THE CEBROWSKI INSTITUTE

IS AMERICA WARMING UP TO GEOTHERMAL ENERGY?

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ADAM SIEGEL: Senator Merkley has just arrived. He was elected to Senate this November and he is on the environment and public works committee so he will have quite a voice as part of the development of climate legislation, which Senator Boxer has set as part of the fall agenda, and which obviously has a very significant energy part.

If one were to go back and look at Senator Merkley's career, but also what is unusual, perhaps – he was unique amongst all of the candidates who won election last year, as I think it would be hard to find a day where he was in front of reporters or his voters, where energy and climate issues were not part of what he talked about. It's rather unusual in the campaign last year.

And with that, Senator Merkley has to leave here in about 20 minutes, so, Senator? (Applause.)

SEN. JEFF MERKLEY (D-OR): Hold on just a second here. I want to make sure I don't break anything! I'm simply not with the modern world, or I'd have my speech all set up on the computer.

Adam, thank you very much for the introduction. And his point is absolutely very accurate. During the campaign last year, I'd talk every day about changing our energy structure and why we needed to do so. And folks would say, Jeff, haven't you read that climate change is about 21st on the list of issues that Americans are concerned about? And, I'd say, well, yes, I have seen that. And they'd say, why are you continuing to talk about this – because you need to talk about the top-five issues that people care about. And I simply would respond that changing our energy policy should be one of the top issues – one of the top issues for a whole host of reasons that I'll talk to you about tonight.

And it was my pleasure as speaker of the House two years ago in the state of Oregon to be immersed in energy and environment policy. And we did a number of things, including, in Oregon, passing the most aggressive renewable energy standard – 25 percent by 2025 – not including the substantial amounts of energy in the Pacific Northwest in the form of hydropower; not including the existing hydropower, which will result in a pretty dramatic transformation of the balance of our power in Oregon.

You know, we have a really historic opportunity to transform our energy policy now at the national level. And it comes down to three things. One is ending our dependence on foreign oil; and thereby augmenting our national security; the second is to create jobs; and the third is to tackle global warming. And I'm going to try and say a little bit about all three of those.

First, in terms of foreign oil, I don't think that this audience probably needs a lot of discussion of that, as I understand there are many staff members from the Department of Defense here. But one statistic that we might keep in mind is that we consume currently 25 percent of the

world's oil on an annual basis. And we have 3 percent of the world's reserves. And so while people may say, drill baby drill, that 3 percent is still a very small part. And it means if we remain dependent upon oil, we're going to be dependent upon foreign oil.

And indeed, this issue about national security and dependence upon just a few foreign nations providing the bulk of our oil energy, it's not just about oil. It is also about other forms of energy.

We have three proposals in my home state of Oregon to create LNG terminals. And these terminals are being marketed solely for the purpose of importing natural gas. And we could see, a decade or so down the road, a similar situation in terms of our dependence on a few foreign sources for natural gas.

Let me turn to the job side of this. And I think President Obama summarized it very well when he said the following: We can hand over the jobs of the future to our competitors, or we can confront what they've already recognized as the great opportunity of our time. The nation that leads the world in creating new sources of clean energy will be the nation that leads the 21st century global economy.

Well, indeed, I think all of us here in this room would like to see America be a nation that leads. And we would like to create clean-energy jobs here in America rather than shipping those jobs overseas. We currently spend between one to $2 billion a day – it got up to $2 billion a day at the height of last summer's energy crisis at the pump. But one to $2 billion a day on foreign oil: We would create a lot more jobs spending that money here in the United States on renewable energy.

And clean energy creates more jobs than fossil energy. In Oregon, clean-energy jobs are growing at seven times the rate of the rest of the Oregon economy. And I also want to mention that we should think of jobs in terms of energy efficiency as well. Creating far more efficient buildings, both new buildings and revamping our existing buildings, creates a tremendous number of jobs and saves a tremendous amount of energy. So it's definitely a win-win.

Well, this brings me to the third point on global warming. There's certainly a range of views about the strength of the scientific evidence. But my conclusion is certainly that the evidence is very strong. It makes sense, it makes sense, that having, for 150 years, an industrial economy on this planet that depends on taking geological carbon and converting it into carbon dioxide in the atmosphere would take and create a tremendous change in the makeup of the atmosphere. And indeed, we've seen that in terms of the huge growth in carbon dioxide concentration. It also makes sense that carbon dioxide concentration would have an impact on retained energy and retained heat.

So all of that vision makes sense, but if we're not convinced by the theory, we can simply look in the laboratory – the laboratory, in this case, being our planet, where we see glaciers around the world shrinking; where we see ice sheets in the North and South Poles shrinking; where we see ice now thin enough that submarines can surface through ice where they never could before; ice in the North rare enough, thin enough, that people are starting to talk about

trans-polar surface transportation, which would not have been discussed 20 years ago; we can see in Oregon, the Red Zone created by pine needles that are migrating north as the energy gets warmer, and so on and so forth.

Certainly huge impacts, by the way, in terms of my home state's forests, in terms of the odds of fire destroying the forest, which of course then puts more carbon dioxide into the air and enhances that feedback loop.

Well, so a lot is going on. What we have to recognize is it is not acceptable to stay on a path, where 50 years from now, we will have a planet that is four to 5 degrees warmer than the planet we have right now. And maybe at first, four to 5 degrees doesn't sound like much. But keep in mind, everything we are seeing on the planet right now is a result of a 1-degree temperature change. And as you go up that scale, the feedbacks and the effects start to magnify themselves.

What we have before us – a clean energy and jobs bill in the U.S. Senate – and there are just a few points about it I wanted to highlight. First, energy efficiency: Homes and offices in North America produce 2.2 billion tons of global warming pollution each year. And I support an energy efficiency standard that requires utilities to reduce waste by 15 percent by 2020.

I just want to point out – many of you have heard about the renewable energy standard – but there's also in the bill, and that's why I wanted to draw attention to it, an energy efficiency standard. And this is certainly very helpful because it makes us realize that energy efficiency is really a form of very clean energy, perhaps the cleanest of all, perhaps the cheapest of all, and it has the wonderful benefit of reducing the bill for our families and for businesses in terms of heating and lighting our buildings.

One of the ideas that I'm putting forward as a separate bill, but then I'll also be working to get it into the energy bill, is that we have a low-interest loan fund that helps corporations, helps businesses, small businesses, individuals pay for energy improvements up front. And to do so in partnership with our utilities so that the bill can essentially be paid off with savings on your electric bill.

So I might be looking at the installation of double-pane, vinyl windows in my home, and it might be that the savings from that investment would more than pay for the cost of installation through a loan, and thereby, I can not have to have a big challenge of getting over that first big investment hill. So that could have a tremendous effect on accelerating the pace with which actual investments occur.

A second piece I wanted to highlight is simply that the bill relates to building a 21st-century transportation system that includes light rail for commuters, high-speed rail for traveling between cities, street cars – and by the way, anyone from anywhere in the country who's thinking about street cars, Oregon Iron Works is building the first street cars built in America in more than a generation and we'd like to talk to you. (Laughter.)

The new administration has – certainly Secretary LaHood – certainly has to be complimented for taking a look at this and recognizing that street cars as well as light rail and so forth add a tremendous amount to the transportation infrastructure – urban infrastructure.

One of the things that I'm proposing that we do is take and have every transportation project have an estimate associated with it that is a carbon footprint estimate to help give us a sense of how different transportation projects might add to carbon dioxide or reduce carbon dioxide as a way of seeing it through an additional dimension – transportation projects through an additional dimension. We certainly see it through the concept of time saved or cost, but we should also be seeing it through the carbon dioxide lens.

We also need to do a much better job on fuel efficiency for our cars and trucks. We're off to a good start; certainly the Obama tailpipe plan is a fine addition. But we could be far more aggressive in this area. Recognize that if we had our residential cars – our passenger cars – if they were able to go 30 miles on electricity – electricity from a renewable source – and had regenerative breaking – we would cut, by about 80 percent, the amount of carbon dioxide that our passenger vehicles produce; with no complicated cap-and-trade, or cap-and-invest, or cap-and-anything. And we need to look at those sorts of places where technology – driving technological change – could have a tremendous impact.

Certainly I'm very interested in biomass because, depending on how we manage our forests, we can produce forests that are far less prone to fire and disease, far better, in some areas, for timber; far better in other areas for ecosystem, and in the process, produce a biomass that is basically saying we're breaking the link from geological carbon to carbon dioxide in the atmosphere. We're pulling that carbon dioxide out of the air and utilizing it.

And in fact, a year or so ago, someone stood up in one of the meetings I had on the campaign and said, Jeff, wouldn't it be just great if we had a device that could just pull carbon dioxide out of the air? An invention that would pull carbon dioxide out of the air! And I said, well, the good news is we have one. And we have millions of them growing right here in Oregon.

Well, we also need to look at diversifying our sources of energy and certainly that means wind and wave and solar and geothermal. Since geothermal is the main topic, I wanted to note a couple things about the blossoming geothermal industry in Oregon.

In Klamath Falls, geothermal energy has been a way of life for decades. The city has utilized the natural energy source to heat homes and buildings. And they have partnerships with various industries, including one that uses a technique to remove pesticides. And it's used, in another case, to power a local brewery. And it's being looked, also, as a complement to wind farms in order to help balance out the load demand and the production – as the wind power comes and goes.

I recently visited Oregon Institute of Technology: OIT. That university is working to become the first campus that has a sizable geothermal energy generator. OIT has used geothermal for decades to heat their buildings. And it likes to say it is the first campus in the

country heated solely by geothermal. But now it wants to become the first campus in the country with all of its energy generated through geothermal.

And so they built a well – drilled a well – last year. The well water came out at a somewhat lower energy than they anticipated. So they're planning a supplemental well in order to reach this goal of generating enough energy, enough electric energy, to provide all of the campuses needs. It's estimated it will save them, in addition, a half-a-million dollars a year, which, for a small college, is a very sizeable sum.

And then just a couple months ago, President Obama announced a geothermal project south of Bend, in Central Oregon. It had been stalled previously, and it will now get the funding needed to explore new geothermal techniques. Essentially what this boils down to is that it is an area where test drilling has revealed very high temperatures in the Newberry Crater area. But these are dry wells, and so they're going to have to inject water into the wells. And that's been a technology that really hasn't been developing very fast in the United States.

I am told that in some parts – and I believe in Australia – there's something like 300 permits that have been issued for this technology. We have done very little of it in the United States, so they will be experimenting, and hopefully experimenting successfully, with injecting water to produce the steam necessary to drive turbines, create energy, power thousands of homes.

So there's a lot of promise. I'll just stop by noting that if we get this right – transforming our energy economy this year – if we get it right – it will have a phenomenal impact on our national security; certainly a huge impact on our economy. We'll be selling products to the world with our intellectual capital and our actual manufactured projects; and certainly put the United States back in the conversation, working with the rest of the world, to take on climate change. Thank you so much for the invitation to come by and talk with you all. Take care, thank you. (Applause.)

MR. SIEGEL: We have mikes; we have time for one quick question.

Q: Senator, Richard Kidd from the Department of Energy, and a proud graduate of Forest Grove High School in Forest Grove, Oregon. You mentioned that you were considering energy-efficiency low-interest loans to private enterprise. What about for the federal government? Last year the federal government invested almost $400 million through ESPC programs. Many of us in the room are involved in that. It's going to cost the taxpayer about $1.2 billion. By the time we pay it back, we're on track to invest a couple billion each year for the next five years as a fed. Any chance that we can get a break as well? Thanks.

SEN. MERKLEY: (Chuckles.) Let's talk. And I just wonder, out of curiosity, how many folks have an Oregon connection who are involved in this conversation? How many folks in the room?

Well, a pretty good number. And certainly not enough, though. You know, Oregon has an ethic involved in renewable energy. It certainly has wind, wave, geothermal and solar

potential. And so we just want to create as much effort as we can to participate in this energy conversation to hopefully help lead the nation in showing the way, if you will, and make this world better for our working families who need jobs, certainly and for our planet. Thank you. (Applause.)

MR. SIEGEL: I'll speak for the senator in that I think he regrets not being able to take more questions because he usually seems to enjoy doing that. But he does have to get back by 7:00 p.m. Thank you very much, Senator.

SEN. MERKLEY: I apologize that I'm schedule to preside – (inaudible, off mike).

MR. SIEGEL: Thank you, again, Senator. (Applause.) What I'd like to do right now, well, what we're going to do is, we're going to turn it over to the panel on geothermal energy. And I believe Jeremiah Baumann, the senator's legislative aide, will be joining. He's not on your bio sheet. Everyone should have bio sheets in front of them, so rather than spending a lot of time to introduce, I'd like to speakers to come up.

And I'm going to be handing this over to Ed Wall from the Department of Energy and our speakers this evening. And he will be running this. Andrew Sabin from the Navy, Chairman Jon Wellinghoff from the FERC, Kermit Witherbee from BLM and then, Jeremiah, please join, from the senator's office. And I'll bring a chair up for you.

Jeremiah will correct me if I get this wrong. Since you have everybody else's name and Senator Merkley, as you know – Jeremiah joined the senator's staff from – you led Environment Oregon – is that correct? He was the head of Environment Oregon. And while every single person I know who works in this domain, the Northwest, has never had anything to say other than the most positive things and they regret that he's moved this coast because they don't have him in their backyard anymore.

So I'm really honored that all of you are here. Thank you.

ED WALL: Well, thank you. I'm particularly happy to be invited to the Energy Conversation and more than that I'm just glad that our office is around at all, given that as recently as two years ago the geothermal program at the Department of Energy was scheduled to be phased out and the budget request for 2007 and 2008 was zero.

We feel right now that the program is undergoing a renaissance, and not the least of which is because of the recovery act funding for $400 million that's allowing us to pursue a broad portfolio, one that ranges from heat pumps at the low temperature end through low temperature hydrothermal coproduced fluids from oil and gas operations.

Finding undiscovered conventional resources to – at the high end potentially of temperature to engineered geothermal systems or EGS. And in doing that we're also engaging new players. Thirteen of the 21 selections that were announced from our solicitation last fall that were announced in October went to new partners that had not worked with the geothermal office at DOE before.

Along with that we're seeing innovative teaming and we're actively seeking cross-industry collaboration; looking to the oil and gas industry; looking to mining; looking also to sequestration for areas of common interest and common application of technologies.

In the area of resources, USGS put out a study last October of resources – the Western third of the United States – and along with 40 gigawatts of conventional hydrothermal, they identified more than 500 gigawatts as the potential for EGS in the Western United States.

This is base load power and based on current performance we could expect capacity factor in the high 90s. With EGS maturity, we can expect geographic distribution potentially across the U.S. combined with low greenhouse gas emissions and we're also exploring numerous direct use applications along with geothermal heat pumps.

Now, on a carbon constrained world, we feel geothermal can play a key role. Certainly geothermal can help meet large RPS requirements that are present in some states and I have noted among the renewables, geothermal has the benefit of being base load in its capability.

Now, the key to our discussion tonight and one of the things I wanted to focus on was the many complex relationships that enter into dealing with the challenges and the risks of geothermal. And really, these are the challenges of finding the resource, producing it, and ultimately getting it to the end user. It's not a simple undertaking.

Just on the technical side, for EGS to work, we need to validate that it works and the generation can be sustained not just over months but over many years. That's replicable in a variety of geologic environments and it can be scaled and done economically.

For conventional resources we have to find the 30,000 megawatts that USGS has in the western third of the United States but we don't know exactly where it is because there is no surface expression, no bubbling hot spring to give it away. So that's the challenge there and we've devoted one-quarter of the stimulus funding to innovative exploration technologies that we can use to try to find the conventional resources and bring them online quickly.

Access to transmission infrastructure is one of the major factors: cost of capital, load consideration, transmission corridors. There are issues surrounding permitting, leasing and regulation. Kermit can tell you that if you go west of the Mississippi in the United States, still more than 50 percent of the land is federal land. In some states like Nevada it's close to 90 percent.

To put together a prospect to produce geothermal also often means assembling a patchwork that may consist of federal, state and private land. We're looking at opportunities – and I know Kermit will speak to it. Opportunities to accelerate the leasing and permit process. How can we speed it up and bring more resources online?

Updating resource management plans with enough detail to be applied. We have an identified lack of available and reliable resource information. And there are national policy

issues as well. A continuity of policy – a good example is a production tax credit. We have seen recent extensions of one to three years. With the geothermal development cycle it's more like five to seven years long.

And we have questions in the environmental arena as well. Let's take EGS for an example. Two key questions there are induced seismicity and potential water use. Now, as far as induced seismicity goes, anytime you have fluid injected or removed from the ground you are going to have micro earthquakes – something geothermal shares with oil and gas production and carbon capture and sequestration.

But perceptions are key here. There was a New York Times article just a couple weeks ago highlighting the risks of development in any proximity to communities. And we're undertaking additional analysis related to that.

Water use is also a concern across much of the Western United States, though use of CO_2 as an energy transfer fluid offers the potential to get around that concern and that's one of the topics we identified in the component R&D solicitation that's on the street right now and will close by the end of the week.

Now we're taking actions to address risks and challenges. We're working with the USGS to expand the resource assessment they did of the Western United States to the entire U.S. to consider low temperature as well as EGS and conventional resources. We're also asking the USGS to develop classification standards so that we could put together the types of resource maps that other renewables like wind and solar have.

And we're pursuing a national geothermal data system which will be a virtual database linking data sets around the country, though it would help in geothermal exploration and production. In the area of seismicity, we are requiring all of our EGS demonstration projects to monitor, collect and analyze seismic data.

We're asking all of our partners to adhere to the international protocol for induced seismicity that was developed by the U.S. and the international community. A couple of months ago we sent a large Berkeley National Lab additional funding to install seismic instrumentation in each of the EGS demonstration sites to provide for constant monitoring and to provide public access through live, real time LBL Web site availability.

In our solicitation that closes this week, new seismicity is also an R&D component topic. We're seeking knowledge growth from the oil and gas industry and we're also looking at carbon sequestration, mining and nuclear activities for where we have areas of common concern.

In the area of water use, we've asked Auriga National Laboratories evaluation group to examine freshwater requirements and the water impact's assessment be performed for EGS. As far as technological research, our goal is to reduce total water loss to under 2 percent. We're examining as ways to do this binary working fluids, air cooled condensers – that's a current topic in our R&D solicitation.

We're examining CO_2 as a working fluid for EGS and we're looking at better ways of reservoir management utilizing advanced modeling, tracers, better imaging of fluid flow and fractured characterization. We're also pursuing interagency working group activities. We have the national academy help us convene; DOD, EPA, National Science Foundation, Department of Interior, USDA and others looking at identifying research priorities in the geothermal area; looking at how we link to existing sources to populate the national geothermal data system; and looking at practices for better management stewardship of geothermal resources.

And we're looking ahead to the loan guarantee program, the third round will be coming later this month. Geothermal is a topic in the second round and four awards were made. We've signed an international partnership on geothermal technologies last August with Iceland and Australia and we feel that's an opportunity to share advanced R&D and best practices to avoid duplication and blind alleys.

And finally, we're working with universities and industry to better define the needs of the workforce of the future and to aid workforce development by putting together cross-cutting geothermal curricula. That's a bit of what's going on at DOE and it's an exciting time here for us, particularly as we rebuilt a program that almost came to an end.

But I'd like to now turn it over to our other speakers. I would invite Jon Wellinghoff to come up next. As chair of FERC he has certainly first-hand knowledge of the challenges of transmission access. But he's not one dimensional. When I ran the transportation program, at energy efficiency and renewable energy he was a leading voice, an advocate for the examination of plug-in hybrid technology and I think not only was his voice heard but that was one of the factors that allowed us to move into that space when budgets were tight. Jon? (Applause.)

JON WELLINGHOFF: Thank you, Ed. Thank you. I had a couple of slides here. Well, Ed's right. I sort of have sort of multidimensions because some of the things that Ed didn't mention were that I actually was on the board of directors of two geothermal companies at different times when I was in private practice for a number of years and actually go back thinking about and being involved with geothermal entities back probably 20 years at least, back in Nevada in the mid 1980s when we at that time, under a federal law called PURPA, were trying to get into place independent power producers.

And one of the major power producers in the Nevada area, northern Nevada area where I'm from, was a number of different geothermal companies that we actually got going and got them encouraged in actually putting independent power projects that were separate from the incumbent utility.

So we had a little competition in rates, a little competition in utility resources. But what I want to talk to you about a little bit this evening in a very short presentation is about some of the resource availability for geothermal. What's known and what has become known recently.

This is a map of geothermal hotspots that's traditionally and generally considered around the world of areas that have most geothermal activity. And these areas align with the volcanic and seismic faults along the Pacific Rim and in Africa and in Asia, and the areas that have

traditionally thought to be the most profitable and the most prospective for geothermal resource development.

And from that there's been developed some traditional numbers – you've heard some of them from Ed here tonight: thirty to 40,000 megawatts of potential of traditional geothermal resources in North America of which about 3500 to date have been developed so you can see even in the traditional area of geothermal, and we talk traditional geothermal electric energy production we're talking about drilling wells and either bringing up steam in natural form or hot fluids and running them through either a steam turbine or some kind of Rankine cycle conversion system at temperatures down to a little over potentially 100 degrees C. That's sort of the low end right now.

And that has been a temperature that's dropped considerably. At one time in Nevada, back in the mid '80s, I talked about where we had a number of firms exploring for geothermal energy. There are actually a number of oil and gas firms that came into Nevada and drilled extensively in Northern Nevada.

And they were looking for at the time the same type of steam geysers at temperatures at 500 degrees plus that they have in Northern California at a place called the geysers where there's about – I think – 1200 to 1500 megawatts of geothermal currently under production there.

And they didn't find that. What they found in Nevada instead was this hot water that was somewhere in the neighborhood for 200 to 300 degrees C, and they just capped the wells because they didn't know what to do with it. So there were these wells across northern Nevada that were capped and not utilized.

But finally there was companies that came in, the most notable of them was a company by the name of Ormat from Israel that developed a binary system where they could actually take low-temperature fluids and run it through a heat exchanger where they would use an isopentane fluid that they would exchange the heat of the fluids underground with that that actually expanded at much lower temperatures, and with that they could then drive a turbine and ultimately generate electricity.

So that's the traditional way that we've seen electricity produced from geothermal energy and it continues to be explored today. One of the places is the Newberry Volcano that you heard about which I believe actually that the Senator talked about, there actually is fluids at the Newberry Volcano.

I've seen the pictures of the steam. The Newberry volcano is one of the hottest geothermal resources in my opinion in the United States and it's been underdeveloped primarily because of political fights and not because of technical issues. I have some personal experience with that, with one of the geothermal companies that I was on the board of directors of.

This is a heat-flow map of the United States that shows you temperatures – and I'm not sure what depth this is here – but temperatures across the United States. And as you can see, the higher temperatures are primarily in the Western United States where you have hotter

temperatures closer to the surface. In the great basin and along the faults in California, Oregon and Washington you have much higher potential temperatures and therefore you don't have to drill as far to look for fluids that you can bring up at higher temperatures to produce electricity.

Here's a map looking at different depths. You have three-and-a-half kilometers, six-and-a-half kilometers and 10 kilometers. And you can see here, as you would all expect sort of a rational expectation would be, the deeper you go the hotter it's going to get.

But the interesting thing with this is that you find out that there's lots of places that are already producing hot water. And they produce hot water coproduced from oil and gas wells. And as you can see from this chart, there is literally billions of gallons of water produced every year in a number of states in the Southeast that have the potential to produce 25 to 30 gigawatts of electrical energy simply by using the existing fluids from oil and gas wells.

And why we haven't before looked at this and utilized it, I can't tell you. I do know that there's much more interest in this now. This is something that I was aware of about eight years ago or so. One geothermal company that I was with – on the board of directors with – they were looking at this although they were looking at places like Newberry Volcano and doing more conventional geothermal development at the time.

But they were aware of the fact that places like Texas and Louisiana and others – Okalahoma – had significant amounts of coproduced hot water that potentially could be used in binary cycles at lower temperatures, the 200 to 300 degrees C that could in fact produce electricity. And so there have been a number of studies showing where these water production wells are across the United States.

There was a study that was done in 2004. Now, when we talked about enhanced geothermal systems, this is now going beyond what I'm talking about in the coproduced water systems. Enhanced geothermal system is a system where you have to drill down and as the senator was speaking of, you don't find fluids but you do find very hot rock and it's necessary to somehow put the fluids down there, heat them up and bring them back up so that then you can use them to produce electricity.

Here's an estimate I believe done by MIT in a recent study that they did showing that from a price standpoint, ultimately, over time, we can get the prices of these enhanced geothermal systems to be extremely competitive with fossil fuels – in fact, probably be at the point we put some kind of a carbon cost on carbon; certainly geothermal will be ahead of all carbon fossil fuels.

And in the bids that I've seen in Nevada – and Nevada has a renewable portfolio standard, by the way, we put in place, in 2001. And as part of that renewable portfolio standard, the utility goes out for bids for renewable resources. And one of the traditional largest bidders to the Nevada utilities has been geothermal developers. And I will tell you, I negotiated a number of those contracts on behalf of geothermal developers. And the results were prices that were substantially below which you could build a coal plant for.

So there's no question in my mind that geothermal is extremely competitive with all conventional fossil fuels, and if we can just develop it on a larger scale – and the issue is really locating the resource and effectively developing the resource in a way that is ultimately cost-effective.

And so if you look at some of these geopressure zones in Texas, for example – here's a map that's been done of that potential – one that was given to me by Charles Baron, who has done some work for Google. And I'll say that it's interesting to know that Google is one of the companies that is extremely interested in these geopressure zones and these coproduced fluid mechanisms of producing geothermal energy. They are investing in this area and they believe it's an area that's very prospective.

If you look at it, some of the temperatures, you can see, are extremely high in these areas at 12,000 feet. And that is levels to which these levels can typically be drilled. Again, geothermal wells usually don't go down that far, especially in places in Nevada and in the West, but this is a typical depth for an oil or a gas well. And, ultimately, if you're drilling that far and you're producing hot fluids, you might as well use those hot fluids for a useful purpose.

And one of the most interesting things to me – and this is my last slide – is the potential of the, again, enhanced geothermal systems, where we're going simply beyond the coproduced fluids, but looking at all of the enhanced systems.

In the state of Texas alone, there have been some estimates that it may be as high as 177 gigawatts of energy, which would be more than twice the amount of energy used in the entire state of Texas currently. And that's only at a 2-percent recovery rate. So you can see that the potential is extremely high.

You can see that – another thing you ought to understand with respect to geothermal – when you're talking about comparing geothermal, say, to wind, 1 megawatt of geothermal is worth 3 megawatts of wind because at geothermal, you have a capacity factor of 90-plus percent. Wind's capacity factor is about 30 percent, meaning that geothermal runs all the time; wind only runs when the wind blows. So ultimately, you have a much higher utilization and capacity factor with geothermal that's a much better resource to use from a standpoint of providing a constant stream of power if you need a constant stream of power over a period of time.

So the potentials are very high but the challenges are also very high. I'm very happy to hear the DOE has finally turned it around and that we've got a good person like Ed in charge and we've also got some money coming into the office. It was a very sad thing, a sad day, when there was a proposal to zero out the geothermal budget. It's something that should be supported. And we need to look at how to lower the barriers for getting this resource fully developed. Thank you. (Applause.)

MR. WALL: Thank you, John. Next, I'd like to invite Andrew Sabin up. He is with the Naval Geothermal Office located in China Lake, California. And he can speak to a wide variety of relationships required to bring that field on production.

ANDREW SABIN: Thank you, Ed. And, I guess, thank you, Mitzi and Adam, also, for being part of the Energy Conversation and inviting me tonight. I just met you an hour ago or so.

I am the director of something called the Geothermal Program Office. It's a small office – a Navy office – situated at China Lake Naval Air Weapons Station in California. And we really have two objectives in this office. Our mission is to explore for, develop and manage geothermal resources on DOD installations. We really have two major functions therefore – to manage geothermal resources and to explore for and develop more.

At this point, there is one geothermal resource on a DOD installation, and that's the Coso Geothermal Field. Many of you may have heard of it. It's entirely within the fence line of the China Lake Naval Air Weapons Station. And it has an installed capacity of 270 megawatts, making it the third-largest geothermal field in North America.

There are 32 million acres of DOD-controlled ground in the United States. And the other mission of our office is to explore for and attempt to develop geothermal and geothermal hybrid resources on these lands.

And what I've done tonight is, instead of me speaking forever or even for five minutes, we've put together a film clip. And this is the third time that it's been shown in Washington, D.C., and the fourth time since we created it. So I guess we'll retire it after tonight. But it has some great explosions and other things – (laughter) – so it'll capture your attention.

(Begin video segment.)

NARRATOR: The Coso Mountain Range, located at the Naval Air Weapons Station, China Lake, is one of the hottest places in the world. It was here, in 1964, that Navy geologist Dr. Karl Austin first reported conclusively the potential for geothermal energy. In 1977, several shallow test holes proved the existence of commercial temperatures and flow rates.

A year later, the Department of Defense established the Geothermal Program Office, or GPO, and designated the Navy as the lead agency for geothermal exploration and development on military lands. And in 1979, the Navy awarded a contract to California energy Company to develop a geothermal field at Coso and to supply power to the Navy, with a demand of 20 megawatts.

In June 1993, the Coso field peaked, with a producing average of greater than 270 megawatts. Currently, field-wide production totals over 40,000 gigawatt hours of delivered power. And plant online availability is above 98 percent.

During the 30-plus years of Coso's exploration and development, neither industry activities nor Navy testing were impacted or compromised. The power facilities can be operated remotely off-site without encroachment to Navy range operations or mission security.

The Naval Air Station at Fallon, Nevada, is located 60 miles east of Reno in a circular depression within the physiographic province called the Carson Sink. GPO exploration efforts

led to the drilling of three gradient holes and one deep test hole. In an attempt to prove the resource and minimize the risk for future investors, the Navy successfully flowed FOH-3. These efforts resulted in awarding a long-term contract to Ormat Nevada, Incorporated, in 2005, to construct a 15- to 30-megawatt facility.

The China Lake and Fallon contracts were made possible through the Military Construction Authorization Act of 1979. Several other U.S. congressional codes strengthened this initial law by authorizing DOD to explore, develop and market renewable energy resources.

This relationship between the Navy and an independent power producer was made possible through a unique contracting vehicle, a public-private venture – a PPV. The Navy performs initial exploration and resource delineation, thus reducing some of the upfront risk for the developer.

Within the 32 million acres of land managed by the DOD, GPO's most recent exploration has taken place at six facilities. At Naval Air Facility El Centro, two geothermal test holes drilled in late 2008, revealed significant heat and hydrothermal alteration. A third test hole was planned for late 2009.

Within the Chocolate Mountain Aerial Gunnery Range, recently acquired high-resolution LIDAR data will augment field mapping and be integrated with potential field geophysics and other geological data to establish targets for a shallow, temperature-gradient drilling campaign in 2009.

At the Marine Corps Air Ground Combat Center, Twentynine Palms, Seabees from the Naval Construction Division drilled five 800- to 1,000-foot temperature-gradient holes. Equilibrated temperature gradients and self-potential data are being assessed to determine the potential for moderate temperature resources in the Camp Wilson area.

The GPO has identified two discreet prospects, independent of the current Navy-Orvat development contract at NAS-Fallon. Bombing range 16 and Navy-managed lands in Dixie Valley will be explored over the next two years. The GPO, Epsilon and the Great Basin Center for Geothermal Research are currently collaborating on a multifaceted exploration program in Nevada.

In Hawthorne, 90 miles south of Reno, the GPO successfully completed two exploration test holds to 4,000 feet in early 2009. An interpretation of equilibrated temperatures, downhold geophysical data and a 3-D seismic data set in the western portion of the base will be completed in June 2009. GPO and Great Basin personnel are conducting additional exploration in the vicinity of anomalously hot water wells in the east and northwest portions of Hawthorne. A detailed geological investigation of selective regions of the south ranges at China Lake will be initiated in 2009.

Shallow temperature gradient holes are also scheduled to be drilled in 2009. For further information, contact the Geothermal Program Office at 760-939-2700.

(End video segment.)

MR. SABIN: So we originally put this film clip together a year ago with two audiences in mind: The first audience was private industry. Coso has been online since 1987. This office has been in existence, my office has been in existence for several decades and, yet, the relationship between Coso and the Navy and the Navy and our office and what we do is poorly known.

The second audience was really for the base commanders. China Lake is one of the foremost Navy testing and evaluation bases. It's extremely busy. The geothermal field is actually entirely within the footprint of a very active bombing range and, yet, for 21 years, the geothermal field has operated without a hitch and the weapons end of work at China Lake has gone off without a hitch as well.

So our argument was to tell industry what we're doing. The Navy is not necessarily going to be in the business of producing geothermal. However, we do a certain amount of exploration and, at the end of the day, if we think there is a resource, we will put an RFT on the streets to have a third party come in and develop it.

So we wanted them to know about the work that we're doing – and then the actual base commanders as well. Many of them, up until recently, really didn't want anything to do with the type of work we do. However, with the military's initiative – that's the term I use; there may actually be a more appropriate term – of having 25 percent of the energy demands on military installations be provided through a renewable resource by the year 2025, they are now incentivized to attempt to develop solar, geothermal, wind.

There are a couple of other things I'd like to point out. Hawthorne is an Army base. Hawthorne Army Depot, as the film clip said, is 90 miles south of Reno. And we, the Navy, is actively collaborating with the Army as we speak to, A, develop an MOA and get it signed so that we can move forward collectively to develop Hawthorne.

We strongly believe that there's a shallow binary resource on the western flank of the Hawthorne Army Depot. We also have strong reason to believe there are additional resources to the East and to the North. So we continue to do exploration work while at the same time attempting to develop it.

And I guess the other thing I'd like to point out – and presumably we're going to have a conversation so I don't really have any prepared remarks – currently, right now, at China Lake, our third-party developer is TerraGen. TerraGen bought the Caithness out in January of last year. They've provided a lot of cash despite the financial collapse.

And TerraGen is very actively providing well workovers and doing every type of development they can think of at their three geothermal properties: Coso, Beowawe and Dixie Valley. And one of the plants that they are testing – or they will be testing shortly – is the development of a 1-megawatt concentrating photovoltaic system within the geothermal field.

And the idea is to augment the parasitic load. As the film clip said, it's 270 megawatts of installed capacity.

The parasitic load is about 25 megawatts. Despite the fact that they have a contract with Edison, they can still successfully – if it's technically and financially feasible – capture some of that parasitic load through the use of photovoltaics or any type of solar.

So what we are emphasizing when we go to these military bases, what we've talked with the Army extensively about and we're also discussing this with the Air Force, that especially in the southwest United States, where geologically most of the geothermal resources exist – certainly along tectonic boundaries and areas of volcanism, it's also sunny. And the footprint for geothermal is relatively small. And if you're going to tie up a certain amount of acreage for geothermal, you should probably try to develop photovoltaics there as well.

So we talk about developing geothermal hybrid systems where you could capture peak power during peak hours and augment that with a base load of geothermal. That's about all I have for now. Or I could speak forever. (Laughter.) So I'll probably stop now and field questions later. Thank you very much. (Applause.)

MR. WALL: Thank you, Andy. Next we'd like to invite Kermit Witherbee to come on up. He has – actually I've been with Kermit many times, but never in Washington before. That speaks to his schedule as he sought to bring about a programmatic EIS encompassing the geothermal program for BLM in hopes of speeding up the leasing process. Kermit?

KERMIT WITHERBEE: I need all the help I can get. I'm of the slide-rule generation. (Laughter.)

(Off-side conversation, A/V difficulties.)

Okay, we're all set. I don't really have a big, formal presentation, just a few slides. The Bureau of Land Management actually manages the public lands, which encompasses about 258 million acres of public lands, most of them scattered through the West, 11 Western states and Alaska.

Though we also – the Department of the Interior is charged with managing the federal mineral estate regardless of who the surface owner is, unless the minerals have been reserved or withdrawn for other purposes like Department of Defense.

And we coordinate and work with those other surface owners, managers, the Forest Service, privately owned land, Bureau of – (inaudible) – et cetera. Ed had mentioned the U.S. Geological Survey's geothermal resource assessment.

And that came out of – they were charged with updating the 1978 assessment that they did after the Geothermal Steam Act of 1970 became law. So this was the first update in quite some time. And they actually briefed the federal agencies and us in Interior last September.

And out of that – and the numbers haven't changed a lot since 1978, but about 90 percent of the geothermal resource occurs on federally managed lands, mostly in the West.

Now, BLM does manage the mineral estate on the East Coast, mostly lands under the Forest Service and acquired lands. But by the end of FY 2008, we had 530 geothermal leases, a little over 820,000 acres. Fifty-eight of those leases are in producing status at that time. Fifty-two of them actually produce electricity in the 34 power plants, of which about half of them are actually located on federal lands.

The capacity – this is a net capacity that gets out into the grid, instantaneous, is about 1275, 1280 megawatts, give or take about – that's enough to supply electrical needs of about 1.2 million homes. The royalty income from those 58 leases was about $14 million.

And I'd like to point out that the Energy Policy Act of 2005 significantly changed how we lease for geothermal. We now lease competitively at a first round for electrical generation. The public nominates the lands for leasing; BLM does their magic and decides, are the lands available for leasing? Yes, they are available for leasing. And what special stipulations to mitigate environmental impacts and protect the environment would go onto those leases.

And then we sell the leases, we schedule a lease sale, we publish a lease sale notice with the lands – (inaudible) – stipulations. There is an oral auction and the leases are then offered to the highest qualified bidder. And the leases are good for 10 years, but they have work requirements.

So anyways, out of that whole process there was another section in the Energy Policy Act which previously the revenue split from geothermal, 50 percent went to the state in which the leases and the activity was occurring; 50 percent went to the federal Treasury, the general Treasury.

The Energy Policy Act changed that; it gave 25 percent to the counties in which the leases occur and the activity occurs as kind of an incentive to the counties to kind of play ball; that was one thought. The other was to offset impacts from the development in the areas, you know, energy activities, that boom-and-bust cycle and impact to the communities, et cetera.

And then another 25 percent came to the Department of Interior for managing the geothermal program and implementing the Energy Policy Act, the leasing program. And that sunsets at the end of fiscal year '10. So we have a pretty good little nest egg. It's not subject to appropriations and it's not subject to fiscal year limitations. So we can carry it on.

And my biggest problem is trying to spend the money. There are a lot of people that want it, but they can't get it from the management and stuff like that. So anyways – oops, wrong key.

Statistics: This is just a breakdown of geothermal leases at the end of fiscal year '08 for the different states. As you can see, Nevada is the OPEC for leases, followed by California, all

the way down to Arizona, which has one lease. And we expect to have some leases in Colorado and we have another lease nomination in Arizona and some of the other states.

California is the largest producer because of the geysers in the Imperial Valley, but Nevada has the most power plants and most operations going on. And, as you can see, about four-tenths of a percent of the total U.S. electrical supply comes from geothermal. It's about the same amount as from solar. Wind I understand is up to about 1.8 percent.

But, as has been mentioned by Ed and others, geothermal is base load; it's on 24/7, high capacity.

And, getting back to the USGS undiscovered resource assessment, this was the map that they presented and will be on the report when it comes out. That's in one of their flyers that's available online.

The warmer colors, if you look up in the northwest quarter of Wyoming. You can see that real red area; that's Yellowstone, which, of course, is off limits – as are all national park units to geothermal exploration development.

As a matter of fact, the park service can't even use the resources because they may impact the resources themselves within Yellowstone and others. And you'll notice there are a lot of black dots in there and those are some of the data points that were used in the study itself. And if you look at it, the big areas, Northwest Nevada and the Basin and Range Province where you've got crustal thinning and tectonic activity taking place.

Ed mentioned that we had also done a programmatic EIS. It wasn't required in the Energy Policy Act, but we did a quick inventory of our land-management plans and discovered that there are resources out there that may be of interest for future leasing and the quickest way for us to be able to lease lands when requested is the basis for the programmatic EIS.

BLM operates under two major statutes. One is the National Environmental Policy Act and the other is the Federal Land Policy and Management Act of 1976. BLM, through the process, combines them into a single document for land-use planning.

The land-use planning process is for allocation of the resources to decide what lands are open, what lands are closed to leasing – and also, if they are open, what special stipulations are required. And if they're closed to leasing – and these are typically wilderness study areas, wilderness areas, outstanding natural areas, certain riparian areas, et cetera.

So we teamed up with the Forest Service and, in the course of 18 months, which is a pretty record time, completed a programmatic EICS for the 11 western states and Alaska. The area outlined by red is the area that has high and moderate potential for electrical generation.

We worked collaboratively with the state agencies, the Department of Energy, the U.S. Geological Survey as well as industry to outline this area. And it does recognize the fact that this is high and moderate; there are other areas outside of the project area there that have geothermal

resources, temperature resources, that can be utilized and there is a special provision for direct-use leasing.

As you can see, 77 percent of BLM and the Forest Service managed lands are available for leasing. The black areas are areas that are closed to leasing. The yellow are the BLM public domain lands that we manage. And the green areas are the Forest Service lands.

This is a little – this is a simple version of our planning process, everything from free planning all the way down to implementation and management – excuse me, it's been a long day – and implementation and manage adaptively the resources on the federal lands. And BLM being a model (for use ?) agency is always balancing different demands on the land, everything from HOV – I'm sorry, HOV, off-road vehicle, management areas, the wilderness areas, the oil and gas, other mining operations, extractive recreation, et cetera.

So this is a long, drawn-out process and can take years depending on the conflicts and interests within individual areas. This is not the easy – (laughter). These are all of the steps that it takes to get a geothermal lease out, everything from conducting the lease sale, going through the field offices for their piece of the process and all the way down through the lease bid sale – and then finally issuing the lease.

So it's not a simple process and there are a lot of road blocks along the way: special-interest groups. Geothermal, fortunately, has been flying under the radar scope of the environmental groups in particular like it because very low water loss within the process, no CO_2 emissions unless it's a steam operation.

So, so far, we've been doing pretty good. The programmatic EIS was not controversial, which is one of the reasons we got it out on time.

NEPS compliance – and this is everything from the land use plan on the top, the foundation of how we manage the lands; all the way through leasing. Now, if the plans are in place and there's a nomination for leasing and we do the site-specific analysis, if there's nothing controversial out there, we'll do a determination of NEPA adequacy. This is the lowest level of NEPA – and then issue the lease. We sometimes have to do an environmental assessment for leasing.

And then, after the leasing, we go through a whole process of use of authorizations from expiration and what's going to be everything from temperature gradient wells and seismic and various other geologic work all the way to drilling test wells into the reservoirs. And then all the way down through the process of eventually, if there's a commercial project there, of doing site licenses, construction permits and commercial licensing.

Since 2007, we've published the final revised regulations on May 2nd of 2007. They became effective June 1st of 2007, 30 days later. And later that months, in July, June 20th we held our first competitive lease sale in Salt Lake City and had parcels there from, I believe, Idaho and Utah. We had a second sale in August for parcels from California and Nevada.

But, anyways, through 2009, we sold 150 leases; they all sold. Some of the bids were over $14,000 an acre down to a low of $2 an acre. The total acres are over 440,000 acres, which is a little more than half of all of the acres that are out there.

So most of the leases out there are new; a lot of them have a lot of prospect; they are being worked on, for the most part. And we brought in $63 million. We've having another sale tomorrow in Reno with parcels from California, Nevada and one parcel from Utah, unless that's been pulled. So we expect pretty heavy bidding on it. I guess we'll see what comes out of the lease sale tomorrow. So far, we haven't had any protest, substantial protest, on leasing at all.

So with that, that's pretty much BLM's – I could probably talk for hours. And I'm often accused of not being able to come to conclusion. With that, I'll turn it back over to Ed. (Applause.)

MR. WALL: Thank you, Kermit. Next, I'd like to turn to Jeremiah Baumann. And he's on Senator Merkley's staff, and agreed that even though the senator could not stay, that he would be glad to, and help discuss what goes into fashioning energy legislation.

JEREMIAH BAUMANN: I was told that the senator's remarks stand, and to participate in discussion, if that works.

MR. WALL: Okay. I think, then, we're ready to start the discussion part of the session. In the meantime, I'd like to thank two folks from Department of Energy – Nicole Reed and Greg Stillman, both of whom played a major role in helping get the panel together. Greg's over here and Nicole's in the back, if you could wave. (Applause.)

I think we have two microphones set up: one right over here in front and one over there to that side. And I invite folks to come over to the mike and address questions to the panel.

Q: My name is Mark Lively; I'm an engineer out in Gaithersburg, Maryland. A big point was made that geothermal is 24/7 in the base load. A couple months ago, Chairman Wellinghoff is reported to have said that he didn't think that we were going to build new nuclear plants, new coal plants, primarily because we didn't need 24/7 power plants, but rather that we were going to need more peaking power plants. At least that's the way I interpreted what he had to say.

How are we going to be able to handle this 24/7 generation given the increased variability that we have with the other renewable resources? How are the engineers going to handle that variability and keep the system going?

MR. WELLINGHOFF: Thank you. First of all, I didn't say what you said I said.

Q: As I said, it was reported. I'm not sure –

MR. WELLINGHOFF: I understand and I'm sure we all understand how, sometimes, things can get twisted as far as what you've said. What I said is we may not need to build any

more coal or nuclear facilities. And the reason we may not need to do that is because under a plausible scenario, enough renewable resources and energy efficiency and other distributor resources could be brought on to provide our needs across the board, which would include geothermal – and I didn't exclude that at all – as one of our potential resources that could run during all periods that we needed energy.

But my point was that there are other resources that are variable, like wind and solar, that, in fact, we can manage and levelize their loads over time – or their resources over time – by also managing and levelizing loads. And we can do that now, and we are increasingly able to do that. We're increasingly able to do that utilizing demand response and other techniques to control loads. We can control anything from a water heater to a refrigerator to an air conditioner to all kinds of other loads, and do so on a dispatchable basis, using digital technology and using that in a way that ultimately the transmission operator can integrate those variable loads to effectively utilize them when necessary.

So that's what I said. I didn't say we needed more peaking; I didn't say we needed less base load. But what I said was that we, in fact, can integrate in variable resources like wind, which we have potentially over seven to 800 gigawatts in this country that could be developed, or actually more. Secretary of Interior Salazar has indicated that he believes there's 800 gigawatts just off the Atlantic Coast. And there's a number of people who've estimated 700 gigawatts in the Midwest – and another three to 400 gigawatts in the western areas of Montana, Wyoming and New Mexico. So there's substantial wind resources; there's substantial solar resources, which would include centralized solar thermal systems in the Southwest, potentially, and solar photovoltaics which could be localized and distributed on homes and businesses.

You combine all of that with the geothermal that we've seen here today, the energy efficiency that I believe you have a 30- to 50-percent potential to reduce loads through energy efficiency, and you combine that with, then, the main loads, using them in a manner than you, in fact, can control those loads in a demand response way and ultimately, I think the whole combined total system can be done where we may not need any more nuclear or coal plants. That's what I said.

Q: Which is about what I understand. I'm sorry that I misstated it. My concern, though, is that the increased variability is being problematic for the engineers to control the system. With the restructuring of the electric industry, there has been a dramatic decline in the amount of load management. It's essentially dead in Texas except for the city of Austin. It used to be that the major invester-owned utilities in Texas had huge loan-management programs. But the restructuring caused them to become uneconomical and uncontrollable. And I'm just concerned that getting the engineering well enough so that we can control the ups and downs well enough.

MR. WELLINGHOFF: And actually, that's not correct – in this sense: In the RTOs, in the ISOs – the regional transmission organizations and independent system operators – FERC has encouraged the bidding of demand response into those markets. And by encouraging that, for example, PJM, the mid-Atlantic RTO, just held a capacity auction for new forward capacity in the PJM RTO within the last three to four months. In that capacity auction, they got almost 10,000 megawatts of demand-response bid into that auction.

Q: That's good. That's very encouraging.

MR. WELLINGHOFF: Not only is that good; five years ago, if I would have said, people would have called me nuts – (chuckles) – to think that that was even possible.

So almost 10,000 megawatts of demand-response bid in, over 5,000 megawatts cleared the auction. So that's a huge amount of demand-response showing that, in fact, if we create the markets for it – and the markets are going to be created and increased because we will need more of it to integrate in the variable resources – I agree with you fully there.

But I think we can do that by creating those markets and allowing entrepreneurs and aggregators to come in and assist with augmenting this way to ultimately smooth out our variable resources. It can physically be done from an engineering standpoint.

Q: Good. Thank you.

Q: My name is Eric Maltzer. I work with the Truman National Security Project. And I just have one simple question for two of you.

One of you put up a presentation earlier showing the immense potential of geothermal in Texas. And then you just spoke of 700 to 800 gigawatts of wind power off the Atlantic Coast. I remember being taught in graduate school about all of the potential – the hundreds of gigawatts – out there. What's the problem? Why do we have so few megawatts? And what can you do to speed it up?

MR. WELLINGHOFF: (Inaudible, off mike.) Ed speeded up the DOE. (Laughter.)

MR. WALL: I think it's a combination of improved technology. And we're seeking, through the R&D effort, to advance the technology. And then it's making – as Kermit and the BLM were doing – making more of the potential areas available for exploration to give the opportunity to put some of these ideas into practice and develop some areas that show potential.

Q: What do you think are the market barriers? Is there capital out there for these types of projects? Are there investors interested? And, what's the total fraction, you think, of cost-effective resource that could be developed as a fraction of the total energy use?

MR. SPIEGEL: I'm going to pause you for one sort of administrative thing. We try to introduce ourselves.

Q: Steven Domm (sp), in the energy-efficiency sector.

MR. WALL: In terms of the potential resource that's out there, certainly, we look to the USGS estimates. We also look to the assessment studies, such as the MIT study performed, looking at 100,000 megawatts potentially on line by 2050. Actually, looking at the assessment

and the analysis that was done, it was actually, we feel, a conservative estimate. And certainly, if you look at the USGS, their estimate of potential for EGS is much larger.

MR. SABIN: I'd actually like to add something to this conversation. As several of us were talking about this earlier, and perhaps it's obvious to most of you in the room, but unlike, say, solar or wind, it's very, very difficult to estimate the true potential resource – geothermal resource – of any one site. You actually have to accept a lot of risk in order to understand what's there. And the risk is in the form of drilling a well, a production-sized well, which may cost between five and $10 million.

So if a geologist went out like we do to an area, and gave a swag – and you saw one or two swags on the film clip that we presented – we think there's 15 to 30 megawatts of potential there. You don't really know what the potential there is until you've actually drilled production wells and tied them into your system.

The Coso Geothermal Field is a 270 megawatt geothermal field. The U.S. Geological Survey in the early '80s, went on record as saying there's no more than 10 megawatts there. And they are then, and still now, the premier earth science institution, perhaps, in the world. Well, they were wrong.

It wasn't until they started drilling at Coso that they found out that – well, it looks like it's 30 megawatts – well, it looks like it's 50 megawatts – well now it's 100 megawatts. And of course, ultimately, it was 270 megawatts. And the boundaries, the limits of Coso, are constrained by the actual land position and by the availability of water. So it's important to understand that when you're making estimates of geothermal potential.

The second thing that I think is very important to understand is the spectrum that we're describing today – the spectrum of what I'll call geothermal. At one end of the spectrum is so-called conventional hydrogeothermal. At the other end of the spectrum is EGS. And there's a chasm between the two.

However the research that the Department of Energy, Google and many other institutions are undertaking right now is going to work quickly to bridge that chasm. But when you see data saying that there's 100,000 megawatts of potential, you have to understand that it's probably describing the other end of the spectrum.

Certainly when the U.S. Geological Survey – and I don't work for the USGS – and I'm sure they won't like me there anymore. But when they describe undiscovered resources, that's even beyond that end of the spectrum. But anyway, you have to understand that distinction.

However, the value – the risk is worth the reward because once you do find a geothermal resource, once you do plug into it, it does have that capacity. At Coso, it's greater than 98 percent. So it just churns. It's 24 by seven. And it's a much more valuable resource if and when you find it.

Many of us at my end of the field seem to think that there's a lot of blind geothermal potential. And we're actively looking for it, but our focus is at the end of the spectrum with the conventional, hydrothermal, geothermal.

MR. WITHERBEE: In terms of why it hasn't been developed, one of the main reasons is commodity prices. Worldwide, the greater majority of geothermal powered generation is from the type of volcanic environments that are in the Cascade, Coastal ranges of Oregon and Washington. But yet there's no geothermal resource development there, and there's been precious little interest over the last 20 or 30 years. The question is, why is that? Competing with hydropower. It just wasn't an economically viable resource to go after.

Second is the structuring of bringing a geothermal power plant for electrical generation on line. One, these companies, individuals, the geothermal industry itself is pretty – most of the companies are fairly small. And to acquire the leases, whether they're federal or private mineral leases, and then explore for and delineate the target where you want to drill your first wells, you need at least two or three full diameter wells into a reservoir to test them. That's anywhere from three to $15 million. And financial institutions don't typically, and haven't in the past, lent money for those type of high-risk ventures. So equity investors would fund these operations.

And when you get to the point where you've got a commercial project and it's been tested, then you can get a power of purchase agreement, and then you can go and get financing. And recently, Ormat has a canned 20-megawatt capacity plant taking four to five years to develop, if everything works out properly, for $70 million.

And so it's not like drilling in an oil and gas well, where you've got access; you've also got infrastructure, you've got transmission lines and those types of issues – and right-of-ways to deal with, too.

Q: I'm Jed Shilling with the Millennium Institute and I have two questions. First, this has been a very interesting presentation and I've learned a lot. Among the other renewable energy, there's been a concern that where it's located is distant from the grid. So there's a real problem of hooking the wind power or other solar power to the grid. To what extent does that affect the geothermal?

And the second question: Andrew had mentioned links with photovoltaics in some of these areas. I would think that solar collection, solar power would be better because you've got large areas of open land with a lot of sun. And the fact that the solar collection uses a hot liquid as well might complement the geothermal. So that might be a better link than just laying out photovoltaics.

MR. SABIN: Well, in answer – to respond to your second point – that's absolutely true. However one of the downsides to developing geothermal in the Western U.S. is the lack of fluid. In fact, that's the downside of most geothermal. And at Coso, they did initially do an analysis of concentrating solar, which requires a working fluid. But the economics didn't work. So the alternative is concentrating photovoltaic, primarily because they're fluid-poor. And I can't remember your first question. Oh –

MR. WELLINGHOFF: On the issue of transmission, I can speak, for example, from experience with respect to Nevada. There's, as you saw on the map, vast geothermal potential in northern Nevada, but, yet, there's very little transmission to get it out. So it's been highly constrained. And geothermal is a location-constrained resource in that you have to develop it where you find the resource. So to the extent that there isn't that much transmission throughout the West – and most of the geothermal is located in the West – it is a large issue, just like with wind or solar.

Q: I'm Joe Rauscher with EPA. And you gentlemen have anticipated my question as far as transmission line costs. We've been told that it costs about a million dollars a kilometer to build transmission lines. Is that accurate?

MR. WELLINGHOFF: Well, it can cost as much as 10 million (dollars) a mile in the East. In the West, it is closer to your million-dollar-a-mile number, especially throughout the desert areas where it's relatively easy to build.

Q: Are there any studies as far as levels of geothermal production and then the transmission lines to get it to the grid? Is there any material on that cost estimating?

MR. WELLINGHOFF: The Western Governors' Association is doing a renewable resource assessment throughout the United States. And that assessment, I know, are looking not only at wind and solar, but also are looking at geothermal. And so what they're attempting to do is to identify resource areas – their location – and then from those areas, identify transmission paths and potentially associate costs with that as well.

ANDREW SABIN: And a company called Geothermics did an analysis of existing transmission lines a few years ago, and that's available online.

MR. WITHERBEE: And the Bureau of Land Management recently – I think a year or so ago, in cooperation with DOE and other agencies – completed a programmatic EIS for transmission corridors for renewable energy. The Bureau of Land Management and DOE – it's a programmatic EIS on transmission corridors. Probably do a Google search or go to BLM and hunt it up under "energy."

MR. SIEGEL: Adam Siegel, Energy Consensus. While I've seen some of these numbers, I thought I'd ask some questions to get you all to put some basic type of information so there's a baseline for people to talk about.

Sort of three questions all related – if somebody were to say, I'm going to build a plant but not knowing where, from exploration to, well, getting permits to be able to explore, to explore, to getting investing, to putting in a plan – how many years, about how many dollars per megawatt are we talking about? It's obviously not overnight with all the complexities.

Secondly, related to that, is about where geothermal is in terms of delivered cost for electricity across the whole system and where, in terms of reasonable, because of all the

wonderful stuff Ed is getting money and resources to be able to do right now – but where can we see those costs being driven down in the next five to 10 years?

MR. WITHERBEE: I guess I could speak to the cost of deliverability of electrons to the grid. Geothermal runs around five, six, 7 cents a kilowatt-hour. I've seen solar, voltaic up around 30 or 40; concentrating a little bit cheaper; wind down around eight or 10. Geothermal sort of competes with hydropower at present. So it's very competitive. What were the other –

MR. SIEGEL: The time and what might change that time? (Inaudible, off mike) – but from start, conception – here's an area to explore – and actually being able to do something?

MR. WITHERBEE: Yeah, it varies from area to area depending on the resource conflicts in that area. And getting away from the not-in-my-backyard concept, or protest for one thing or another. From start to finish, an individual or a company nominates lands for leasing, they've already done some preliminary work. And that might take up to – maybe up to a year to get that lease up for sale. It has to go through a NEPA process – well it has to go through an adjudication process, a NEPA process before it can be put up for sale.

And then it's also posted for 45 days and there's a protest period within that period. So once the lease is issued, the company is going to do additional exploration on that leasehold, which can be everything from geological, mapping, sampling – hydrogeochemical sampling – to drilling the temperature gradient wells, seismic exploration – all those activities take permits – notices of intent – and once you've narrowed down on everything and you want to drill a well, then geothermal well-drilling is a lot more complex than oil and gas drilling.

There's a limited number of companies out there that have the capability and the expertise of drilling those wells. An oil and gas well starts out with maybe a 16-inch diameter to set the casing, but a geothermal well starts out around a 27-, 28-inch diameter. That's a big hole. And when you get down to the bottom at five, six, 7,000 feet, you want to have eight or nine inches of well-bore down there, because the larger the volume of the hole, the greater capacity you can carry the heat up in the water.

And you also need a good plumbing system down there with water to carry the heat up to recycle it. So that process – we're just talking federal now – you've got permitting of three wells – that can take another year – up to a year depending on the conflicts. One of the issues that we really have that BLM has been working is the sage grouse issue. Now, sage grouse is not an endangered species, but it's where BLM and the Forest Service and other agencies are managing it as if it were a T&E species to avoid having it listed by the Fish and Wildlife Service.

And if any of you have spent much time in the Western U.S., there's an awful lot of sagebrush out there and a lot of sage grouse habitat and leks. And that has something to do with half-a-mile radius around those leks – in some places, two miles around those leks. And if you overlaid all those, they get listed – you're not going to have wind energy and you're not going to have solar and you're not going to have geothermal in a lot of areas. So to get back to your question, you're at around seven, eight, nine, 10 years before you can even get a power-of-

purchase agreement – anywhere from three to seven, depending on some areas already had wells that had been drilled and had been capped and stuff.

And then you've got to go through a whole permit process of getting the site licensed, a utilization permit, a construction permit, and then once you've got it constructed, then a commercial use permit so you can start selling the electricity to your end-users. So it's a long, drawn-out process because the geothermal developer is working from start to finish – it's all on their own; you know, they're not selling the gas to a third party, so to speak, although that may be changing with how the Energy Policy Act changed how we lease. And the geothermal companies now, lessees, are going to have to start working cooperatively in many areas because we now have multiple lessees within the same areas that are being explored for. Did that answer all the questions?

MR. SIEGEL: More or less. (Laughter.)

MR. WALL: I think it's worth noting, though, that with the advent of the binary systems that are modular, skid-mounted that some of the lead time in development can be reduced in actually putting the plant online versus the conventional system, where you have to actually order the turbines and construct the facility.

Q: Brian Anderson (sp), West Virginia University. I was a panel member of the MIT report as well. And now I have one quick comment just to reinforce one of Ed's earlier comments that the assessment that we did in the MIT report, where 100 gigawatts was a number that resulted out of our assessment, we did make quite a few very conservative assumptions within that. We really consciously chose to err on the side of conservatism, and so those – the 100,000 gigawatts number is – well, is on the conservative end and is limited, specifically, by economic constraints.

So as part of the MIT report, what we really did was analyze it in terms of even conservative growth in the cost of fossil base-load power. And so that 100,000 gigawatts is an economically recoverable fraction, not a technically recoverable fraction. And then I do actually have a question, not just a comment. It is that one of the earlier – well, we've been discussing a lot of the barriers to implementation – geothermal – and it was even brought up, what are some of the barriers to wind.

And one thing about renewable energies, particularly wind and geothermal, is that they're very capital-intensive at the very beginning of the project, and then the payoff is much slower than, say, a coal mine or an oil and gas well, where the payoff comes much faster. And so the risk involved in geothermal development – the risk to investors is much higher in the beginning because it's so capital intensive. But then the fuel is basically free. So the question is, what is being done specifically to try to lower that activation barrier to make the risk lower for investors so that we can speed up the geothermal development and bring us down the learning curve?

MR. SABIN: Well, one could argue that the Department of Defense is doing that through my office, because what we do – and Kermit misspoke when he said federal lands; he meant BLM lands.

MR. WITHERBEE: Yeah, I'm sorry.

MR. SABIN: Because the federal lands that we oversee are in a unique situation, and in fact, I think the uniqueness of that situation is probably going to come to a boil here, as you should know, Chris, and Captain Romauvick (ph) as well. We removed the risk to develop potentially by doing a certain amount of exploration on our own. And when we get to the point where we think we have found a resource, we put an RFP out on the streets to develop it.

And one of the things we're trying to do is compressing that time by actually – we're experimenting with this at a large cost – doing NEPA work in parallel to our exploration, making the huge assumption that we think there's a resource there. So we've already invested several hundred thousand dollars doing a programmatic EIS on one of our areas while we're doing exploration to somehow compress the time.

But if and when we get to the point where we think we have found a resource – and again, you don't really know until you drill those production holes and turn on the lights and the lights come on – the risk is still there. But that's part of what we're doing and part of the reason we're expanding the profile of our office is so that developers know this. And they are beginning to kind of follow us around.

A lot of the areas that we're looking at are areas that have been understood to have potential geothermal for several decades, ever since the oil and gas industry pin-cushioned the Western United States with temperature-gradient holes in the late '70s or early '80s. There really hasn't been a systematic approach to exploration since then, with the exception of the Department of Energy's efforts over the years and a couple of universities in the Navy, that's it. That's the only thing that's been done in geothermal exploration.

MR. WITHERBEE: Right, and as part of the – by committing $100 million of our stimulus funding toward exploration, including drilling of oil to validate the innovative technologies, we're hoping to put some more money behind this effort. And it is in recognition that the up-front cost is high and the risk is high along with it. I think in the interests of time, we probably ought to move along.

Q: You just touched on my question; you said the risk is high. I don't really know – oh, I'm Greg Davis. Until you dig your hole – oh, the Institute for Defense Analyses. So I dig my hole for $5 million and I find out if there's power down there. If I'm at China Lake, I find out there's a lot of power down there. Is there data on how risky this really is – how likely – when you look at the projection that you made before you dug the hole until you dug the hole and you turned it on and the lights came on and how many lights to get an idea of how risky this is and how likely you are to really strike it rich?

MR. WITHERBEE: The numbers we see are about one in five hit in conventional hydrothermal exploration. We're seeking to improve those odds by promoting the development of more advanced exploration technologies prior to drilling.

MR. SABIN: And we also feel the same way – in addition to doing the exploration that we're doing, we – and I'm speaking for the Navy; I'm probably speaking out of school – but we feel that we also have the obligation to take it a step further. So we actually have spent a lot of money and a lot of effort over the years attempting to develop better exploration techniques – so kind of identifying the envelope and pushing it and seeing if this works, if that works – various applications of geophysics, remote sensing, et cetera. And I think it has a lot of potential but it's – well, the proof is in the pudding, really.

Q: Carinia Cusick, and I am a renewable energy consultant. This question is for Commissioner Wellinghoff. You mentioned that there's about 30 megawatts of coproduced hot water in the Southeast alone. That would seem to be kind of low-hanging fruit, so obviously there must be some barriers that have been standing in the way that have been keeping it from being attractive. Could you highlight some of those a little bit as to what have been some of the challenges as to why there hasn't been a lot of interest in this coproduced hot water?

MR. WELLINGHOFF: And the simple answer is, I have no idea. (Laughter.) It does seem to be extremely low-hanging fruit, and actually, as I understand it – let's see, I'm not sure which number you were quoting – I think I said 30 gigawatts of conventional in the West. As far as the coproduced hot water, I know that there's an estimate, I think that's part of the MIT study, of 5,000 megawatts of potential in Texas alone. Yeah, I guess that's right – I did say 30 – you're right, because I added up all those figures in the one table, so it is about 30 gigawatts. And it seems like it's extremely low-hanging fruit.

The hot water is being produced, it's being thrown away; it's, in essence, energy that's not being used. So I really don't know why it hasn't been developed, and I assume in part it is part of the earlier answer we got here, that the competitive prices have been such that it hasn't been economical to develop it. But it certainly should be economical today, given the current prices of energy. And in Texas, I think the current average price in Texas this week was like $90 per megawatt-hour. So it should be extremely economical to develop. Beyond that, there may be other barriers that I'm not aware of.

MR. WALL: I think the recent advent of a variety of binary systems in terms of size that can be matched to the resource will prove a way forward in this. We're trying to – we're working with the fossil energy office and Rocky Mountain Oilfield Test Center in the first demonstration of generating electricity from coproduce fluids at an oil and gas field.

We're seeking to bring another one online in Jay (ph) and we've committed $50 million of the stimulus package toward demonstrating it in other geologic environments around the country. So we're hoping to serve as a catalyst because we agree with Commissioner Wellinghoff that it's too good to just throw it away. I think this is going to have to be the last question, I've been told, regrettably. I think we had a good discussion here. But please go on.

Q: I'll be brief, gentlemen. My name is Brenda Cockerill (sp). I'm here – actually, employed by the United States Coast Guard, here as a private citizen. She touched on my topic, actually – the coproduced or the byproduct hot water. I wonder if anyone had thought about putting some sort of condition in the leasing agreement that would allow the government to take

advantage of that hot water in these oil and gas leasing agreements that the Bureau of Land Management controls?

MR. WITHERBEE: Yeah, that's – when the Energy Policy Act of 2005 was written, there was a provision in there where mining claimants who had an approved plan of operation – mining operation – going on could acquire a geothermal lease noncompetitively. And one of the reasons was from conflicting resource uses – having top filing and stuff like that – and the other was for the benefits of – say, in Nevada, that the mining company that's actively mining gold out there could utilize the warm waters – the hot waters – for heat-leeching, for speeding up the process.

Unfortunately, the Energy Policy Act did not have a similar provision for oil and gas lessees. And hopefully – last I knew, it was still on the legislative agenda for Senate Energy was legislation that would give a similar provision to oil and gas lessees for federal lessees. But as it stands now, for federal oil and gas lessees, they would have to acquire a geothermal permit, or I should say a geothermal lease, to utilize the heat.

And they'd either have to do it – if they wanted to generate electricity, they would have to have a competitive lease issued; if they wanted to use the electricity for their own purposes, for their operations, they could do it with a direct-use lease. And direct-use lease basically is without sale of the resource or electricity. And that includes net metering, because net metering is a sale of the electricity and resources. Hopefully they'll have that provision. But so far, most oil and gas companies either purchase electricity off the grid or, in remote locations, use leased gas for operating their pump shafts and facilities.

Q: Thank you.

MR. WALL: Well, on behalf of all of us, thank you very much for participating in the conversation. I believe all the gentlemen afterwards should, hopefully, have a few minutes afterwards to continue the conversation. Nora Maccoby, who, amongst her many hats, is the author of the review of the first 31 Energy Conversations has a few closing remarks.

NORA MACCOBY: Yeah, on behalf of the Energy Conversation and the Cebrowski Institute, the Naval Postgraduate School, I'd like to thank everybody for coming. The leadership that we're seeing in the government, and especially in the Defense Department, is going to be the critical difference between civilization and anarchy, because without energy, we don't have a civilization. I'd especially like to thank the Navy for its leadership and foresight in sponsoring the Energy Conversation, and understanding that it's not just about the technologies, but it's about the politics.

And we've really got to ramp it up, and I believe we have a leader now, in the White House, who feels this way. So that we can stand up and be the leaders that we need now, all of us, as we march forward and find solutions to the problems and meet the challenges. So thank you all. Our next conversation is on super-batteries and energy storage in September so I hope you all join us. Thank you.

(Applause.)

(END)