Department of Energy – Quadrennial Technology Review
Clean Electricity Workshop
Wednesday, June 8, 2011
University of Colorado, Boulder
University Memorial Center - Aspen Room
Boulder, CO

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XXX: For those of us actually trying to write the first draft of this thing, is to understand the principles whereby the DOE should form up its portfolio in clean energy specifically, but more broadly in technology. In know that we were trying to give you some budget data so that you could chew on that, I don't know if we're going to be able to do that or not. So, maybe we should defer that for a little while so we can actually, yup. To start by getting your sense, we've got six boxes out of line for six strategies, and I can tell you by far we're putting the most money into clean electricity box, absent weatherization lines, it's over a 5 billion dollar chunk. But in the big programs going forward, clean electricity in the form of CCS, Demo, Sunshot, wind, some geothermal use the biggest chunk of money. And let's talk about your sense of how the portfolio should be balanced, maybe across the six boxes, and go into your sense of balancing, and go into your sense of where it gets.

XXX: I don't think that the framing documents so far fully addresses the new paradigm of gas. I think we're in a new reality, and I thinik that if we look through the portfolio, we have to ask what is the motivation? I mean these are the problems, gas is domestic, it's good for jobs, it meets the criteria that the president has set out for clean energy goal. And it meets the economic, it's easy to site and permit, and it's the easiest to get financing for. And that seems likely to be the case for the forseeable future. I don't think we can dance around that, I think we have to address that head-on.

XXX: It depends on, so the President's goal of clean energy 80 percent by 2035, gas gets a 0.5 multiplier, that means that if everything else was zero emission, people push gas from it's 24 percent now to 40 percent.

XXX: Without CCS.

XXX: Without CCS.

XXX: Speaking of that, when you say without CCS, when we speak of gas in the context of clean electricity, should you not assume CCS? And say, of course shouldn't the goal be gas with CCS? Just saying, unless we want to define clean as 50 percent clean.

XXX: To meet climate stabilization goals we need CCS on gas post-2030.

XXX: I just want to make two points, one of which is how confident are we on gas? Because if you look at the EIA projections and the 2011, they project a 9 quad increase by 2035, a three-fold increase, but only a 3 quad increase in total gas, and that is because conventional sharp decline is projected in conventional gas, and I think that really needs to be

addressed number one. And then secondly, if you're going to do CCS for gas, it requires with power plants, it requires a very high carbon price to motivate it and one of the very interesting opportunities for getting around that high carbon price is to co-produce electricity and widgets in the same plant because then you consume gas right up front, and the catcher cost is a lot less than it is for a standalone plant.

XXX: So I would say that there's risk in assuming that gas will remain cheap going forward, and therefore it's just a matter of risk mitigation, it is wise to develop and try to deploy alternative technologies. I'm actually, I think that the risk you will begin to discover as you try to deploy more and more of these wells is that you'll see increasing resistance as people become more knowledgeable about what the actual impacts may be.

XXX: The other possibility is that they really like the economic activity.

XXX: Exactly, we don't know how that's going to play out. But the other part is that clearly this means you have a much tougher cost target for meeting clean technologies than me, and I would say that the main message is that right now you need to be thinking about much more than just cost reduction of these technologies than you did maybe a few years ago, and that means that you're looking at higher-risk, somewhat longer-term options because you can't' rely on just the conventional evolution of these technologies to get the cost points that you're looking for, even for nuclear. I mean you would have to see for example the Westinghouse AP1000 almost certainly would have to do major redesign, new design certification, and make substantive changes such as power uprate and other things, they could potentially hit a 50 percent cost reduction target if Westinghouse really worked at it, and really built off the experience of building the first few. And SMRs it's a challenging—

XXX: Can I get back to the higher-level goal? Our goal is not to deploy technology, our goal is to reduce emissions and provide secure, economical sources. So let's stick with the gas for a moment, we've been talking about the price of gas. What determines the price of gas, and what can you say about uncertainties? Should the government intervene if the price gets too high? You know the government has other levers they can use to keep the price down, if it chose to do that. So, that's you know kind of one level of question.

The next level of question is if the gas is going to be too expensive, what are the sort of technologies that I should have ready, not necessarily pushed, but ready because I say push, they will take their own evolution, and again if the goal is not to deploy technology but to reduce emissions, I should be technology agnostic. Or should I, or are there other considerations?

XXX: What I would think of would be the, for example, for the nuclear if you want to have it as a technology that could prevail over or mitigate against potential volatility that might emerge in natural gas, one of the things that would be nice to do would be to bring down the construction time required for these facilities. And therefore, there I think there's many reasons to be to be focusing more effort into uh advanced construction technologies such as steel-concrete composite construction, where you can do modular, fabrication in modules in factories, preassembly of the—what's being demonstrated in the AP1000 with the goal of trying to compress this time so that you can make a decision and deploy capacity more rapidly. I think that might be generic for all of these technologies and we see important impediments currently related to regulation where if you could have a more predictable and rapid approach to permitting the different various technologies, that could be helpful, and we would be more responsive. So, those would be things that you may want to be focusing on trying to improve uh in this interim period given the reality of cheap gas.

XXX: Let me ask the question well, so you need to get a timescale of when the technologies will be available and some ways we need to have more capacity, more focus on that. Nobody is going to say thank you for delivering, thirty years from now. So you have more capacity from whatever technology you have in the portfolio. You are going to have more space in delivering clean affordable energy, so that map needs to kind of be a cost map. But I think the resource, because if you keep talking about the price of gas, you're going to keep confusing yourself about what's going on in the environment today, tomorrow, next year, and you're never going to have a plan that will stretch into the years. And you can't plan anything to do that doesn't address those month-to-month gas price.

XXX: So you thought about the resource, you got at least 200 years worth of gas.

XXX: So you need to put in a planned system. So we want to burn it all in the next 50 years, or do I suggest that maybe this is the right burn rate, and this is the right technologies. Can carbon capture come in here, because you have to spend more energy doing carbon capture, I mean it's, yea, you've got to build that and figure out how to keep the price affordable and just prompt technology. So it has a staged approach and it has to be the surplus and risk balance.

XXX: I think we have to, regardless of the fact that you say 200 year supply, it's an uncertainty, and I think a value included with clean and affordable should be the value of diversity, because diversity takes out uncertainty. So you wouldn't want to have all your eggs in one basket.

XXX: Utility diversity is firm on gas.

XXX: That's another thing, if you focus on long-term future and cheap gas, you need to look at hydrogen technology because converting natural gas to hydrogen makes CCS cheap, I think. It's easy to get the CO2 out when you do that. And if you can figure out how to integrate, within that of course we have sort of abandoned that as a main trajectory except for transport, but maybe one wants to go back and look at hydrogen again as a major energy carrier within the system if you're going to have a lot of natural gas around, because it could make CCS affordable.

XXX: I know, so it's good.

XXX: I'm not a real enthusiast in hydrogen, but as an intermediate, it's a very powerful feedstock for doing all the things in centralized facilities, but I spent 15 years of my life working on the hydrogen economy and in 2004, I kind of threw in the towel when I realized it wasn't going to happen in my lifetime, my children's lifetime, or my grandchildren's lifetime, and in fact I shouldn't objectify working on coal biomass and working on storage of electricity and CCS, because we have the same emissions level as we have hydrogen, and it requires big changes in the infrastructure, so I think that the changes in the infrastructure and realizing your carbon emissions and clean energy goals are—

XXX: The other thing is that hydrogen plus fossil carbon equals oil. Yes, understood, and if you're getting rid of the carbon dioxide—

XXX: I'm not enthusiast for this but pragmatically speaking, it's a pathway forward that gets at least some of the carbon back into the ground at a reasonable cost.

XXX: I just want to bring in a comment related to this natural gas thing again. Low gas prices are attracting strong investment in gas, again. So I think the question that has to be addressed is how much of this is going to be available?

XXX: So yes and no. Alright, I mean this is both the beauty and the curse of the free market. If there's more demand, the gas producers will produce more and keep the prices where the market wants the prices, so—

XXX: The other issue is that in actual policy perspective, from and energy security perspective is putting your eggs in the gas basket and the infrastructure and infrastructure protection that might not be the smartest play. I mean two main trunk lines going down in Florida carrying gas for the majority of your power generation. I mean one crazy guy with a deer rifle blows it up. And you're out, so there's some policy, energy security here as well for natural gas as generation.

XXX: It also raises the question of the value of this fuel for generation.

XXX: Okay so that's another big topic. We can switch to that now.

XXX: Are you talking about transmission in general, or is gas more fragile?

XXX: I think gas is more fragile just because of the network, I mean it's harder to go around a line that's down. Right, and it's a longer fix. I mean you're on the electric grid and you need a new transformer there, the same crazy guy with the rifle can take that out, take the spare out, and you've got to ship that over from Europe, and that's a long boat ride over. But you know that network and stuff can heal a little better if they've got a couple of large diameter gas pipelines.

XXX: I think that network is also more of a network in terms of multiple pathways, and more distributed sources.

XXX: Before we get specifically on gas—

XXX: Can I just crash the line? When we talk about gas being cheap, I go back to should we not consider the price in the context of gas with CCS. I mean for the simply for the reason being that we are still talking clean. In coal, you absolutely do consider CCS with coal, it's, they go hand-in-hand today when you think about using coal for power, you will include the full cost of CCS.

XXX: Although there were two gigawatts of installed capacity last year that certainly weren't CCS.

XXX: Well I mean, I guess not today but going forward. And I think that's a reasonable statement, I think that you could fairly say, certainly in all of North America that there will not be a coal plant built without CCS at least not for the foreseeable future, unless you are talking about maybe one that is in progress as we speak. So shouldn't we think of gas for electricity, clean electricity, shouldn't we at least from DOE's perspective, view it in that light. Whether or not that becomes a reality or not is different, that may price it too high as Bob indicated, but at least from a policy perspective, shouldn't it be considered to bear the cost of CCS?

XXX: I think that depends on your timeframe, right? I mean you could put gas in now and say okay I'm just going to retrofit when technology matures, and there comes an effective carbon price that makes it worthwhile, but right now a utility is going to put a gas combined cycle in because that's what they can get permitted.

XXX: What price do you need right now to make CCS with gas?

XXX: Okay well they would do that today with coal, when they run 30-year economics, they might put CCS in the 15th year, so at least should they not be thinking today that if I'm putting gas in, what's the likelihood—

XXX: So I'm carrying around in my head 7 dollars a ton is what I need to make CCS with coal work, is that?

XXX: It's in the ballpark, yes.

XXX: It's in the ballpark, right. And gas is more than that, right?

XXX: Well then maybe it puts more of a focus on that cost, would be—

XXX: I think gas, the dollar per megawatt hour adder is lower, because of a lower carbon footprint. The cost per ton of CO2 avoided is much higher because of course lower CO2.

XXX: The current thinking now is maybe just kind of avoid that issue, or?

XXX: We get to write the document. Your opinion or posture—

XXX: Well I think one thing to consider in this gas discussion comes back to the point that we made yesterday in the breakout, I think the distinction of where we are today and the current market realities, and I think gas is a big issue on the table, and how far we're trying to go in the future. If the idea is that well a dash to gas is sufficient to meet all of our goals, well that has some serious implications for how I think I want the portfolio. And if it's not sufficient to do everything that we're looking at, then I need to think about pricing in the mitigation part, and I think the framing document needs to get at this, that idea of saying well this is the market as I see it today, in fact now, we're going to need to be at this time point in the future, I think that would help give some clarity to this discussion of how much I have to say well I need to take these series of actions with gas, or a broader portfolio.

XXX: So again it's a question of we the DOE, how to anticipate the market, or try to move it in certain directions?

XXX: I don't think move it is the point that I would make. It's just the question of how much do I need to use? If we can develop something that's going to be satisfactory anyway, then it's easier to do than if it's not sufficient. How bold is our goal?

XXX: Our satisfaction shouldn't be measured in technologies; it should be measured in if I get to these higher-level goals. Greenhouse gases, security, reliability, so on.

XXX: Those are the same metrics that individual utilities are using. And while they're building gas right now, because economically that's their option, by far almost all of them have a portfolio mix. I don't think any of them are betting the farm on gas, but I think it's a risk management approach that drives you beyond just saying gas is the answer.

XXX: The other thing that I just happened to pull up is the EIA website is new capacity additions over the last 50 years. Overwhelmingly gas. Fallen off significantly since 2005 overall, and in recent years, about 30 percent, but again that's capacity.

XXX: There's a question there. For gas in general it talks of you know how much renewable penetration do we think we're going to get moving forward, how much intermittent resources are we going to have, and you know the question of you know gas or backing up those intermittent sources versus what we've been seeing in the last couple of years, gas being put in for baseload capacity, so.

XXX: Does gas buy you coal? Even without a carbon price?

XXX: Even now, if you look at the real downturn in demand in the past couple of years, and coal went down from 50 percent to 46, and gas went from 20 to 24, so over the last couple of years we've seen it. Carbon exacerbates that.

XXX: This structure by the way shows about 5 gigawatts total of unsequestered—

XXX: One of the big issues it the electricity demand growth is pretty slow. And so that most of the opportunity for new construction is going to be to replace retired coal capacity, and so the numbers in the EIA 2011 are quite interesting in that regard in that they project as a result of the various environmental regulations EPA is considering for coal powerplant and it's already engaged it, it's up to 73 gigawatts retired by 2035—

XXX: So that's 25 years, 73 gigawatts, that's 3 a year.

XXX: And most of that's going to come before 2020. The utility mack rule is out, they're going to need compliance by 2015.

XXX: And then the other one is that they also estimated that if there was a carbon policy put in place, carbon policy alone would retire about 135 gigawatts in the same timeframe. And so one of the big issues is what do you do with these existing sites? Because it's a lot easier to build new plants at existing sites than to get permitting for refuel sites. And so I think that that is something that really needs to be thought of very seriously and what I've been working on the last couple years is looking at strategies for repowering these old coal power plant sites with these co-production facilities that could either be coal and biomass or natural gas and biomass with CCS. And because the capture costs for these systems are so low, because you have these liquid fuels and that you can transport that CO2 very long distances to remote CO2 NOR fields and still be competitive and at the end of this long life so where you do this it doesn't have to be near the CO2, EOR opportunity. This is in sharp contrast to the power plants where the capture opportunity must be very high, and you just can't do that.

XXX: There are a whole list of issues I want to tap.

XXX: I have an alternative approach to repowering those sites as well, SMRs.

XXX: You made a critical point that used to bug me, I'd like to put it on the table and maybe put it to rest in my own mind, and that would be the carbon balance associated with using captured CO2 for EOR. I remember a discussion at Princeton back about 5 or 6 years ago, I asked well how many carbon atoms do we get out of each carbon atom we put into the ground? And the answer is 2.

XXX: How many do you get out for how many—

XXX: Out in oil for each CO2 you put in.

XXX: I'm not sure that this is the right way to look at this issue.

XXX: Well let me finish the way I'm looking at it then you can correct me. So you know, net, I dug some coal out of the ground, I've gotten the energy out of that coal, put the carbon from that coal back into the ground, but now it puts twice as much out, so net is not obviously—

XXX: That's where you draw the box.

XXX: Yeah right, so help me understand.

XXX: I'm not sure that actually this becomes truly relevant because the cost of the real market for storage in EOR, there's two different issues when we talk about EOR and many people are enthused and maybe falsely enthused that maybe there is a demand to pay for the CO2, and while those oil fields may be able to hold a certain volume of CO2, that's not necessarily the volume that they would pay for. For instance Wayburn, by 2020 or by 2025 will have taken 30 million tons of CO2 in total, and they won't pay for one more drop. 30 million tons in 20 years is not very much, they won't pay for more. There is no economic reason for them, now they may be able to hold a little bit more. So once you get to a certain point where you've saturated the desire to pay, it becomes no longer relevant to pipe your CO2 with 100 miles, you're better off putting it in your back yard in some other storage for 5 dollars a ton. So today there's a little bit too much enthusiasm behind it only because not so much from the dollar issue, but more from the regulatory issue that we can get done. I don't think, I think it ends up being a very small part of the long-term solution therefore the balance is kind of a sideline debate.

XXX: And it helps the economics. Yeah, right.

XXX: So what this does is facilitates the decarbonization of the power plant or co-production facility, but you could in principle add extra biomass into these systems to offset not just the emissions from the synthetic fuels, but from the oil as well, but you would need a much higher CO2 requirement per incremental barrel in order to do that if you use wang technology it would be difficult to reduce the emissions there, but if you use pure CO2 as Denver does in the gulf region then you could conceivably greatly reduce the emissions from the crude oil-derived products as well as the synthetic fuels.

XXX: Good.

XXX: Your perspective, I mean are you actually going to influence the market, and the demand with that, because if you're putting it in, you're offsetting oil—

XXX: It just seems to me that if your goal was to stop digging carbon out of the ground, pushing more carbon out of the ground in the form of oil is not the right direction.

XXX: Unless you look at it and say you're pushing it out locally, and that's offsetting oil that's going to be pushed out of the ground there.

XXX: But I would argue that you are increasing the supply of oil which would drop the price and, the savings are marginal.

XXX: There's another angle on this as well. These coal biomass to liquids and electricity strategies are geographically-limited opportunities. They are going to be mainly in the US and China, Russia maybe, and Australia, and most of the world is coal-poor. But there are a lot of regions of the world that are coal-poor but biomass rich, okay. And in those countries, you could pursue CCS for biomass as a very good strategy for not only producing liquid fuels, offsetting the emissions of the petroleum-derived liquid fuels that are otherwise very difficult to decarbonize and I'd convince myself that there is enough non-cropland-grown energy production from biomass worldwide that this could be very significant, but it would require CCS in many parts of the world where people aren't paying attention to CCS because these are fossil fuel-poor regions. Like some various regions in sub-Saharan Africa and Latin America and South Asia and the like.

XXX: Is there enough space around the world for CCS?

XXX: I think so. Those regions haven't really been studied, because they think they are above that for CCS. But the global interdependence assessment committee has been stressing for a number of years the critical importance of CCS for biomass in order to reduce the cost of carbon mitigation much more generally. And the problem is that the pure biomass options require very high carbon prices to be cost-effective, but the coal biomass or natural gas biomass coproduction options enable you to get in the game much earlier, and that means that countries like the US, China, and Australia can all do this, can take the lead and make it feasible to do these pure biomass and CCS options later.

XXX: Just on the sense of the areas that are not being explored, I want to come back to distributed generation. Is it FE or the EIA just put out a measure of shale gas resource around the world. I can't remember if it was IEA, it's very large, and in some cases it's where you'd want it to be. And so again the game is perhaps changing in the US, and it will be changing. Okay let's turn to distributed versus central distribution, one of the things that I did want to bring up. So how do we start that discussion ?

XXX: Our breakout group talked about them certainly not being mutually exclusive when you're making selections on research and development investments, but they certainly proposed that our goal is in question. So, where to focus your resources.

XXX: Let me try a theory. If you're just interested in the economics, never mind reliability and so on, the economies of scale will always drive you to central, or at least to bigger distributed. Whether it's solar, wind, and so on we like to put things in the same place. When you talk about SMRs it's not in your neighborhood, but it's going to be 8 ganged onto a site.

XXX: We were talking about this yesterday. We were talking that in the wind industry the large-scale is to move from the protection to wind turbines as an individual device and what the cost is. I used to install something like 20 some odd gigawatts, so that's on the order of magnitude 20, I'll say for the sake of argument 30 billion dollars of equipment that goes into the network and transmission.

XXX: I also see one of the important issues with storage that's commonly overlooked is that if you perform a foyer transform on the difference between supply and demand and try to figure out what's going to be the duty cycle on your storage, if it's daily, day to night type of stuff, charging batteries in cars, whatever it is you're doing, that's a frequent duty cycle and you're getting more out of your capital investment than if you're trying to manage weekly to monthly to yearly variability.

XXX: And there is no one storage thing, I mean it's everything from fractions of a second for frequency regulation up to the hours and days for, or going through the windless periods and so on. So there's no one thing up. I think as you get to shorter frequencies it gets easier, and the really large-scale long-term storage, we only have two options right now and I would not bet on batteries for that. Too expensive, and the energy densities are so low.

XXX: Reliability and efficiency are in conflict.

XXX: Another way to describe is that in the shorter frequencies you provide an even service, in the longer frequencies you're betting on the value of the energy that you have stored to be your business model, and electricity is cheap.

XXX: That's right, but I would think that the diurnal variations of you know spinning nuclear at night and having wind blow at night, I mean that's really where you want it.

XXX: The other thing you start is the possible electric vehicles, and you're going to have diurnal smoothing the load so that you don't have to worry about it so much. So back to the distributed versus central discussion.

XXX: I was going to pick up on the storage issue here and I'm wondering if DOE has done an exercise of comparing the relative economics of exploiting offshore wind with exploiting onshore wind plus storage plus long-distance transmission, but serving these costal markets, and using that exercise to allocate resources among these different areas. You know, and there are four areas here, and one is a national grid—

XXX: You really do want a systems way of thinking here—

XXX: And then another is the storage issue and if you're going to exploit the heartland wind for serving coastal markets, you should also consider bringing in a Canadian wind, because Canada has one tenth the population, and very comparable wind resources, and if you're going to exploit the heartland wind for the coast you ought to be considering that as well.

XXX: I would like to comment on that. A lot of it is about planning, and if you have north and south strong grid, you could even out the variability quite a lot. If you had east-west you can export and you've got a good offering set up pretty much, and so I think it's very feasible to do these things. There are people developing power right now just to see if they can basically set up a renewable box in the grid and the like and then export back to these markets.

XXX: The issue here is a very difficult problem for a national grid theme. There was a task force that that was their number one priority, and on day one, and we are no further along towards a national grid now than we were at that time. And I think, I mentioned yesterday that the one thing that was very good that DOE had done on future gen project was that they had been extremely effective in bringing about high level of public acceptance for this. It is unique on the whole planet, nobody else can do this for CCS and I felt that the US did with future gen 1. And I think DOE ought to be thinking hard about how they can use these same skills to deal with the really more difficult energy problems associated with a national grid. Because I think if we are going to get off square one with that, that has to be the first priority. It's not a technology issue; it's a public acceptability issue.

XXX: On that point, can I ask from your perspective, it appears to me that the success was driven mostly by the fact that they needed a competition for economic development. So is that really though a model that can work?

XXX: Well at the same time, DOE held a large series of meeting with various stakeholders—

XXX: They were kind of pep rallies for the project.

XXX: Well no, I think they were really very honest descriptions of the benefits and risks of this and this didn't take place in a lot of these European projects, and that's why they ran into these very serious problems. And DOE got started very early on this in the whole process.

XXX: The European climate, and look at the seasonal variability, and talk about the difference in areas where it's 10 to 20 percent nuke as baseload, staggered wind and solar, and so the seasonal variability between the wind and solar sector are very nice combination. And so you have the technology to manage the generation in a smart way and to move out the distance if you have the capability in distance just in terms of transmission, and we'll get to transmission, then start looking at the systems operations, then it becomes quite rational and you can actually easily manage the control mechanisms and manage these things in an efficient way.

XXX: A very key aspect of this future gen 1 was that DOE spent a lot of effort educating these various stakeholder groups about the strategic issues, not just the benefits to the local community, but also why are we doing this? What is the national perspective on this? And that same thing can be done with the national grid.

XXX: We need to do more of that nationally. One of the other advantages of distributed that I have heard, and this comes more from the social science side, is when it gets down to the neighborhood level or the individual rooftop or backyard or whatever, it makes all this energy business much more real to people, and hence maybe more willing to understand or easier to understand some of the bigger issues. And in fact you may not need to do this at the few kilowatt level. A couple hundred watts of solar panels and you get the same effect. Maybe a good place to take a pause in the conversation and have a look at the budget data that we passed around on the sheet. This shows how the department energy program money, and it gives us a little of office of science money mixed into this, is apportioned among the 6 strategies. The top panel shows the FY 12 budget request, which is you've seen is in the process of getting rearranged by congress. And then the bottom shows the stimulus money that was a one-shot allocation and the scale is such that the stimulus as you can see, the big circle on the lower right in the stimulus is 11 billion dollars, whereas the numbers in the upper right or in the upper panel are measured in hundreds of millions, so there's a different scale.

We could talk through, who knows the color-coding and the numbers best? XXX? Just maybe guide us through the color-coding in the upper panel a little bit, clean electricity supply most.

XXX: Right so the teal is nuclear, that's the 444, fossil's the 291, geothermal is the 23, hydro's the 39, solar is the 457, wind is 127, and what's the other, is it biomass? It is under 1, and the top left OE is the grid, the office of electricity.

XXX: And then stationary efficiency, the 394 is weatherization, and the 454 is the industry, right. And on the bottom row, vehicle efficiency is all vehicle efficiency.

XXX: It's all the alternative technology program. Electrification, the 100 is for hydrogen program, 288 is the vehicle technology program, so that would be the batteries.

XXX: It's not broken up but there are stationary hydrogen fuel cells, those are buried in the electrification, I'm looking on the bottom, it's not broken out enough.

XXX: So as you look at these numbers, two things to bear in mind. One is this is only the government funding, does not include what's going on in the private sector. And second it does not include the international scene at all, of course. But nevertheless it gives you some sense of where the DOE is putting its resources at the moment. And one of the questions that we asked for in your groups is the people that are responsible for setting these priorities is what are the rules? Why is it as it is? And everybody either just smiles or laughs when you ask that. It is what it is.

XXX: On the brighter side, in Europe they have a couple years ago the European commission went around to the industry and asked for upping their standards for investments, and I can't remember, I think it was two and a half was the ask. So there is actually a report in Europe where you can go in and see how much each individual country is doing on R and D, and I think it would be reasonable for each of the areas to ask in a little bit back to where are they in the different stages. So what should the public investment be, and what is the role of that public investment? How much are you going to match the industry? And one way of putting it in relation to the wind industry is growing like crazy if you like, but to put it that way if you have a growing industry you still need to support it, and if you don't grow with it, you're pretty much planning to close shop. Because even though it's growing like this, on an average base it's growing like 20 percent over the past 20 years. So it's something between 15 and 20, so if you don't grow with that, you're closing shop. Grow your budget or grow your opportunity, or R and D, or plan how your activity's going to be in the future in terms of R and D. You're pretty much reducing your role gradually if you don't grow that. But I think it's true for all industries—

XXX: Is that the right thing for us to do, is to reduce our role once the industry has taken off? So just again, we do essentially no fossil R and D at least in terms of extraction technologies, the argument being those guys have got plenty of cash. When will wind ever get to that point?

XXX: Well I think we're heading there at a pretty high speed, and I htikn that the point for wind is that it's transitioning into becoming a professional industry if you like, and so the role is changing from more a monitoring role, a supply of education, and maybe some technology pieces around the future repowering and furthering capability, those kinds of, and the integration piece. But I think the integration piece is not necessarily a wind issue, it just happens because we're first and the ones that makes the biggest noise in that arena right now. Solar will look at very soon and so America will be the noisy child.

XXX: Could you clarify how you currently defend the pie chart? What do you say today when someone says how did you come to that mix?

XXX: This is not a part of the department I'm involved, and I think what I would say, or I imagine Christina, Kathy would say is that this is our best judgment as to how to optimize the federal impact. But the reality if you look at what goes on inside the department is not that really, it's a mix of history, of in some cases personal enthusiasms, or the program managers or the leadership, or it is political wings. And I think that probably—

XXX: And a lot of these, oddly both in OMB and the PURPS committees, the discussion are over the deltas, not the absolute math. So charts like this are unfamiliar to both to OMB and the appropriators.

XXX: I second that, right I mean, what are we going to do to the fossil budget? In my case the last year, should that go up or down, it's not what should fossil be in relationship to what we're spending on nuclear, photovoltaic, the—

XXX: It's largely defense of prior winds, and less a display of current cuts.

XXX: So if you look at these pies, you can ask the questions of is this the right balance of grid versus clean electricity supply all in? Right, the grid, the office of electricity is relatively young, it only started in response to Eastern blackout you know 8 or 9 years ago and it's growing. So when you look at the importance and benefit of having a robust grid where we can move power around, a lot of intermittent renewables, you might advocate the grid ought to be a little bigger than it is in relation to—

XXX: Is that the most glaring inequity, or is there—

XXX: Well if you look at bang for your buck for efficiency and all the benefits you get upstream in transmission and generation inefficiencies—

XXX: Weatherization is not a particularly good way of getting to efficiency in terms of –

XXX: Right, but the government has done a horrible job of public education right, is there something that DOE could do to act as a catalyst to get people who you know make their house, put insulation in. It doesn't cost a lot of money to do that, but we've done a horrible job of government to get that. I mean we're a glutton society and we are very inefficient so—

XXX: I should probably put a bit more in the bottom line generally, probably in vehicle efficiency and electrification given the importance and urgency of the oil issue. You know and we look at the mismatch from the top and the bottom.

XXX: One thing that really strikes me in looking at the top row here is especially in the clean electricity supply category here is that I think that regarding the issue of commercial-scale demonstrations, you really have to move to off-budget strategies, and that's one of the reasons why future gen 1 failed because of the budget issue, and it shouldn't have been a budget issue from the get-go.

XXX: At the bottom, I mean that big purple, 3.4 billion, is future gen 2.

XXX: A billion dollars of that is future gen, but to Bob's point, to this 291 at the top, that's R and D, there is zero budget request for the last several years because we said we're demonstrating current technology with the stimulus fund. There is no money in the five-year budget outlook request for demonstrating the next generation of you know better technologies.

XXX: Demos are expensive, and it's hard to accommodate within these budgets.

XXX: Another question in terms of balance of course relates to how mature the technologies are and what the opportunities are. If you compare solar and wind, it doesn't look unreasonable to me in that I see substantively more long-term potential from basic and applied R and D on solar and photovoltaic perspective of major advances than you're likely to

see with wind because wind frankly you are in an evolutionary phase of trying to prove that you're not going to revolutionize our technology for wind from where it is right now. And so in terms of balance, one of the things that's missing here is some indication of what industry is doing because we need to be thinking about what our nation is doing in terms of investing and if you don't—in fact this is a major point behind PCAST is that our industry is also under-investing in this area and it would merit policy effort to incentivize them to do that, positive and negative incentives I would think, various different methods to ensure that we have the proper portfolio here. Of course I would think that EPRI for example is pretty tiny compared to this overall budget, which goes back to the point that if this is not enough, certainly what industry is doing falls very short. Where's electricity storage?

Audience: It's in the grid.

XXX: Is the DOE doing anything on CAES, compressed air energy storage?

XXX: I think in the recovery act there was funding to essentially quadruple the domestic ability for CAES at power plants.

XXX: But it's not just a question of building these things, it's a question of there's a lot of R and D. CAES is a sideshow as far as I'm concerned. The issue is that if you're going to couple CAES to wind, it's not going to be in salt domes, it's going to be in aquifers, and as soon as you put air underground in aquifers, there's a whole bunch of science issues—

XXX: And it's awkward because you're getting crowded, we're trying to put the CO2 down there, and the CAES, better not mix them up.

XXX: I didn't understand, you said not in the salt or?

XXX: Yea because salt domes are located primarily in regions of low-quality wind resources, okay. But aquifers are very well correlated with high-quality wind resources.

XXX: Think Midwest.

XXX: Midwest and the Great Plains and what very good correlation but for CAES you need very particular formations. It's quite different from what you need for storage because you have to have an anticline if you're going to store air in them, and one of the things that I was ttrying to push with various DOE folks during the stimulus era was to do a detailed geological assessment of the CAES capacity on a reservoir by reservoir basis and I don't know –

XXX: There's a little bit that's going on, Kurt Oldmanberg is a researcher out at LBL that's doing a little modeling in that area as far as CAES in saline reservoirs, but you know it's probably a couple hundred K of work.

XXX: So what should be considered is that the historical funding of the storage has been on the order of 5 percent of what the office of electricity is at. They've had the program management there has leveraged that to the best of his ability, but it has been a very small amount of funding that has not enabled detailed exploration of the areas of opportunities that are available. The recovery act was in principle a demonstration, a set of demonstration programs for 16 storage demonstrations and it was shovel-ready. So it will represent the first new CAES being deployed in this country in many decades, and I think the third fourth and fifth CAES plants in the world which is a marked improvement over what existed previously. But as far as novel research and you know to those types of efforts that was not done it was a capability to do that from either a motivational aspect from the recovery act which had very different motivations from what we're discussing, or from a budgetary aspect from the capability of the program.

XXX: I should clarify, when I characterized the CAES as a sideshow here, and that is you have to learn to crawl before you walk, and if you look at, in the recent interest in CAES, because there's more fossil energy. But if you detailed modeling that lead on these systems it indicates that the greenhouse gas emissions rate for an integrated wind compressed air energy storage system that provides baseload power at 85 percent capacity would have greenhouse gas emissions less than that of an IGCC plant with carbon capture and storage. Okay because, so you don't need to go to zero emissions, you can do a heck of a lot with the technology that we have except the technology we have is really based on ancient components. The gas turbine and a CAES and uncooled turbines.

XXX: There's an investment in pretty much two startup companies that did hydrothermal that developed a new piece of machinery that can do without any fuels, so there are some investments but they're not economic.

XXX: I'm not saying you shouldn't do storage, but I'm saying that the ones that use fossil fuels are good enough to get started and the name of the game should be let's do what we know how to do and make marginal improvements in that instead of leaping to the next generation. You've got to do both.

XXX: I think that's a good point, doing both is a good point.

XXX: More reactions to the budget numbers. Anybody?

XXX: Maybe this is a big conclusion, but the fossil which is the purple in both cases. I think it would be interesting, and maybe you do it in another level of detail, but it would be interesting to look at what's surface versus subsurface.

XXX: About 150 million is subsurface.

XXX: Very small compared to the surface.

XXX: That's our regional partnerships, and moving into our large-scale projects with—

XXX: Even in the, when you do a large-scale project, a lot of crosscutting issues if you identify subsurface with geothermal or compressed air. My point was in the major projects, do you break those down and make sure, because what tends to happen is that carbon capture and storage, although we want integrated large demonstrations, there's a huge value into doing actually the two pieces individually, and not actually doing them linked. Because of the scale issues and cost issues, if you can't get the 800 million dollars to do the capture piece, you end up not doing the 50 million dollar storage piece which could add a huge amount of value from the standpoint of proving up subsurface issues that could be used on the next surface project that comes along. So how do you deal with, do you deal with that?

XXX: Yea, so basically the way we deal with it is for this 291 historically going back a decade the fossil R and D budget was about 400 million a year, now we're at 300 million a year roughly. R and D for the regional partnerships for all of the subsurface work, putting the small-scale ten thousand tons of CO2 in the ground, and proving that out 20 places around the country in the subsurface. Moving now into the large scale, 9 projects we're going to inject on the order of a million tons a year. That's about 150 million dollar effort and its relatively flat you know we're going from 20 small-scale projects to about 9 large-scale, and in that 150 million dollar realm also includes the monitoring, validation, technology development work and doing the best practices of everything that goes on in the subsurface. So that's 150, so in terms of the rest of that 300 million or so is all above-ground efficiency work and improved capture technologies, better sorbents, solvents, membrane separation. All of the demos for the large-scale 9, including future gen, comes out of a different pot of money that came out of the stimulus money and nothing is included in the budgets for demos going forward. Do we

separate out on the demo money how much is used in the subsurface versus not, not really because it all comes out of that demo pot. There are some different subaccounts under each project, but we don't allocate that.

XXX: An interesting note is that there is 150 you talk about a large chunk of that actually goes to the procurement of CO2, and the reality of it is actually is you don't actually even need to use CO2 to qualify commercial storage site, you could commercialize a 100 million ton storage site without ever having to inject CO2. CO2 adds to public acceptance, but you can do water injection to prove reservoir jet boundaries, geomechanics and so forth. It actually would be nice if that was set in a separate pile to see how much is actually going into CO2 versus pure subsurface work

XXX: I agree with you, a large chunk of that is buying the CO2 because right now you got to buy it at the market, and what is it?

XXX: What does CO2 cost?

XXX: And other than for public acceptance, like I said you can inject salt water to formations to get the same impact, technically.

XXX: My suspicion is if you dig into any one of these wedges, you will find sort of anomalies like that.

XXX: Sorry to get into—

XXX: No, no it's an interesting point. How much is really going to productive research or demonstration?

XXX: Is there a general issue in budgets that's associated with this complex problem of, as you approach commercialization, you need some types of subsidies in the industry to address first-mover barriers? We discussed that and on the one hand political leaders want to see industry chipping in to pay for this, some evidence that it's got potential. But then on the other hand then they view it as being subsidy to give industry any money, and so you have this dysfunctional way of looking at this that makes it very challenging to use funds in this way. Is there anything that can be done to figure out how it is that you further legitimize these tools, because I think they can be critical?

XXX: I think that if we could write down a best practices of how do you go from successful demonstration to market priming to tapering off of the excuse me incentives, not subsidies, we've talked about. As the thing takes off, that would be a real contribution that we could try to write down. There is no theory of that.

XXX: I think that because what we would observe, where we've seen successful demonstration happen in the nuclear field is that this peloton effect where you do get a number, a substantial number of commercial entities if you can organize things so that they can move forward in a common way, and they're jockeying but you're basically working through many of the early risks. If you can see a peloton forming around some type of technology which happened with the utilities on the early site licensing effort that 17 coalesced together and cooperated to move forward, we even saw that, we're seeing that currently on SMRs. You have multiple players who are investing their own resources, but working in this earlier phases in a cooperative way, and so it may be just a way of describing that phenomenon. I think that you can watch the same thing from the current NGNP consortia of chemical and petrochemical companies to launch some type of early site license effort to address the unique issues of collocating SMRs with chemical facilities.

XXX: One of the core problems in the big demos, and it's there in the SMRs, is who bears the risk in the end? And obviously the private companies would like to move as much as it

can onto the government shoulders and the real debate is about how much of the risk the government should shoulder.

XXX: it needs to be 50-50, it's a cost-share, and that doesn't work well because in fact earlier on government has to pick up more risk and as you get closer, you will see industry being willing to increasingly pick up a larger fraction of the risk. And how you do that properly in a way that is sufficiently legitimate, that the political leadership believes that these are not excessive subsidies and how you describe that I think is something that merits effort to figure out how to do it well.

XXX: There's different kinds of risk in what you just said is that the technology risks for the function, there's the permitting and licensing risk which is significant in the near-term. And I would say the grid risk, how's the grid going to evolve—

XXX: And the business risk. You know, if gas really stays low and the economics don't come down in the way you think they are, you're not going to make money.

XXX: I think the department incentivizes I think it interacts with those different kind of risks differently.

XXX: Yes. And better or worse, I mean we are in the end a technology shop.

XXX: One of the really big insights that came from me from participating in this activity is that I really felt that nuclear was the only energy source that faced really tough regulatory hurdles, that basically we were alone in that being the problem.

Audience: (Loud laughter)

XXX: The thing that I would say is that I would expect that this is actually a general perception that renewables are actually easy from this perspective because they're so popular compared to doing something dirty like CCS or nuclear or whatever.

XXX: Until you try to put one in. Okay, then it's a different story.

XXX: Maybe there's something to be gained from doing something that is a crosscutting how do we do this sort of thing better when it comes to working with all of these energy technologies because they're regulated that could actually begin to legitimize also the need to have government assistance to overcome first-mover barriers that arise from this. And if one could point toward the commonality, all of these technologies face these hurdles, and if you want any of these to be successful, if we could get better at overcoming these hurdles and learn more lessons from—

XXX: The dimensions are siting, permitting, adoption—

XXX: The whole thing takes meeting societal requirements for safety, environmental protection, and that is why we regulate these technologies, and if we could actually think that maybe there's the opportunities to share best practice between these disparate different energy sources and cooperate a little bit then maybe everybody could benefit. In the end it's still a competition, but again it's a peloton. Why not all of us work together to advance this particular problem involvement on the hill.

XXX: You're absolutely right, in fact we do that somewhat anecdotally in that for example in marine hydrokinetics and we're looking at offshore wind, we do a lot of extraction of where nuclear has been and what they have had to do from an environmental assessment standpoint to try to use that data as much as possible to not try to recreate it. And it gets back to this if you're going to do it generation and a portfolio approach, we talked about this in our breakout session, what are the common practices, what can we do very synergistically when we approach this with a portfolio that we could really take a lot of costs out of the system and do this systematically and bring in not only DOE but recognize for the systems perspective

that we're impacting a lot of other agencies at the same time, so let's take care of this at once and not try to fight that battle. And on your 'I'm facing this alone', I'm flying to Martha's Vineyard tomorrow to do a public hearing on the cape wind project, followed by another public hearing in Bedford. I'd be happy to trade places with you.

XXX: I've done a similar hearing and let me tell you it's not a fun job.

XXX: There's been a lot of ivory tower stuff on this, energy economics and renewables. One of the problems is that of the tools and mechanisms that we have in the federal toolbox some of them are in the purview of DOE and some of them are outside. So we've got a loan guarantee program, we got our demo programs for each of these applied technology budgets. But you know the markets perturbed with the tax credits and subsidy and incentives, other things, but you know there's thought that's been given as far as how you optimize that going forward but it's such a hodge podge that—

XXX: So this is a QER issue probably more than it is a QTR issue. I mean we can and will raise it right.

XXX: There's also a question of how do we want regulation in general to evolve and in the nuclear field but also in the environmental field, the EPA field, we've been pushing toward the idea of trying to use more risk-informed and performance-based regulatory strategies because they in the end work better. And I've co-taught a class on risk assessment with a professor of public health that does a lot of risk stuff, and that the sharing insights in these areas is very helpful. I also collaborate with people in civil engineering; they've been focused on trying to figure out how do you create a regulatory framework for building safety and structural safety that is more performance-based as well. And this in general seen our regulatory system evolve more towards achieving the societal goals without constraining the means by which you do that. But providing adequate assurance that those means will meet those goals is a good direction to go. So again, maybe there's something that's crosscutting effort in science, risk assessment, and other relevant areas of science that could contribute to improving the regulatory system in general in the United States.

XXX: I think that this is not a new problem. It existed in hydro for a long time, and I think wind is getting there. So the safety issues are one thing, but the ecological issues are random, from the engineering perspective they are random.

XXX: Random in the sense that specific?

XXX: Site specific and they're chaotic events that come site by site when you encounter species, when you encounter barriers to deployment or permitting. And within the EERE space, each of the programs is beginning to approach an environmental component, but there are definitely science gaps there on the ecology side that have to be formalized and translated into technology issues so that they can be commoditized or. And so there's a whole spectrum from science and technology around the ecological permitting piece that right now is random because we can't see into it well enough.

XXX: Are there ways, can you take some of these technologies like Google aerial maps and try to make NEPA process or the wildlife, finding endangered species process more systematic and take modeling and visual aerial photography analysis?

XXX: And that's certainly done on a national scale now with other agencies, but in the end, you can do a lot of that kind of work within the energy research to predict what kind of barriers you are going to encounter, and to estimate and to manage your risk, but when you get down to the site-specific level you actually influence it with the information, you have very little control over that. It really becomes a, you may want to follow up.

XXX: Well, yeah and there's another sideline. There's also a huge opportunity here. I mean when you're doing a renewable source you do what I call a development activity where one is developing in the context of working with the environmental community going forward with the evolution of that technology, that's radical change, and I want to generate something and say how do I assess what the impacts are? And things we don't talk about, and I think there's more and more initiatives to do these types of collaboratives within universities that of the codevelopment type of approach where I'm very cognizant of what the issues are, engineers talking to biologists as I progress to try to come up with a technology in the end where I understand what the issues are and can I implement paradigms and or adapt that technology to do some avoidance of what these issues would be. But I would like to get back to the regulatory piece, the point that was made of some type of synergistic intergovernmental coordination, and I give you the example which has just happened at a fish and wildlife land-based systems which they released their I'll say it finding that could literally shut down if it was taken to the extreme 200, 300 gigawatts of development within the US of wind. Totally out of left field, totally in an uncoordinated manner, they thought there was coordination. So this intergovernmental coordination of these activities, now that we're off the bench top, past the demonstration, and we are looking at major systems integration to become a strategic portion of the penetration of the grid will be absolutely critical or we're not going to be able to be successful on the current.

XXX: Good. We are an hour and a half into this, I'd like to take let's say 10 minutes break, and then yet another set of topics that we will dig into.

XXX: Okay can I just say one thing? Permitting at the local level is also very inefficient. Because if you go from one city or another city to another county, the people, the local people have different views of things.

XXX: It's called the political agenda, in many respects.

XXX: Okay, let's take ten minutes.

(Time elapsed for break)

XXX: So let me try at least two other lines of discussion I'd like to pursue. But let me try this. It is often said and I think we've heard it said in the last couple days, that a relatively predictable and material price on carbon would sure clarify this business. And you know we can have a discussion about when and if we're going to have that, but it isn't at least for the next couple of years. Nevertheless, we have other things that provide some degree of certainty and push in the directions we want to go in renewable portfolio standards in the stationary sector and the renewable fuel standards in transport. So to what extent are all the RPSs playing the role that a carbon price will play? Is that enough to provide a market goal? Just your thoughts on the extent to which the RPSs are really helping to move the technologies forward, if at all.

XXX: I think it's a miserable policy tool. It excludes nuclear. It's the best available technologies so it actually is not tied to emissions in any way. There's no lifecycle element, all you need to do is to meet some threshold of qualifying for meeting that name and it doesn't matter whether your dirty, but there's ways you can use biomass which are very destructive that could qualify, so I have this is one reason why even just moving to clean energy standards as the possible way of getting something that would be bigger and achieve the policy goal you would really like to have by having a price on carbon is you know. It smells a lot. It may be what in the end you just have to do because it's the only, basically the issue you run into is that the optimal way to achieve the societal goal of reducing carbon emissions is to have a

cost placed on it but the benefits of doing that are distributed and there's not constituency that's willing to fight for it and engage it because the transaction costs for each individual that are going to benefit from it are just not worth it.

XXX: I mean they're all constituents, a vast NGO community.

XXX: Yes, but it's not nearly as effective as having a set of manufacturers and industry base, or a concentrated constituency which is going to like a technology mandate as opposed to something that is an economic framework. And so technology mandates can have concentrated support which can overcome political hurdles, and that's why portfolio standards can work even though in the end they're not particularly or efficient way to achieve a performance goal of reducing emissions and protecting the environment. That said, it may be the only one that's going to work, and it may not. It may be that the only way that you solve this problem is by developing clean sources that can compete without a carbon tax.

XXX: We have also through one of the, it's turned out that the process of deregulation of electricity markets and has arguably created conditions that have made it far more difficult to invest in those sources which are capital intensive precisely because it removes a lot of predictability about revenues so that you can make informed decisions that used to exist. And I would say that in some sense that's unfortunate because in those markets that we deregulated, as in California, the consequence has been higher I prices not lower prices.

XXX: And I think once consumers realize that there may be some instability of---

XXX: I think it's interesting to look at two different portfolio standards that we have here. One is the renewable portfolio standard versus the low-carbon fuel standard in California. And on the other hand you have four at the national level, the renewable fuel standard. Okay RFS, and one of the issues with RFS 2 in particular is that the advanced biofuels trudge of RFS 2 has very ambitious goals that were stated in the energy independence and security act of 2007. It's over 300,000 barrels a day of gasoline equivalent by 2016, or 900,000 by 2022; there's no way those goals are going to be met because the main candidate for meeting those goals is cellulosic ethanol and it's just not going to hit—

XXX: It's not going to happen at a large scale.

XXX: It's not going to happen, and so I'm wondering if there is wiggle room in that case to extend that to a low-carbon fuel standard a la California and at the same time looking at the renewable portfolio standard for electricity, making that and evolving that to a national standard, but having a low-carbon standard instead of having a renewable portfolio standard. Given the change in the political climate with regard to these alternative technologies, I would think both of those changes would have much more prospects of moving forward at this time than say 2 years ago.

XXX: So electricity standards as you know is under active discussion. Fuels, I have not heard that discussion.

XXX: But I think the reason why the fuels should, can, and is likely to be discussed is just because you change it or lose it, essentially, because the goal is not going to be realized.

XXX: And I would just say that the low-carbon fuel standard has a set of issues, but it is much better focused on getting an efficient solution to the problem that you're trying to get than something that just selects a class of technologies that qualify where you have to have a certain amount of it and it's not related to the real goal that you are working on.

XXX: What is the real goal? In transportation, the real goal is reduce oil consumption.

XXX: And hopefully we do greenhouse gas emissions.

XXX: Well if you reduce oil consumption, sorry fossil liquid consumption to take into account CNGs. In the electricity sector we've learned how to credit efficiency back to the generators so that we start to think about generation efficiency. We don't do that in the transportation sector, I wonder if we couldn't learn, somehow roll the supply and demand together, also it should credit both.

XXX: Do we credit that on the stationary generation side?

XXX: Certainly in California utility makes money by promoting efficiency.

XXX: We do that but that's promoting end-use efficiency. If you look at the clean energy coming up, there's a lot of low-hanging fruit of increasing the efficiency of generation.

XXX: I hadn't thought about that, yes. Even better.

XXX: And right now that's not in the conversation as far as does that get credit under the CES approach? And is there a role for DOE to play there? I mean a lot of this is low-hanging fruit, but again if you do that, then those plants dispatch more, and that raises your hurdle for the alternative competing technologies.

XXX: Alright, that was my bit on, go ahead.

XXX: Do some scenario planning for evolution models where you kind of see what happens with prices and policies.

XXX: So we, this team has not done any of that apart from back of the envelope things. Within the department, there is what I describe as at best ad-hoc set of exercises that go on largely with EIA but you know again my own perspective, not enough social, business awareness, it's more technological.

XXX: But even with that, we try to use carbon prices as the sensitivity when it could have been the cost. It was pretty interesting to look at the evolution over 50 years when you put in different assumptions, and you change the price point of nuclear and all that, it goes up or goes down, and same for wind and carbon capture with gas, it's a pretty interesting exercise.

XXX: I'd like to ask the question about the value of different planning tools. You know the EIA does a lot of analysis, but it is based on economics. It is economists in the EIA that are looking at economic data to derive both current and projected fuel consumption. We've gone through a lot of planning exercises in the department, and what you always see is that people tend to either push or say that their technology will arrive at a given price or levelized cost of electricity or something else. And I guess, does that type of analysis provide any value when the system operators that I speak with in the utilities that I speak with one, may not believe it directly, but two and more importantly they're concerned about the operational impacts on their systems that it's not that the economics are secondary, but they certainly can't be considered in and of themselves.

XXX: To understand that and inform that of what those price points and R and D roles ought to be, what the DOE doesn't do and maybe what we should move towards is actually doing dispatch analysis. Saying that if we put a plant out with this technology for cost performance, here's how it would dispatch against the existing generation assets on this note on the grid at a local marginal pricing type of approach. And you basically have two slider bars for sensitivities: gas price and carbon shadow price. And you do that for various areas of the country because for what was mentioned earlier, the technical optimal solution for the Northwest looks quite a bit different than the Southeast and elsewhere it's going to be fairly technology advantageous or specific. And so that sort of systems analysis isn't done to a great degree in DOE we go well here's the 30 year LCOE. Is that a good way to set an R and D goal?

XXX: The wind program is looking at that, the hydropower program is looking at that. Low-flow and dispatch analysis—

XXX: Right, we are starting to move towards dispatch analysis, the DOE in general to move more towards—

XXX: NREL has a model for IIED that's an application, and something that's dispatch—

XXX: I never reached very well as seventeen times is supposed to represent the entire year. It's not an acceptable tool for that type of conversation.

XXX: This importance of dispatch analysis is very high. And a couple of examples of where this is very important. Analysis that we've done at Princeton several years ago on comparing wind compressed air energy storage baseload systems to coal IGCC systems with CCS shows that on a levelized cost of electricity analysis, it's a dead-heat competition between the two. Okay but that's for design capacity factors in each case. But when start to separate the sheep from the goats when you do a dispatch analysis because the wind CAES system is going to have a much higher capacity to defend and hide capacity factors, and economic dispatch competition and so at the end of the day, it will beat the coal ICGG with CCS. And secondly in terms of these coproduction plants that make electricity and liquid fuels, there's a great reluctance to you know deal with this in the real world because of the challenge of having to deal with these three commodities products simultaneously for sort of different markets, liquid fuels, electricity and CO2. Who's going to own and operate these things? But they're incredible economic dispatch competition because you have 2 products and not 3 on the fuel side and for particular systems if oil price is greater than 75 dollars a barrel, the minimum dispatch cost is zero. So these are going to be dispatched first onto the grid and they're going to be able to defend high capacity factors and force down the high capacity factors of everything else the more and more they're deployed. And I think those kinds of systems are going to be very powerful in overcoming these very strong institutional obstacles to such technologies.

XXX: I'm not sure, and you all can tell me differently, that to do that kind of analysis would be—

XXX: I know one man who does it, he's a young engineer who works for me and they built a model for about the last year and in the conversations he's had with the lab and out with the ISOs folks, there's a great need for doing this and we must do more of this out there.

XXX: A lot of your national labs do that.

XXX: They do it on an ad-hoc basis and it's not coordinated in any fashion so progress made in one area is kept in that area. So it's not actually known has some very interesting models that have not been incorporated into the rest of what the DOE does.

XXX: I have to push back a little bit and many of the efforts within the programs are tied in with the existing utility infrastructure. These are interconnection-wide scale efforts that are coordinated, and they are not looking out fifty years necessarily. If you put it out 20, 30 years, those efforts are going on, but they are extremely difficult.

XXX: So let's elevate the discussion a little bit, XXX what I heard you describe is a paradigm by which this hybrid paradigm where you're essentially providing more than just power onto the system, but you are providing a service. And that service is consistent energy and you know, who does that responsibility lie with? Is it the independent power producer? Is it at the RTO? Is it at the investor utility? Because these are very big questions that will affect whether or not hybridized generation deployment is even possible.

XXX: Yeah, I agree, these institutional issues are a challenge and I was telling John on the break here that I had a very interesting discussion with Bruce Brain at American Electric Power last fall, and I told him that I sort of had given up on regulated utilities as owners and operators of these coproduction plants because there's no unique way to decide what part of the plant is associated with making the liquid fuels and what part is associated with making electricity, and how are you going to rate-base that? And his response was very interesting, he said don't give up on regulated utilities in this area, what you say is theoretically to concern, but at the end of the day the regulators are most concerned about low rates to the consumers, and having a coproduct of liquid fuels is key to low rates and your strategy.

XXX: Let's not talk about bridging sectors, let's talk about you know wind and CAES combined so you can write other examples of where you can have first dispatch essentially. So there has been an effort I think in upper, eastern Washington where they were talking about having regulated service area rather than just renewable. So they were going to combine a variety of different resources, but it wasn't going to happen at the independent power producer, it was going to happen at some much higher level. So who is responsible, and you know electricity is kind of interesting in that you don't actually have to be collocated to have a co-impact, and so what entity is responsible for coordinating that?

XXX: I don't think that question can be answered at this time, but it's associated with the institutional issues that stand in the way of these hybrid systems going forward. They're very complex, but we have difficult problems we're facing. And the economic model, the environmental footprints look terrific for them, it's these institutional hurdles that stand in the way and I think that a lot of creative thinking is required about these institutional issues. And they are usually discussed at the end of the day.

XXX: One of the problems we have from the DOE perspective is a lot of the problems we are trying to deal with are not technical problems, they're institutional, regulatory. And you know that's not the DOE mindset, but, we do technology. We do widgets, and we are in the business to go ahead.

XXX: I have to mention again that there are efforts in the pacific northwest that is being supported by multiple parts of DOE. It doesn't go beyond the electric grid, but it does look at energy and coauthorization of all the services both for the economic value of the energy delivered and the robustness of the grid. So those things are gaining coherence in that area relative to other markets.

XXX: Right and I mentioned eastern and upstate Washington; I think we're talking about the same thing so, yeah.

XXX: One of the themes that came out of yesterday is that there needs to be much more focus on systems instead of widgets, and these are systems issues. And so it's consistent with everything we talked about yesterday.

XXX: It's not to say that the widgets aren't important, but not the rate that they are being stepped at the moment.

XXX: We just did some analyses where we were again taking wind technology, seeing how we had to drive wind down to natural gas-type prices in the 2030 timeframe and we did some scenario planning based on this model where we actually just hardwired and drove the price down below natural gas, and still it was not selected as a technology that one would deploy when it gets to this dispatch issue. And as you separate it out in terms of the bottle, it was the capacity value associated to the dispatch capability of that technology that even on a

head-to-head LCOE value, I still was not going to gain parity because the dispatch issues, so it really is a limiting issue from a systems perspective.

XXX: So LCOE is only one and not a very effective nature.

XXX: You hit LCOE with parity and you don't take care of the systems issue, you're still not going to get there.

XXX: We've got about 45 minutes left, or so. Talk about what's DOE's role, are we looking just domestically, or are we looking at a systems perspective with what China's doing and others?

XXX: So the international aspect is another I will put down on my list. I will learn more and—

XXX: I was just going to say I think that out of the three economic metrics, one is LCOE, the other one is minimum dispatch cost and other dispatch issues, and the other one is internal rate of return which is very important for coal production strategies.

XXX: Alright, we had a comment at breakfast, I think it was Asa who made it, about how we should think about CCS going forward and it was sort of down on retrofits and up on gas, and so you want to try to reprise that statement and see what we actually get—

Asa Hopkins: I don't remember exactly what I said, but it was basically you know if no one's going to build, well, looking forward in the US, a lot of existing coal getting turned off, what's getting built is gas, so CCS there's a market for CCS it should be on gas plus CCS.

XXX: Domestically. If you look globally and if you're looking at climate, you have to look globally, China in five years is going to build more coal plants than we built in an entire century, and they're going to double that over the next few decades, so you know globally you almost have to have a technology that retrofits CCS to existing coal plants at a price point that can deploy in China.

XXX: So I have heard, at least for US retrofits, that's a really difficult thing to do. Because space limitations, and would you sink the capital into it?

XXX: Right now you would just throw it away and build a gas plant. So right now we have 235 gigawatt of coal that are out there. Depending on your assumptions on how drastic the EPA regs are going to be, 60 to 70 gigawatts are probably going to go away over the next five years, those are the smaller older less-efficient ones. So what you're left with is to learn 75 gigs of coal moving forward. If you look at the ones that are larger that have all the emissions controls on them, there's probably well over 150 gigawatts that's prime for retrofit assuming that you can get a technology cost performance down where it makes sense at a given carbon price. Well people said that there's physical space at the plant, and when you do that, you look at Google maps and is there space in the pad, there's well over, it's in the 100 gigawatt range, right, assuming a price point. But yeah the question is do you target that, or all the new capital that China iss going to not give over the next 20 years. And so you look at gas, and I agree with you that in the US looks to be a larger share and growing.

XXX: I'd like to follow up on this China thing here. Which I think is really important and we've got to figure out how to collaborate on something the Chinese are interested in doing. And one of the judgments that I'm making is that I think these polygeneration plants are going to be built in China before they're built anywhere else.

XXX: Because they want the fuel, or the chemicals.

XXX: No, it's more complicated than that. It has to do with a couple of characteristics of the coal industry in China that are quite different from the coal industry here. The coal industry in China is very integrated, they do everything. To put this into perspective in terms

of gasification technology, there are 400 plants in China that make chemicals or fuels by gasification. Okay, and those are either existing under construction or planned to come online in the next 5 years, okay 400. So they have 400 gasification based energy systems that produce pure streams of CO2, okay. Companies like Chenoa, which is the largest coal company in the world are thinking very seriously about expanding beyond chemicals to get into polygeneration and the reason they are thinking about this is the experience with all of these existing chemical plants has given them a high degree of confidence in the technology. Okay but chemical markets are niche markets, okay; these are all real small plants. There are 400 of them but they are all very small. Of those 400 plants we've identified only 18 that provide more than 1 million tons of pure CO2 a year, which are very good candidates for early CCS demonstration projects, which I think the US should be thinking about collaborating with China on. But these coal companies are interested in going beyond chemicals because the electricity and fuel markets are infinite compared to these niche chemical markets. They have the confidence that they can do it, and companies like Chenoa not only do what US coal companies do which is take rocks out of the ground and put it in railroad cars, that's what our caricature industry, that's what they think coal is. They also own the railroads, they also own power plants, they own these chemical plants, and theyre chomping at the bit to get into these polygeneration markets. And they have enough residues that they can do coal biomass, coal processing for these things and you get a 50 percent reduction in greenhouse gas emissions for 5 percent biomass.

XXX: So they are just venting CO2?

XXX: Well they're venting except that Chenoa is already storing 100,000 tons of CO2 per year in conjunction with the direct coal liquefaction plant in inner Mongolia. Okay and they're planning to expand that, that's a huge plant, and they're thinking about doing this for indirect liquefaction projects as well.

XXX: So the broader question is what can we, should we learn from this and how can we.

XXX: The question is if you want to move CCS forward and you need to demonstrate these technologies at scale, the way to do that cheaply and as timely as possible is to somehow partner with China to do it.

XXX: Is that true in the nuclear also? China is, or at least they were deploying nuclear at some prodigious rate, can we learn anything from that?

XXX: Well certainly the AP1000 construction in China has been very helpful from the perspective of facilitating the possibility to build them here through providing the demonstration, they're replicating the module manufacturing that they built in China right now in Lake Charles so that they can do the same kind of modular construction. And the plant in China, they're building a second one now that has the capacity to supply all the modular components, equipment, construction, everything for 2 AP1000s per year. And China is in the process of standardizing and looking at how to do a power upgrade on the AP1000. They've realized that they don't have the domestic capability to license upgrades to the passive safety systems, so they brought in Westinghouse to help them. So there is, I think there's a basis for establishing some collaboration. Certainly they have a tremendous manufacturing capacity there.

XXX: Some of the utilities are trying to do that better, I mean Duke has a VP who's been going back and forth. One of the questions is if it's demonstrated in China, would the US industry pick up the ball and run with it? Is that sufficient for them?

XXX: On nuclear plants it's interesting. You can actually have a large amount of domestic content, and you want that because it's lots of steel and concrete. You have specialized components like the reactors, and steam generators, we're not going to make them, the large ones in the United States, going forward it's unlikely that we'll ever reestablish that capacity. But it makes a lot of sense this modular component manufacture, is being put in locally. Because you want to be able to ship these things a reasonable distance by rail, or by barge.

XXX: Just a data point. So the company that transports a reactor that we help develop over a couple decades, we're building one down here in Mississippi, it's one of our demo projects. It's going to take if we're lucky another 5.5 or 6 years. They had a license to build one over in China, they started construction this year, they are going to start shakedown and operation this year.

XXX: And it's very helpful to have a growing market if you want to demonstrate new technologies, and the first-mover barriers and costs are much smaller than expanding market than they tend to be in a stagnant market because you can envision selling more in the longer-term. If you can sell more, you are willing to take on more, larger first-time costs.

XXX: May I just mention also that, so a lot of foreign companies are going to China because they see these low barriers, but a lot of Chinese companies are trying to access the US market and trying to, like utility companies, and some of the larger manufacturers want to get their hands on the US. They ask about how they can partner with US companies, or how they can access just being able to build and create jobs here. So they are trying to spin it as we can provide you with jobs if you can give us technologies. Kind of like a weird tradeoff, but really in their favor.

XXX: I think that, particularly in the nuclear side, there's also what we're seeing coming out of Fukushima is that there's very good reasons for US to be engaged with other countries that are practicing this stuff because the severity of the accident, there are many aspects of what happened there where things probably would have gone much better if the regulatory framework looked more similar to what we have in the United States. The way decisions were made, where responsibility and authority are delegated and at what level. In the United States, operators in the control room have the complete responsibility and authority to take any action to actually respond to an accident and in Japan the prime minister was involved in the decision-making. Which, if you think about it actually—

XXX: Where did he get his engineering degree from?

XXX: The particularly when it comes to trying to, there's a massive cultural change in the US both in how we manage and operate nuclear power plants over the last 25 years, and many of the practices such as 3-way communication that now occur routinely in nuclear power plant environments, even in management meetings, it is really weird to sit in a management meeting where somebody will say 'I understand, I have been directed to do this.' And then wait to get the confirmation, because in 3-way communication, somebody tells you to do something, you repeat back your understanding and different orders of what it is that you think you are supposed to do. I understand, I have been told to open valve bravo on train alpha, or whatever. And then only after you hear that you've interpreted the direction correctly do you take the action it it's very strange to sit in a management meeting where they are doing that. But this, these, so we know that you can make substantive cultural changes over time to adopt practices where the system will work more reliably and efficiently if you do it, and it gives me some confidence that if the United States engages with other countries

we will see better practices adopted where we will see less likelihood that we will see a disaster replicated like the Fukushima accident.

XXX: So in China they see these foreign companies coming in and we're going to offer you this, government's going to offer you some help because we need to teach you guys, but they really see themselves as an equal player, like the playing field is even. They have IP that they want to share like there's the terms of engagement have to change.

XXX: I want to follow up on this very important point and focus my remarks in particular on gasification technology. The very early gasification plants in China were all foreign technologies, and now they're introducing a number of their own gasifiers. And right now IGCC technology making electricity only is not going forward in the United States very effectively. We now have these, in existing projects, we have three gasification based, and only one of them is pure electricity, and that's the transport reactor project, because the heeka project was just transferred to SCS and it's going to be another electricity plus ammonia plant and there's a worry about that particular coproduct because most ammonia is based on natural gas and natural gas at 4 dollars a million BTU means that it is going to be difficult for those kind of technologies to thrive economically. And I think that if we want to evolve IP relating to gasification, we'd be well-advised to find a way to team up with the Chinese and evolve IP collaboratively with them, and do it with polygeneration because in China IGCC, even though they have this green gen project, it's not going to be able to come close to competing with pulverized coal plants which in China cost between 500 and 600 dollars a kilowatt with flue gas desulphurization, and are built in a year, and they run the FGD whenever the inspector comes.

XXX: I did want to jump in for a minute and just say a word about the S part of all of this, the storage piece. We started the discussion of you know should we be thinking of gas, and there's always a debate on the capture side, and that's all important discussion. We talked a little bit about working with China. When we talked about storage, it's first of all it's pretty much agnostic to where you capture and how you capture the CO2, with some small considerations. I really believe that if I build you a commercial-scale, 100 million ton storage site, I can pretty much put any CO2 into it. So it's agnostic with respect to that aspect of strategy. But it's also a very local issue, so the fact that whether or not we are storing CO2 in China or anywhere else in the world is not necessarily relevant because it has to be identified and done locally to gain public acceptance. So I'll only bring this up to move this forward in terms of strategy, when we are debating whether or not we should be on gas, or what we do on the top side, maybe there should be a little bit more distinction going forward between capture and storage, because in storage we have a huge amount to gain at 10 percent of the cost, at a faster pace, we can move on giving the public confidence of where and how to qualify storage sites, without putting CO2 into the ground, without having new building injector well, without having to get class 6 permits, without having to worry about viability, a lot can be done.

XXX: Is the public, I hate to say it, is the public smart enough to understand those surrogate measures of confidence?

XXX: Well I would say yes, I don't, you mean the public they won't understand if you don't inject CO2, is it safe? Well I would say the reason I would say yes, even if you inject CO2 I don't think they'll really understand. It's not really a very good, that's not a confirmation in any case. Especially because when you inject from a subsurface perspective, when you inject a million tons of CO2 which we might think is commercial, and you do that for 3 years, that doesn't really give you the confidence that you can inject 100 million tons

over 30 years, you're still left with a huge challenge. So you're almost better off solving the 100 million, 30 year issue without trying the-- So I always go back to the incident where if storage could be isolated a little bit, then it would also have the advantage of doing subsurface geotechnical work that could have side benefits in geothermal, could move at faster pace and at lower dollars, and in an environment where every dollar counts, we can get big bang for our buck by somehow drawing that out of generics. And I say that at the risk of being criticized because maybe people call for integrated demonstrations, and I don't want to diminish the need for that but I want to say this too, a little more about storage.

XXX: So I want to underscore what John just said and add another element to it that we haven't yet put on the table and that is that you consider this first R and D program around we've already discussed three issues, CO2 and compressed air storage and geothermal, but there's another element that could be put in here as well and that is if you're going to meet the national goals for 80-plus percent reductions of emissions by mid-century, we need to agree that we need to decarbonize natural gas as combined cycles as well as coal plants but what are we talking about here is decarbonizing load-following peaking power, okay. An alternative to use of natural gas for this purpose because there is all kinds of uncertainties about the future of gas and how they're going to do this with gasification plants is to build in excess capacity to produce more hydrogen which you store underground in at night and you put it in load-following and peaking turbines in the daytime, so add hydrogen storage to this mix of, in the subsurface R and D portfolio as well.

XXX: When I picked up on demonstrations, I want to know if I can kick the conversation to ask about the DOE's role in the portfolio. And so my thought process goes like this. We've touched on the uncertainties facing investment decisions going forward and how that makes the planning challenging for making these decisions. Well you know one way to address these uncertainties is to say that my portfolio ought to be a collection of options, and have a lot of possibilities, some that might prove very useful if the conditions break right. Now that's a kind of theory, but I've got this challenge I'm stuck on, and that is if I have a collection of stock options I exercise that option by calling my broker and it's done almost instantly. In the DOE R and D perspective though it's not exactly trivial, actually you can talk about a billion dollar demonstration to develop the technology to the point that it's ready to be demonstrated, to the point that its actually ready for commercialization. And I know Bob had raised the point a couple of times about taking demonstrations off budget but I think part of the challenge. As I go through this conversation I still remain conflicted in how to think about what is the appropriate way to sprinkle in DOE resources at which part of the process? I don't know if you've had any insights from the QTR process where DOE would leverage its ability or anyone else has insights that would alleviate my concern that we could get stuck on this.

XXX: Loan guarantee is a practical tool for the demonstrations. Do they generate data? For nuclear they are, because you can have a revenue stream—

XXX: So the rule for the loan guarantees—

XXX: I'm thinking of some combination of potentially loan garuntees plus some type of purchase contracts such as purchasing research services, demonstration services.

XXX: Let me just describe for you people how the loan guarantee program operates. It must, a project is proposed it goes through a thorough financial business technical vetting. Sometimes we get involved my office has one person on these things, and then it gets approved or not. And then it starts the whole process over again. In general the loans were, and the guarantees, there's a criterion that there must be a—

XXX: Reasonable expectation of return rate—

XXX: Right so first instincts or first couple of instances of deployment in the US.

XXX: Right there has to be fewer than three operating—

XXX: Right, but the biggest hurdle is that I's got to be a grid investment, and then people naturally ask well if it's so good then why is the DOE involved at all? So there continues to be a lot of philosophical confusion even within the demonstration of why we're doing this program and so on. So it's not a way to get serious demo, and the things that you and I would call a demo, enough of a way to test something out. These are at best larger programs, because you have to ensure it's going to work—

XXX: Adding to this distinction between demo as proving down technical risk and demo as getting yourself through a regulatory process.

XXX: That's a difference.

XXX: So those are different purposes.

XXX: Because the other way that you could essentially reduce first-mover barriers would be to enter contracts to procure services from unique facilities that are unique in some way. So if it's choosing a new fuel to enter into service, to test fuel, to provide fuel samples for post-irradiation examination, and therefore to generate an additional revenue stream. You know I guess O of E doesn't like to enter into things that create a long-term obligation so it may be difficult to enter into this sort of procurement contract as another mechanism, but the interesting thing is how it restructures risk. Because in the end when you structure it that way, in the end the facility has to work and produce product. But it is actually production tax credits work in some of the same way. And so you, the commercial entity therefore is incentivized to have a vision process and to achieve something that will function because they're taking on the risk if it doesn't work they don't receive these revenues, and personally I'm attracted to structuring federal subsidies in ways that create incentives for efficiency and for effective completion of projects as opposed to our traditional approach in the nuclear side which is to use cost plus when we are building a—

XXX: All of these are all solid business deals, otherwise they have different levels of risk, but by and large they've got to stand up. And they evolve long-term, the power producers have been in 20 years, or something like that, it's a lot harder with the fuels, some of the hydrocarbon fuels, to get that kind of long-term contract. By and large it's not a standard to get those fuel projects approved.

XXX: The loan guarantee differs whether you are regulated by the IE or the IPC, and at least the coal sense a lot of the utilities tell us that they don't need the programs because they aren't capitalists.

XXX: So we're doing this in the long-term wind projects and then in solar I guess there is a lot in the pipeline. But I've got to tell you, I don't know some of the prices as opposed to the costs that the utilities are paying, somebody's making money.

XXX: Actually that's one of the reasons that the portfolio standard is popular is because the subsidy, the magnitude the subsidies conceal from, it's not an explicit number per kilowatt hour, and it therefore can actually be a substantively larger subsidy than you can get from something that involves the amount of kilowatt hours.

XXX: Right. I mean we've seen some fraction of the deals that we do the division so we know how much the subsidy is. I wouldn't want to buying electricity in California.

XXX: Every time I go somewhere else I try to charge my laptop.

XXX: (Laughter)

XXX: What other things would people like to expose?

XXX: I'd like to talk about the role of the DOE and what the people around the table really see as the role. Both of my breakout sessions there was a large focus on supporting technologies that may be out of favor to perhaps allow them to weather the unpopular state that they're in now until they can perhaps bring them up in the future. There was a large focus on increasing DOE expenditures and decreasing cost-share demonstrations. I guess I would just like to understand from this group is that what DOE is? Is the most valuable thing that DOE do with its money putting things on the ground?

XXX: I would say that that's one of the very valuable things. I'm grateful for carbon capture and sequestration because all of our scientists that used to work on geomodular depository for nuclear waste that are now unemployed, thank you very much, actually have found employment in this area. In other words having a broad base of capability in the national labs and things people can work on as national priorities do this is extraordinarily important to maintaining our base scientific technical, and the and in having a reservoir talent that you can call on when you get back to working on problems, which I think it's going to be just another year or two that we will be baseline and going in a somewhat different direction for how we're going to deal with waste, and there will be a pool of talent still there, because of that national lab's capacity to act as a sink, to move people around.

XXX: That's good.

XXX: I think we need to be thankful to the core, where you're coming from. And that's about risk reduction. And you've got to ask yourself why is that mission any difference when you talk about carbon capture, gasification, what have you. It's not any different. The only difference is that different time scales involved, there are multitude of technologies but the mission is the same. If this is your mission, you have to reduce the risks of the technologies to meet the energy provisions for the nation, and you have to say yes to the, because the industries are evolving, developing, maturing, some mature industries like carbon capture and it comes out of mature industries with a different piece than the renewables. So they're different beasts. That's what we're talking about, and I think that you need to stay truthful to, you have to reduce the risk of these technologies in different ways and that's your mission because that's what at the end of the day provides whatever the labels can be, whatever energy, whatever, and so forth. And I think you need to stay true to that mission and you need to figure out how that fits into each of these sectors

And then the other piece that we've been talking about today is system invention piece. It needs, in the office that is key. So I don't think that you need to step away from the national technology portfolio and realize, and take that core values and that's what we do is reduce risk.

XXX: So risk mitigation, not to end others completely, but many of the comments that were made yesterday, that seemed to manifest into the desire to have DOE mitigate the risk of capital whether it's loan guarantee, or whether it's cost-share for demonstration or any one of these other things, the risk mitigation component that I heard far beyond anything else is reduce our capital risk. Whether by paying for half of it, or by guaranteeing the loan. Is that the right?

XXX: I think that the object is that that an ask for cofunding situation. You have to ask for these, or the new metrics of going back to the industries and saying look guys, this is the part that you're financing, and this is the part that we're helping you with, and I think you need to stage these different thing, all the different pieces. Nuclear is a completely different

piece than a wind turbine and what's required in terms of support for them, and it's I think for the wind industry, I think what's confusing when you look at the wind industry it's all over the board right now because some have taken off and some are just beginning, there's some talk about medium-piece blend. There's all kinds of talks about, the industries are really beginning to ramp, so it's a little bit of a confusion phase. So in other words, so your beginning to it that phase for that. Biofuels are also important because some of the big oil companies are doing serious investment in biofuels and have done it in the past, so that's again a different animal, a different. So I think your question is too simple, really. So what, you're being faced with a lot of facts that I think you need to go back to okay, this is how we see the technology evolve from A to C and if this is the kind of game that we're going to play with these players. So I think you have to take another approach. So I think that you should define this as our role is to cost-share from the people, and you need put the offer on the table and see what happens.

XXX: No general principle is what you're saying, and that we really need to treat the technologies as, what else?

XXX: Where are the technologies, what is the potential? What is the maturity? Because then you need to put that offer on the table and see what happens. Because I think that there's lot of confusion of facts. Everybody asks for everything, so I don't think you're getting very much further by asking what is the right answer, because there is no right answer. And the other piece I think you can do is as a department is you could take a look at the regional initiatives and see how you can leverage those. There could be a tremendous, instead of seeing them as disruptive or something, I think you can be a wonderful pipeline of opportunities that you could pull from. So I think the regional have regional interests, but you can leverage some of your initiatives, stronger offer initiatives, by having a clear strategy.

XXX: I think that as far as these large-scale, first of a kind commercial demonstrations projects are concerned, the way DOE in my mind should be thinking about what their role is to evolve R and D programs in support of the commercial demonstration. If we decide today to do a commercial demonstration project that's going to come online in 2016—

XXX: Let's say SMRs in a decade—

XXX: In the mean time you can do a lot of research that would support that and that could come out of appropriated budget.

XXX: We don't do it that way.

XXX: Well let me just suggest, I'm just saying that's the way it should be done in my opinion. Maybe set up a quasi-public corporation to do the commercial-scale demonstration projects, DOE's role would be to support the anciliary research and also to build the intellectual case for the demonstration that would be carried out by this quasi-public corporation and to use off-budget information like a wires charge, and maybe if you're going to do low-carbon fuels at long-term power, a long-term purchase agreement by DOD, and things of that nature.

XXX: When you look at how we do scientific research, which are also billion-dollar class projects, accelerators, laser, or whatever, we fund the R and D for a number of years before we decide let's go build a project, and of course we're funding the R and D as we build the project, and that's been very successful. And we don't do it that way in energy.

XXX: Well I think we should.

XXX: There's so much more inside our control on the—

XXX: I understand, I do. Alright. I want to finish up—

XXX: Can I? I would like to add to the value of what's good and what role the DOE can play, and certainly you referenced it, but I think keeping the human capital alive for some of these things, that can be lost very quickly. I know that with carbon capture and storage, we're going to rely on the universities, their programs, the enthusiasm of the youth to want to do this sort of thing. That could go away really easy, it's fragile and I know today there's a lot of various university consortia programs which, if nothing else they keep people working on stuff, they make an enthusiastic, we can't do that in industry. I can't hire, I can't, but I will rely on that being available.

XXX: I would second that. In the 1990s fusion research is the reason why we have a capacity today to do nuclear engineering on fission. And having some diversity in your portfolio in sustaining the base scientific technical capabilities is a vital thing to do as we see industry and politics fluctuating and priorities, and things emerging, our capacity to be responsive. And is, it's the universities and the national laboratories that are important, who is the scientific technical talent that we have maintained. And we have had people available when serious things crop up, we are able to develop solutions in the timeframe where we can implement them. So I would second that.

XXX: So intellectual capacity, good. Let me thank you all for taking the three hours, I know you're all busy, but this has been as good as yesterday, maybe better having this discussion with you people that know these things deeply. I'm going to just close it off by providing a little perspective, and it's got to do with the regulation and regulatory stability confidence to invest and so on. It's not a new issue in the US. And one of the things that I like to point to these days is you go back to the federalist papers and you got Madison writing 220 years ago, I'll just take the time to read one paragraph of federalist 62 if you're interested to read the rest. This paragraph about senate, and why it is important to have a senate as opposed to a house, which has a greater degree of stability and seniority. It says, "A great injury results from unstable government. And while the confidence in public councils damps every useful undertaking, the success and profit of which may depend upon the continuance of existing arrangements. What fruit a merchant has in hazardous fortunes in any new branch of commerce when he knows not that his plans may be rendered unlawful before they can be executed. What farmer or manufacturer will lay himself out for the encouragement given to any particular cultivation or establishment when he can have no assurance that his preparatory labors and advances will not render him a victim to any constant government interference that can go forward which requires constant auspices of a steady stream of national policy." So these are not new issues, and if we accomplish anything with the QTR, maybe we can try to get a little more constancy, and have the federal government constancy with its policies.

Audience: Here, here.

XXX: Thank you all.