many years. I went back there last year, and most of the taxis now use natural gas. We pulled up into a natural gas station, and the guy opens up the hood, not the side of the car. So being an energy guy, I jump up. I have my camera ready, and I'm taking pictures of this guy filling up his taxi with natural gas. Not many of those in Washington.

How is that taxi drivers in Cairo are ahead of us? That's a good question. The refitting for them -- I talked to the guy afterward -- would cost about 150 Egyptian pounds, or about \$40; somewhere around there at that time, \$30 or \$40. That's all you have to do.

All right. Natural gas; we don't import a lot of it except from our friends in Alberta and elsewhere in Canada and our friends in Trinidad, Tobago, which is the number one source of liquid natural gas. And we have a lot of it in coal bed seams. We're pretty solid when it comes to natural gas. And we're going to be even more solid when it comes to natural gas.

So why do we continue focusing on oil? That is a big question. We don't have to import the natural gas. We don't have to import the coal. And yet, we continue.

It's inertia. One of the real problems of strategizing anything, and I'm sure you realize this, is the inertia of people who make the decisions. It's easy to continue doing the same things, when reality hits you square on the head. Either that or you just don't even want to look at it.

Where is most of this stuff to be found in the future? The unconventional stuff.

Alaska is going to be a blip. This nature preserve in the north that everyone's arguing about just doesn't have that amount compared to how much energy we actually use in this country. It'll be a blip, much like what happened in Prudhoe Bay. It was a blip. It started peaking the year after it was producing.

Also, if we turn to natural gas cars, what are we going to do? We're going to start stressing out our natural gas systems, so then sometime in the future we're going to have to start importing natural gas. This is where we require that flexibility.

We can actually produce oil from anything. You can produce any hydrocarbon from any other hydrocarbon. I put that turkey there because that diesel that they're producing in southern Maryland in that plant is made out of turkey waste. You add enzymes to any hydrocarbon waste, and you can produce fuel. Any hydrocarbon can produce into any other hydrocarbon.

This is an algae farm. You know that stuff when you go bass fishing? It kind of gets on the hook and it's really irritating and sometimes you lose fish because of that? You can start huge lakes of this stuff. This stuff ingests CO₂ as food, essentially getting rid of that problem if you have it large enough, and you can produce oil from it with the right enzymes. That biodiesel Mercedes is run on algae.

Okay, we're going to focus on those offshore things instead of looking at new technologies and other alternatives. There's just simply not much out there. It looks like a lot from this map. You add it all up; lots of billions of barrels, about 116.

Now let's separate out what everyone's arguing about; what they can't get to right now, that they want to drill in. Eighteen billion barrels. Seventy-seven trillion cubic feet of natural gas, which is pretty good; that will help. But people focus on the oil. We need to focus on other things now. That's not enough. Again, it's a blip.

What about peak oil? This was the artwork, by the way, that was stolen out of a museum in Amsterdam. It's called *The Scream*. If we don't consider the realities or the ambiguities or the strategic aspects of peaking oil and the degree at which it would peak and the speed at which it would peak, we are going to be in serious trouble.

It takes many years to set up refineries. It could take even more years to set up new technologies. To

completely dismiss the reality of tens of countries going peak, including our own in the 1970s, is going to lead us into a very difficult time. If you think the great recession is a problem, look out.

This is an interesting chart from the American Nuclear Society. Of course they have a grudge. [Laughter]. But if you really take a look at it, this is sort of what's happening here. It started in the 1850s, the 1870s. It could peak out. Move that a little bit to the right or left. Spread it out a bit possibly, have some bumps to make it more realistic. Maybe push it to 2050, 2090, but even Exxon Mobil and the Department of Energy and Shell--I spoke with a lot of their people in October about this.

Total; the Chairman of the Board of Total said that's it, we're looking to alternative energies; we know where the future is heading.

And I know one of their chief geologists, John Lehair, and we met in Saint Andrews, Scotland, a few months ago. We had a long talk about this. This was the fellow who was tromping around in Angola and equatorial Guinea and throughout Africa and throughout Asia finding oil. He knows how to find oil and he knows the problems, and he is really worried.

So it's time to put mind to matter and create a new energy future, and the Air Force can be a part of this. There is that solar tower. We have wind. Way on the top right there is concentrated solar power, where you can actually store the electricity. Don't be fooled, folks; you can store solar electricity. You can store wind electricity. You can store it chemically. You can store it in molten salts. You can store it in oils. It doesn't necessarily mean you need sun all the time.

Bottom left. This is in France. This is tidal energy. Anyone been up to northern Canada or Maine, you see the tide changes. Use that tide change. You have wave energy. Any surfers here? Think of those big waves and jaws in Hawaii. Turn it to electricity; you have multiple gigawatts on that beach.

And then of course, there's nuclear, and there's the solar aircraft, which used to be on the edge many years ago. Now it's not so much on the edge.

We need to look at the realities squarely. Forget all the daydreams and sentiment for the past or the future. These are tough decisions. We have to get beyond ideology

and look at the numbers. Look at the possibilities. Look at the on-the-ground data.

Being military people, you know exactly what I'm talking about here because you need to know what's on the ground. You need to know where that bullet's coming from, and the bullets coming from the energy systems could be severe.

For example, the al-Qaeda fatwa. By the way, they can't write fatwahs because they don't have a legitimate sheik to do it, but they write them anyway. The fatwah to go after oil, to shut down the Western economies, they almost got into Abkaik. Abkaik is the number one sweetening facility in the world; 6.3 million barrels of oil out of the total million barrels of oil going throughout the world markets every day of 82, could have been shut down if they had a few mortars at the right towers for six months. And then we're talking about a \$350 barrel of oil and you folks are riding your bicycles to work.

We're limited by our willingness to change. This is important. Don't just get out of the box. Forget the box. We're limited by our leadership in many ways, who want to continue with the same old ways of doing things. The same old ways will walk us right up against the wall.

Our imaginations. We have some great minds in this country, and we have great minds that could add into the coalitions. Think of a future energy that would be much better than what it is today. We have a lot of intellectual energy in this country, and it's going to take a certain amount of aggressiveness to argue against those who don't want change. And change is needed.

We have to increase energy efficiency. We have to lightweight things. Lightweight cars. Lightweight aircraft. Even slowing down the aircraft. You folks probably know this trick. You can save energy by simply slowing down the aircraft. Considerably. A hundred miles an hour, 25 percent for some aircraft.

Alternative transportation technologies. Pilotless aircraft. Alternative fuels, of which are there thousands of technologies. I could talk about this stuff for the next 20 hours, but you probably already guessed that. There are just so many things out there that people aren't talking about.

The DoD could be a vanguard. DARPA. Energy ARPA. Something along that way. There's a congressman I met in

October who is trying to push through an energy ARPA.

Energy invention prizes. Okay, throw out \$100 million dollars to figure out the best car. How many people with real good brains like what we have in this country would go to that?

All right. The next Bill Gates is going to be a person who cracks the code for transportation. It's probably going to be some kid in a garage tinkering with his '52 Chevy, trying to figure out how this is going to change.

We need to be smarter. Leadership. Education. Educate people about what it is. The numbers. What's out there.

Creativity. This country is great because of the creativity of its ancestors and the creativity of the people of today. We shouldn't give up that competitive advantage in order to remain in inertia.

There's going to be a lot of investment necessary, but there will need to be proper incentives. Thank you.

[Applause].

Moderator: Thank you so much, Dr. Sullivan. I've got some really good questions here. Unfortunately, we've got two minutes and I know most of you want to go hear General Schwartz speak so if you need to leave for that, that's fine but there's questions about the Air Force using nuclear energy, the Air Force using synfuels, there's questions about electricity and whether or not they will be fuel efficient. I don't know how you want to address all these, but I wish we had time to delve into each one individually.

Dr. Sullivan: All right, one thing that the folks here could do -- Let's go back to the beginning here. Take down my e-mail address if you have any questions. Dr.Sullivenergy@gmail.com. I have a combination of my last name and energy. Send the questions along. I'll answer them. I'm pretty good at that.

Also, really good questions get me thinking about different ways of doing things. I do not have the answers to many of these questions because there is no one single answer to these questions. There are many answers.

About synfuels in the Air Force. Mike Amini and his crowd. Mike recently retired, from what I understand. They're still working on this. There's no reason not to do

that, but the question is what about the security of those synthetic fuels. What capacity will we have for those?

Nuclear in the Air Force; I hope we're not talking about nuclear aircraft. Because when I was at Oakridge they talked a bit about that. That would be a rather heavy device and also would be containing certain difficult things inside of the engine.

There is a way to set up battery systems within the aircraft. As these batteries become more perfected, you could use nuclear energy on bases, small nuclear plants, to charge those batteries. For small aircraft anyway. And if you perfect those batteries, the aircraft could fly for many hundreds of miles. But of course that's in the future.

Another problem with these new batteries, however, is they have rare earths and we're going to be trading off one insecurity for another. And guess where most of these rare earths can be found. China.

If someone tells you that green energy is entirely green, it is not. If someone tells you that green energy is our way to walk away from potential conflict, not so. Because there could be conflicts over solar panels. Because some of the silicon for those solar panels comes from places like Kazakhstan.

Whatever is a natural resource that's outside of your own country is a potential source of conflict because your alliances today aren't necessarily your alliances for tomorrow. Think of the Germans and the Japanese in the 1940s, and think about how close we are to them today.

Moderator: Dr. Sullivan, thank you so much for a very, very informative and entertaining presentation.

Dr. Sullivan: Thank you.

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