DEPARTMENT OF ENERGY QUADRENNIAL TECHNOLOGY REVIEW

ADVANCED FUELS WORKSHOP

DoubleTree Hotel

300 East Ohio Street

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XXX: I am XXX and I will take you through some of the more dry logistics of the morning and leave the exciting stuff to the Under Secretary.

So the first bit is to point out to you that you are not members of a Federal advisory committee, nor do we intend to use this group as a Federal advisory committee.

We are seeking your individual opinions, we are not seek group decisions or consensus opinions from this group on any issues, whether they are technical or particularly any action that the Federal government may or may not take. We welcome your individual opinions.

To recap, we are after your individual input, not group decision making. And just as a head's up that may result in somewhat stilted language from us at various points, that is just to make sure we are on the legal straight and narrow.

Along those same legal lines, please bear in mind antitrust laws and restrictions, check with counsel before engaging in activities such as collecting or discussing non-public data, evaluating public data about future prices or costs, or discussing topics including legality you are unsure. Please refrain from disclosing any proprietary company cost supplier price information or any proprietary

company information.

We want to stress that we do not intend by this workshop to encourage any specific cooperative activity among participating companies that is not clearly authorized by current law.

Onto the more fun stuff, we are running this process as openly as we can in hopes of engaging everyone who might have input and interesting things to contribute. We are committed to engaging a wide community, the ways of that engagement includes a publicly accessible website, release of all ex parte communications. We published a request for information on a framing document in March and received a number of comments on that document, and all those comments are themselves public, and we are running a number of focus groups and workshops like this one from now through the middle of June.

For the ground rules for this workshop, we will make anonymized notes from this workshop public, they will be posted on our website. There is a court reporter here who is going to create a transcript. We will remove names and anonymize as best we can, but note that the goings on here are public in that sense.

So, speaking of the workshops, we have a number of workshops of which this is the first, then next week in Knoxville we will talk about vehicle efficiency and electrification; two weeks after that we will be in Pittsburgh to talk stationary

efficiency; then the grid in Tempe; and clean electricity supply in Denver, Colorado. We will have a Capstone event in the second half of June in Washington.

So today you should have gotten a copy of the agenda. I apologize you don't have name tags yet, although I see one coming in the back, we might have name tags now, but the name tags were stuck in traffic for a while. We will give you the name tags at the break.

In a moment XXX will give some remarks, then we will have a panel, then a chance for discussion between the audience and the panel, then a break, then we will move next door to the breakout room and have some breakout sessions on the same kinds of questions that the panel will discuss, come back in here for report-backs so everybody can learn from what happened at all the different breakouts, break for lunch, next which again is-door, then repeat that pattern for a more technical discussion with a presentation from DOE staff on more technical roadmap issues, breakouts on those, report-backs again, then another full discussion here.

With that I will turn the mic over to the Under Secretary.

XXX: First of all, thank you all for coming and taking the time to help us out as individuals in this exercise.

I thought what I would do is to try to provide a little bit of context for where this meeting and these discussions fit in the overall plan as well as to seed some of the thoughts that we would like to get your opinions on during the course of the day.

What we are really about is trying to provide a context and robust framework for what the Department does in energy.

The Department really does three or four different broad things. We do basic science in the Office of Science. We do nuclear security in the NNSA. We do about $6 billion a year of environmental cleanup and then we do about $4 billion a year in energy technologies.

And the QTR, Quadrennial Technology Review Process, is really focused on those energy programs and perhaps some of the basic science to the extent that they help develop energy technologies.

We are really looking for a set of principles or a framework or a story that we can tell about the Department's role in achieving national energy goals and use that also to set our priorities and the portfolio of things we work on internally.

So we are interested in a process that starts with framing the energy challenges, discussing the roles of government industry in the National Labs and universities in transforming the energy system, roadmaps for key energy technologies, principles by which we can prioritize, discussion of how we should

be doing demos, and the connections between energy technology and energy policy.

The timeline is more or less as follows: Back at the end of November a PCAST Task Force chaired by Ernie Moniz and Maxine Savitz recommended, among other things, although it is the most important recommendation, was that the government execute a quadrennial energy review analogous to the quadrennial defense review.

There are many reasons why that analogy is imperfect, if not specious; but, nevertheless, it seemed like a good idea to try to have a plan.

They also recognize that doing a quadrennial energy review would be a massive undertaking because energy touches so many different federal agencies and also recognized that given the cycle in the present administration it was the wrong time to undertake that.

And so what they also said was, DOE, you go off and do one yourself for practice and we think you can do that in about six months. And it took about two months of haggling back and forth within the Administration as usual about whether we were going to do this or not. Finally, in January the Secretary said, okay, Koonin, go do it.

We have focused the exercise on technology and energy technologies because policy is necessarily much broader and so we are trying to stay

within that lane of energy technologies and the policies that might relate to its development.

And so, you know, the final document, which I will get to in a while, if it were to say you ought to increase the ethanol tariff, just as an example, that would be out of scope. But if we were to say you need price supports at the level of 30¢ a gallon to make some particular technology useful we could probably say that. So techno-economic analysis is okay, but particular policy methods to get there are out of bounds, for obvious reasons perhaps.

We put out in the middle of March a framing document, which I hope you all had a chance to see and think about a bit. Public comment for that ended a week or so ago. As XXX mentioned, there is a website that has got all of the public comments up there, they really make for quite interesting reading. They were released a few days ago.

And now through mid June we are embarked on a series of six workshops, this is the first, so you have the pleasure of helping to invent it and improve it, but it will not go perfectly over the next day, I can assure you that, that is fine. That is why it is research, right?

And the goal is by the end of July or beginning of August to have delivered to OMB a fully cleared off report on this exercise for approval,

which will probably take a couple of months and then release; certainly before the end of the year one can hope for. We are keeping as we go through this in close touch with other parts of the government; hopefully it will come as no surprise when we actually deliver the final document.

Let me talk a little bit about the logic flow so that you can understand where we are and where this discussion fits in. This was really inspired by a diagram that John Deutch put together in the early '90s when he did the bottom-up review in the Pentagon, which was the forerunner of the Quadrennial Defense Review.

It starts with three strands here, the first on the left is the energy context, supply demand, essential facts about energy.

One of the challenges, and we have framed them in terms of three right now and of course interested in hearing your comments on these, oil security/U.S. competitiveness/environmental issues that naturally lead, in our opinion, to a set of six strategies which you have seen in the framing document.

You know, I am not going to go through the Sankey diagram -- presumably pretty well known to everybody -- but an important feature that people forget, particularly in discussing alternative fuels,

is that there is effectively a line across this diagram that separates transport from everything else, and at least at the moment transport is a unique problem compared to power and heat and so has different sorts of challenges associated with it.

The other thing people forget are the relative magnitudes of the energies here, and you can say, you know, we are going to run electric cars by PV and you can just look at the magnitudes of the boxes involved and realize that is a pretty heavy if.

That kind of context is something we hope to be able to set in the framing document, I am not going to go through it all for you.

One of the reasons I am going through some of this is to give you a sense of how we are talking about it to sort of help you frame whatever individual comments you may have.

Energy security concentration of -- it is embodied in oil price concentration of conventional reserves in the hands of NOCs and the decline of the IOCs as the -- somebody said to me this morning the NOCs really start to become IOCs.

U.S. competitiveness, we don't manufacture much energy technology in this country anymore within batteries, one percent in 2009 of U.S. production.

The Federal deficits, both historic and projected, are certainly a piece of U.S.

competitiveness also, and to what extent can the development and manufacture of clean energy technologies help here.

And then, of course, the greenhouse gas story and climate as well as other environmental impact.

These are the things that we are expecting to talk about as motivations for what the Department of Energy or, more broadly, the Government is doing in energy.

The strategies we have talked about, one of the responses I would like to get from you, either individually or in public, if you like, is this the right framing of the problem, does this help tell the story to the non-expert audience. Six is a number just about everybody can remember, it more or less keys with the Sankey graph and maybe is a useful way of talking about it.

THE one that we are, of course, focused on here is the alternative fuels.

Okay, so that is what is going on in the left column.

On the right column is a set of technology assessments. And I like to think about these as the basis factors from which we will form the solution or the pallet from which we will paint the picture or whatever metaphor are the ingredients to make the stew, whatever metaphor you want to use.

We have spun up a set of 14 teams of DOE

and lab folks who are trying to construct within the next several months an assessment of technologies that the Department could be pursuing. And all of the usual suspects are there, including perhaps a few of the unusual ones.

I think we have to in order to be able to tell a credible story talk about what we are not going to pursue and why as well as what we are going to pursue and why, and so these are meant to be complete, as I like to say, not terribly detailed, kind of at the one-to-one-and-a-half significant figure level. The more detailed things, of course, are the DOE program plans, and that is not for us.

This, by the way, should also include what industry is doing in terms of technology development.

We want to know what the potential is, if we go forward what are the milestones to bring down costs, develop technologies, schedule who would do it, and so on. This exercise today is in part the afternoon will be about helping out with this.

What are we looking for in these technology assessments, why is the technology included or not, headroom technically, resource potential, what is the current state of play, what is the roadmap, what has the DOE done or not done in this technology, what are some of the policy barriers toward developing the technology or deploying it and some

technology-specific things. So it is that kind of flavor we are interested in as we go about assessing the technologies.

The last part of the logic flow is the most difficult in many ways because it is not about technology. It is about players and roles, what are the roles of the private sector versus the government, what are the roles of the different agencies within the government, how do we pull the different levers of economics/policy/technology in order to change the energy system, what are the roles of the different players, academia/lab/private sector.

Ideally answers to those should lead to a set of principles that govern the DOE portfolio. For example, DOE should work on -- more at the early end of the technology chain ladder rather than the later end of the technology chain or DOE shouldn't work on anything that can't get to at least a quad a year or 500,000 barrels a day, whatever number you want to pick, right, what are the principles there.

Some things are too immature or too far away to even worry about. Other things are too close/too commercial for the DOE to be involved with, how do we strike that sweet spot.

So it is those kinds of questions that we need to be focusing on for the morning. And I will get a little more explicit in a while.

One would then think in this sort of platonic or Euclidian view of how things work you

should be able to take the problems, the technologies, the principles, and come together with a set of priorities and a portfolio for the DOE balanced both within the strategies and across the strategies.

That is not the budget process, which has gone on quite separately inside the Department and the Government, but to certainly inform the budget process, and that is what we are trying to do.

So we are interested in your individual inputs on the roles of various players, on the principles for prioritization, and on the connections between innovation and energy technology and energy policy.

There is a chart here which is an I-Chart, I am not going to go through it, but it is a couple of the comments abstracted from the many public comments we received specific to alternative fuels.

Here is Near Zero, which is a group that Karen Frye and folks put together or a set of experts dialoguing among themselves, perhaps, considering whether DOE funding is necessary.

Jane Long, whom some of you may know, at Livermore, said biofuels are being worked very hard by venture money and the implementation problem will be a policy problem. Jane is saying, well, what, DOE, are you really doing here, other people seem to have the bases covered.

Here is somebody else: The entire

section is biased by the audacious statement that drop-in fuels have a structural advantage over gaseous fuels.

I am not going to comment on my sense of any of these, but just to tell you this stuff is up there, it is on the web, if we have wireless in the room, which I gather we do, you can all browse this stuff as might be appropriate during the presentations or quietly.

Here are some questions, let me start, and then we will get the panel up and have a good discussion of these.

There are lots of fuels and pathways, should we be making bigger bets, fewer of them, or support all bets with fewer dollars? This is a question of how do we move things forward.

What are the rules for entry, allocation, and exit in the fuels portfolio? When do we, DOE, get out of a technology, when do we get in?

As a technology becomes more mature, how should our role and posture in the DOE change?

What value does the DOE provide you, your organizations?

What has been the benefit that the DOE has given you or detriment involved in alternative fuels?

Oil prices, of course, are an important element for this discussion. What happens if they go back down to, I don't know, $40 a barrel, or what

happens if they skyrocket to $200, how should we change our priorities? How does the portfolio look different? How does the balance depend upon the oil price?

How do we balance across the boxes in the Six Strategies? In the transportation line on the bottom of the Six Strategies, result, fuels, vehicle electrification, and ICE efficiency. If one is available to go all the way in electrification to BEVs, alt fuels become superfluous for passenger cars, so how do we take that balance into account?

And how do we balance the greenhouse gas discussion against oil security, which can be intentioned for certain solutions?

How do we think about competition or cooperation in alternative fuels R&D with other countries? There are things that we want to keep to ourselves, should we fully open, when in the value chain do we do that?

Okay, to get a little more insight into those questions, we have put together a panel that we will talk among ourselves for over a half hour, I will try to keep some order, and then we will open up the discussion more broadly to all of you with the panel.

Let me start very brief introductions.

Bill Provine is currently the Director of Dupont's Biochemical Sciences and Engineering Biofuels Division in Central Research & Development and he has

responsibility for the DuPont biofuels research programs, biobutanol, cellulosic ethanol, and so on.

Bill, you will forgive me if I don't read more details of the biography. Bill, why don't you come up and we will introduce Don.

Don Paul is Research Professor of Engineering Earth Sciences and Policy Planning and Development. He is a multi-disciplinary guy, that is pretty clear. He also hosts the Tech Chair of Energy Resources and is the Executive Director of the Energy Institute at USC. And before he went to the bright side of academia he came from the dark side of a distinguished career at Chevron, 33 years, eventually retiring as the Corporate Vice President and Chief Technology Officer.

I have interacted with Don a lot over the last couple years, great to have you here, Don, thanks.

Ian Purtle, Ian is from Down Under, originally undergraduate degree at University of New South Wales in Sydney and MBA up in the Northern Hemisphere, way north, University of Minnesota; a big latitude jump. He is currently the Chief Scientist at Cargill and responsible for sustainable energy for the corporation and is immediate past president of the AOCS, and if I knew what that was I would tell you, but Ian can probably.

What is AOCS?

XXX: It is American Oil Chemists

Society, but we inspire to be a global organization so we changed to the letters rather than the name.

XXX: Last, but certainly not least, my good friend Lee Lynd, who is Professor of Engineering and Adjunct Professor of Biology and Earth Sciences at Dartmouth. I believe the best part of your title is Professor Extraordinary of Microbiology at Stellenbosch. And he is also Director and Chief Scientist of Mascoma, which I am sure is well known to all of you as a biomass energy startup that he co-founded. He has been on the Dartmouth faculty for 24 years and has got degrees in bacteriology and engineering and is all about biomass and bioenergy.

I am going to go back to some of my questions. Let me start off with a pretty high level one.

From your perspective of being involved in the alternative fuels business, what do you think the right DOE role is here? Are we doing the right things? Are there things we could be doing better given, of course, the constraint in resources? Is DOE being helpful, a hindrance, so on.

I will sort of throw the floor open for group comments.

XXX: I will start, people can always do better, right? There is always room for improvement.

But I think if you look at the DOE over

history, I think where there is probably more of value at least from an industrial perspective and from a XXX perspective is this bit about de-risking R&D in an early stage and really enabling R&D across what we see as well with the three bioenergy centers really providing and enabling technology that they basically catalyze the industry.

I think where the DOE tends to fail more so is that as it gets progressively downstream of that enabling technology I think it progressively gets weaker and weaker in terms of its ability to execute in the marketplace and really starts at times I have seen sometimes they try to drive industry in ways where they might not be the expert knowledge partner to drive industry in a particular direction, so I think that needs to be carefully thought through.

XXX: I think that the DOE has a really very important role in assisting the United States achieve its energy objectives. And it is particularly, I think, on the front end of that process that is very important.

And so I agree with my colleague that as we progress down the chain that DOE's role does weaken, but I think at some point in the transition between providing a great deal of initial support that the role of the DOE really should move to a different one, which is creating an appropriate -- or assisting in creating an appropriate policy to ensure the commercialization of the tracks that are chosen.

XXX: Certainly I would agree with what my colleagues just said. I would add a couple of things.

One, the maintenance of or the enablement at least of the science base upon which the technology development takes place, and this is a long-term objective in terms of supporting in particular the strength of the U.S. science base and that involves an educational role, I think, to some extent as well, and one thing that hasn't been mentioned but I think is important, as was important when we were at XXX and interactive, for example, with the National Laboratories on advanced computing. I mean, I know that that is something that as time goes on the ability/the role of the advanced computing simulation, things like that, as you build out evolve and diversify the energy system is important as well.

I would agree with my colleagues that in general as you move towards commercialization the role changes.

I do think that as we have diversified what I would call the invention end of the energy system with more start-ups and more diverse approaches to producing fuels there is a gap that was historically filled, for example, in the major energy companies where we went from benchtop to pilot to demonstration of scale to commercialization.

There is a critical gap sitting around

pilot, demonstration, and scale where if you have a very diversified front end the question is how does that get done. When it was all internalized inside the big oil companies, we did it. If we had to go out and build a $500 million plant we did it. For a lot of start-up companies that is not even in the realm of possibility.

So I think there is this question is if you diversified the invention part of the system, where does that sit and how does that get done.

XXX: I think that what the DOE should be doing is very, very important and I think that DOE does many things well.

Specifically I think the mission statement that was in the document circulated is rather good, I am not particularly clear how I would improve upon it. And I think the six areas are very good and very specific. It may be that people can recommend improvements, but I think those are a good start.

At the same time, I like most people in this room have been interrupting -- interacting -- maybe interrupting too -- interacting with the DOE for decades, and it is not just my opinion, everybody I have ever met -- and, XXX, you and I talked about this briefly before the panel -- feels that DOE could be more effective.

Now, that is partly because everybody has a little bit different idea, no one will ever be

completely happy, I understand that is a piece of it. I don't think that is all of it.

I tend to think somebody in government, and I tend to think it ought to be the DOE, needs to radically accelerate actual deployment of technologies.

I understand that that is complicated, but if you sort of take that out of the equation and just wait for the private sector to act I think that we get where we need to go with some urgency a lot more slowly. So I don't know if I disagree or not, I am not sure if you folks were saying that it happens less well or it is less important.

And I would also like to underscore and expand on this notion of a gap. There is this idea of the progression of technology from early stage through pilot and all the rest of it, and I agree with the gap that you described and I agree that that has widened with different players being involved and, frankly, even the large companies often reconfiguring how they approach this sort of thing sometimes could be more like small companies explicitly, which is interesting to me.

But I think there is another dimension to it that I see really acutely. Look, I go back and forth daily sending e-mails and exchanging e-mails with a biofuels start-up company and with a bioenergy research center and I see each of those entities

expecting the other person/other entity to do some things that in fact aren't happening very much. They are, broadly speaking, in the innovation domain.

I see an innovation gap, which I don't think is quite the same thing as sort of the piloting gap and I think that it would be very useful to think about filling that.

XXX: All of you raised the issue of the DOE necessarily interacting with the private sector, and I heard from some people that we perhaps are weaker as we move down the technology chain toward deployment, we the DOE.

One of the things that has impressed me, and I have heard it from a number of other discussions we have had within the department, is we are aspiring to catalyze the private sector. After all, the government can't spend enough money to change the energy system itself. But we, the government and the DOE in particular, don't understand the private sector as well as we might and perhaps not well enough to do a good job of catalyzing.

Reactions to that as individuals? I mean, you all have private sector experience. Do we understand you?

XXX: I think the short answer is no. And I think that activities like this are going to at least start to breach that gap and have these types of conversations that we learn more about each other, because I do think that it is a two-way street.

XXX: I guess a couple of comments there, XXX, and of course you have been on three sides, you kind of see all the dimensions.

I think that there is intrinsically a challenge to understanding each other in part because of the fundamentals. In business companies invest their own money and live or die. In government you are investing on behalf of others, there is a natural -- it is more of an open loop process.

I think that is what distinguishes, I would argue, DOD from DOE, DOD is actually the consumer of what it develops and you have a different process.

I think the other key thing that where I know you and many in DOE understand this, I think broadly speaking, there continues to be a challenge when you talk about the energy system of actually understanding and embodying, I think, in your strategic plan the issue of scale matters in energy. It simply is the overriding issue because of the amount of capital that has to be drawn ultimately from the private sector and, therefore, the time that it takes.

Maybe we will get into this debate about should you accelerate the rate of deployment or should you have perhaps a somewhat elevated but sustained effort. I think one of the biggest problems in energy R&D that I have seen over both from a government

policy as well as the private sector is things come and go, and things coming and going has a material effect on things that take decades to change.

So I think scale matters, maybe we will talk about a target, about what matters. In my personal view it takes a million barrels a day on the national system to move the needle. That is a huge number any way you want to cut it. It takes decades to do it.

We can argue about how fast you want to deploy new technologies and get stuck on the front end when they are expensive, but those are issues that I would say.

But there is an intrinsic challenge to understanding it could be better. I would argue that perhaps it is better, at least in some segments now, but there is an intrinsic challenge because of the differences.

XXX: Maybe just to add a couple of points. I mean, part of the dynamic here is the scale of funding that is brought to the table through the Department of Energy and other government agencies. So the small amount of funding, right, at the position of catalyst I think is appropriate and then at another level of funding that is like the banker, the investor, something that is fully funding and enterprise becomes different, maybe more of a DOD sort of model. It depends on the role in the strategic plan nature, which tends to be more of the

catalyst it looks like of the Department of Energy.

I would say as you go down progressively down the point of needing an investment, what I worry about is the government pushing bad projects to market more quickly just for the sake of saying something can be done.

If as you progressively go down that chain if you don't get more people to buy in with their own money as things progress I think we might march ourselves right off a cliff, so that is what I would worry about.

Another point I want to say in terms of looking at the strategic plan is I know we were kind of disconnecting the whole policy domain here, I find it a difficult dilemma to have the strategic plan without a solid policy or know basically what you are aiming after and knowing that that policy is setting up the market opportunities for industry to also respond to.

So wherever we can somehow/someway figure out how to connect a more strong policy environment with appropriate funding from the government and then across the agencies of the government, not only within the DOE, which tends to be somewhat disconnected between the departments, within the Department of Energy, but also between the DOE and the USDA or the DOE and the DOD and the other agencies, I think is very powerful. The United States is the leader here

in alternative fuels and we have got to capitalize on that.

XXX: Before I let you say something, let me just talk about goals, I mean, I didn't put up a slide.

The administration at least has a number of concrete goals that bear on energy matters, reduce oil, some people phrase it as oil imports, but everyone knows there is no such thing as foreign oil, there is just oil, volume three-and-a-half million barrels a day, clean electricity to 80 percent by 2035, a million electric vehicles on the road, so there are some goals.

There are not the policies in place, they are being discussed in order to get to those goals. And then, of course, the strategies for the government within those policies is what we are talking about here really.

There are some concrete goals, whether they are achievable, realistic or not, remains to be seen.

I am sobered by, when is it, 1991 or '92, the government said we are going to have 30 percent alternative fuels by now, and of course we are at 9 percent, 8 percent by volume, right.

XXX: And I think those goals are great, I am 100 percent behind those goals. It is a question of having goals turn into policies, the part that other people will have a decade-long investment

profile to know that when you get there you haven't wasted your money.

So that is the disconnect, it is like how can we change that dynamic. I think that is the innovation, getting back to XXX's point, that is what is creating this innovation gap, is not having that faith or substance in the long-term policy.

XXX: Predictability.

XXX: Predictability.

XXX: Just quickly, you asked, XXX, does the DOE understand the private sector. Well, I think not completely.

But if you take a step back it seems to me the job of the DOE is to represent the public interest, and so there is also an issue about the private sector in completely understanding the public interest and as someone mentioned it is a two-way street. And it seems to me, okay, fine, understanding is incomplete, but it is vital that that effort continue of the two sides understanding each other because I truly believe that without that these kinds of goals you are talking about will not happen on their own and you said yourself with respect to policy.

And, in my observation sometimes the DOE acts with too little regard for industrial realties and, frankly, sometimes it pays too much attention to them.

I remember long enough ago that this particular individual has probably moved on from this particular branch of engineering -- of the Department of Energy, but with this very proud, almost chest-thumping attitude, I remember a particular representative within DOE saying we do what industry tells us. And I was like, you know, the job of the DOE is actually to do what industry won't do in the public interest to fill the gaps to accelerate, et cetera.

I think DOE needs to have itself understanding, and it often acts if it doesn't have that, and that is actually the departure point, and then understand industry. Often DOE is sort of in this middle ground and not that satisfying to people on either side.

XXX: This exercise is partly for internal in the DOE and, of course, partly for our role in the bigger picture.

We have had I think eight or nine internal focus groups where we spent a couple hours each with DOE folks just talking about these same issues. Yes, we are trying to figure out what we are internally as well as what we do externally.

Again, frankly, for someone who is relatively new to the government, you know, five or six years in the energy business, it is somewhat surprising that no one has been asking these questions before.

I will put another sort of high level question for which we get a very interesting range of responses.

What do you think the current principles are that define the DOE's research portfolio in either alternative fuels or, more broadly, in energy? If you were asked to tell the story about why the DOE does what it does, what would you say?

XXX: A perspective I have often heard, it is only a partial answer and it is not a complete one or a fair one entirely but there is some truth to it, if you put a black box around what the DOE does and you sort of try to reverse engineer the algorithm that is operative in there you would come out with the conclusion that being constituent responsive is very, very important. And I think sometimes that is at the expense of being vision responsive, which goes back to the earlier point.

XXX: Anybody else on reverse engineering?

XXX: Looking at some and not looking over the entire Department of Energy, which is a fairly broad concept in looking at alternative fuels, a lot of it seems to be response to legislation. Getting back to XXX’s comment in terms of if the constituent is the legislation and then that is the U.S. citizen, if that chain works well, which sometimes it may not, but I think it has been very

responsive and not much as the leadership vision, even though at the highest level I think there are those leadership principles, but when you get back and reduce to fundamental principles in terms of funding requests for proposals, I think it becomes much more responsive.

XXX: I think the Constitution says we do in fact work for the Congress.

XXX: I understand.

But in some ways, too, you can -- it is a question, too, the question how can you influence through your expertise once they come back to you, it is an iterative conversation, I don't think it is a one-way conversation, it could be much more could be beneficial to -- I don't see everything, but it would be nice to have a much more iterative conversation.

XXX: I believe XXX assessed it was a similar reporting relationship conversation to Congress, if I am not mistaken, and the dynamics are very different there.

XXX: NSF is not -- I love the NSF, they supported me for 25 years when I was a professor and have great sympathy for what they do, but they are not a mission agency in the same way that the DOE is. The NSF mission is go out and educate, support basic research. The DOE has got very specific missions.

XXX: But the relationship to Congress is structurally similar, is it not?

XXX: I think Congress' attitude towards NSF is different than it is to DOE than it is to DOD and NSF, different.

XXX: I think one point, obviously there is the national security component of the DOE in its historical role and in particularly the nuclear weapons program.

There is the National Labs, which are a unique entity in a sense for DOE as well. When you get into a whole discussion about what are the National Labs and what should they do, of course they originated primarily out of the national security interest.

I think there is a broader issue, and one could talk about it is complex because it ultimately crosses the boundary to other federal agencies.

But one of the points I am willing to make, I don't think it is reflected as well as it should be in the framing document, is that energy ultimately in any form is tied to some form of natural resource. I don't care whether it is wind, sunlight, oil, gas.

And, historically, although it has been part of the Department of Interior, there is a linkage between the development of U.S. natural resources and the energy phase.

In fact, when it comes to competitiveness, which is another theme, just wanted

to get this out before I forget, among industrial nations U.S. has by far the most diverse, largest natural resource base. So one of the questions is why wouldn't providing the technical -- some of the technical underpinnings, enhancing the development of the technical underpinnings for the development of those natural resources, be part of the role of DOE.

And this particularly is true today with now the emergence of the opportunity that has lots of molecules and unconventional resources, lots of challenges that go with them, that the development of U.S. resources to feed the energy supply system one could argue is or is a mission that DOE historically has had some kind of mission, certainly back in the late '70s, that argue how well it all worked, but there was an imperative about the development of U.S. resources and DOE provided the technical underpinnings.

XXX: So the way I look at this is that really I think the DOE can play a role of strong advocate to Congress because DOE clearly has the technical expertise that Congress does not. So I would look to the DOE to play that role, say, guys, this is what needs to happen.

XXX: I would like to refine that question a little.

We should advocate for technology, specific technologies, or we should advocate for a sound techno-economic basis for whatever Congress

decides?

XXX: Well, you know, it is a whole bucket of things, so it gets to my point a little bit, it starts out, you know, what are our national energy objectives, on a very broad sense, gets back to analyzing then what resources do we have in this country to achieve that goal.

So we have the raw materials that XXX alluded to, we have the National Labs that XXX alluded to, and then the question becomes if we do an analysis of where we want to go, set the goals, what we have and what is missing.

And so basically, I think, you got to look at it as developing a business plan and from that business plan become an advocate to Congress to get it done.

Now, is it technology? A part of it is. A part of it is supporting implementation. A part of it is measuring the end results of did we achieve it.

You know, you should look at the success of the Department of Energy's support of the ethanol program, I think, as being quite amazing and we got that capacity on the ground ahead of schedule. So there is a great success story.

XXX: And we support -- the Department supports very little ethanol work right now, it is starch-based.

XXX: And I don't think they

should because the industry should become self-sufficient. If they can't be self-sustaining at this capacity then there is a whole other problem.

XXX: Would you extend that same perspective to the oil and gas industry, it is an even much bigger industry, self-sustaining? Is there a need for research involvement in oil and gas or do we let the industry handle that one also?

XXX: I will let XXX answer that one.

XXX: I guess what I would say is on the far front end, I will use some specific examples, we did when we were at XXX we were developing the next generation reservoir simulator, which we developed on a proprietary basis, hundreds of man hours worked. We worked closely with Livermore Labs on some of the fundamentals of advanced computing, gridding, how do you make multi-billion cell models; a trivial issue if you are going to do it.

At the very front end where you have advanced technologies, particularly computing I would argue is a singular role because labs can have machines that are not commercial yet but you know what they will be when you get there in ten years they will be, so that is a huge advantage for anything dependent on that; fundamental science all the way up.

Then I think when you get to situations where there is a clear, emerging political boundary issue which could be, for example, the issue around

environmental impacts around the development of unconventional resources, there is a role there because that is not a role that industry by itself, I mean, in this case is going to do and ultimately going to probably have to develop, commercialize, and implement, but when there is a political environmental boundary then I think there is a role. I would say the same thing obviously in the nuclear arena.

XXX: And I think you have seen the government or you will see the government step up to that in deep water and also in shale gas, unconventional.

XXX: Let me give you an example of where I think the DOE also can play a very important role, so if you look at CO2 emissions as an example, you asked me about what should the oil and gas industry do.

Well, the oil and gas industry together with the coal industry produces a lot of the carbon that we use. And then on the other side of the coin we have the power industry which takes those raw materials, converts it to electricity.

I think there is a great opportunity for that group to collaborate with the support and leadership, initially at least get them together, leadership from the DOE in initiating that to look at so what can we do with CO2. Clearly with the depletion of our oil reserves we are going to need to

be looking at enhanced oil recovery, and one of the ways to do that is to use CO2.

I know the DOE has been working in that space and I certainly support that and I think it is a great idea, but I think the industry base should be broader.

XXX: So, you know, a view at one end of the philosophical extreme, people say that is great, it is not the government's role to stimulate that, if industry sees an opportunity and a need to do it they will do it, and otherwise, government, you are trying to pick winners and losers and don't go there.

The same is true in the deployment story, and just return to that discussion for a minute, of where the billions of dollars of capital will come from. The DOE has had a loan program, a loan guarantee program, for a while now and there are a number of folks who say that is just not the government's role, it is in the end the private capital market that does the best job of allocating, people say, Capital and Government, you stay out of it because you will have all kinds of distortions associated with distributional politics, et cetera, et cetera.

XXX: I don't disagree with the essence of your comment. However, you know, I think there is a role, a mediating role or initiating role, that DOE can play to bring these people together. After all, they are all involved in the same thing.

XXX: To get back to the point about being a catalyst, I think especially as you go in the deployment or into pushing traditional oil and gas into new territories is providing the mechanism via the catalyst, whether it is in the deployment projects where I think we have to question is the vast majority of the money to make those projects are happening are all coming from the government when you look across loan guarantees, grants, what have you, I would say that is not quite being a catalyst, that is being the funder.

But if you are in there with a program that catalyzes other people to bring the money in and de-risk the proposition, I think that is the role I would like to see of the Department of Energy is in that catalyst role.

XXX: In the financial sense.

XXX: Or the technology or finance side, either question, you have got to get the whole innovation chain going, so either one.

XXX: I think one of the ways without answering the question but looking at the strategic plan is to understand the nature of the supply chain for each of these things because they really don't look the same.

For example, you mentioned coal. The coal industry and the way coal is used and developed as a natural resource, the structure of that industry

and supply chain doesn't look anything like oil and gas. I mean, and the resources available for research and new technology are vastly higher.

One could argue that has been the problem of geothermal development. When geothermal was developed originally in the late '70s it was oil and gas companies that did it. Why? Because geothermal isn't a power business, it is a natural resource business. They knew how to drill wells, they knew how to develop resources. They sold out of that, it got acquired by utilities and that was it. I think it is important to understand. And then when you have start-ups with new kinds of feedstock sources being brought into the system the supply chain is not very well developed either, so that may require a different role.

And so I don't think it is a one model. I think it is a question of what is the development, what resources are being developed, what is the role of the federal government in that resource.

That is another thing that hasn't been mentioned. The Federal government is the biggest land holder of the United States, it has a big effect on natural resource development.

What is the nature of these supply chains and where is the place to play?

XXX: You all --

XXX: I think it isn't a simple one-answer model.

XXX: You all in the various industries understand the supply chains, you have to if you are going to be able to do business.

I will come back again, several people -- I won't put my own opinion in -- have said the Department does not understand those supply chains as well as it could to be effective. We tend to do more widgets --

XXX: I think that is key.

XXX: -- in discrete technology development.

I didn't get consensus there and I am not looking for it.

XXX: I think that is partially the challenge of going between the department agencies like the USDA when you talk about alternative fuels, not having a stronger bond there I think you start to -- the supply chain breaks down whether the DOE is even given the biomass source, well, that is the USDA's problem, but you get into alternative fuel but that is DOE, so you get a little of the bit back and forth action there, it is not like completely disconnected or common objectives there, but it would be good to get a stronger bond there.

XXX: This notion that you were referring to a minute ago, XXX, of step aside and let the private sector optimally allocate capital, that will be true, that will work, according to the

private sector's objectives. And if that is all that was important then that would be a great idea.

I think it is a bit of an idealistic or idealized, I should say, world that, you know, DOE can keep its nose clean.

To me catalytic investment, when you consider the cost of the status quo and the idea that we are either choosing to not invest in little, inexpensive things or continue to bear the costs of big, very costly and risky things to me it is rather a no-brainer and I can extend the notion of catalyst well into commercialization, and I urge that we do that.

One of the realities, which I don't know is widely appreciated, is in my opinion there is a tension, because on the one hand many of the environmental advocates recommend say, look, we want to be technology-agnostic, we want to be outcome-focused, which for one thing has proved hard to implement as a practical matter and so we can wait for perfect outcome focus legislation, meanwhile various clocks are ticking with all sorts of price tags on them.

But the other problem is that a lot of those incentives, although they may work theoretically, are really heavily discounted when you go to investors. If you go to an investor and you say this investment depends on at least ten years of continuity of government policy, they will either

discount it or some will simply say I don't invest in ventures based on that, this is from direct experience. By contrast, if the government comes and says here is a check for half the capital cost it is a done deal and it is not discounted.

That is the tension, that in an ideal world everything would be outcome-driven, but for various reasons that isn't very effective.

That is what drives, I think, drives people back to, yes, some of this "picking winners." I think what we need to be doing is picking a broad enough slate of winners that we are willing to fail and recognize that is part of the thing.

As long as we are talking about government providing capital, the government has to have a higher risk threshold than the private sector or it means absolutely nothing, and that has been significantly in doubt of late.

XXX: I was just saying I think it depends on looking at these change in where you are. In the end, 95 percent of the energy infrastructure is privately owned and is going to be funded by private capital. Ultimately investors must be able to invest money and make money on a risk-weighted rate of return basis. If you cannot do that it is not going to happen no matter how interested people might be in it being of the public good.

XXX: The key thing is when you have

got new, high risk technology competing with established, low risk sub-cost technology you can either help things over that hump or not.

XXX: And it is the helping over the hump or not, and that is the way --

XXX: Obviously to propagate it has got to be driven by a private sector engine.

XXX: And this is the challenge of whatever you want to call, public investment incentives/disincentives/subsidies is that ultimately they have to go away and the entity must make it across the line. Sometimes they don't. In other words, they get to the point where without the subsidies they can't survive.

So it is a complex process, it is not completely clearcut about how in looking at that in looking at when will private investment come in at scale and what will cause it. But the business model risk is a serious issue for private capital investment, with good reason because they are going to invest billions and are going to live with the thing for 20 or 30 years; startup doesn't have to live with it for 20 or 30 years.

XXX: I am going to ask one more question and then we are going to open it to the audience.

XXX: I just would be very cautious about which hump to get over at what point in time. What I worry about is sometimes they are trying

to go too quickly all the way to build a huge plant just because private -- just because venture capitalists want to cash out as a potential issue.

So I think you have to be very careful that every project you cure the challenges in the laboratories and the pilot plant and then you get to commercialization. If you don't have in that first plant a good economics in for the first commercial demonstration you are probably going to be failing long-term, and I really worry about that.

XXX: No argument there.

XXX: Let me put one more alt fuel-specific question to you all and then we will open all of this up for a broader discussion.

If I try to parse or pull apart the oil security issue, there is several different dimensions to it. One is the geopolitical vulnerability of increasingly concentrated resources. Another is the billion dollars a day that is going offshore in a balance of payments for imports. Another is the greenhouse gas issues associated with oil use. And the last is the price and not only the magnitude but the volatility.

And it seems to me a theorem, and I would be happy for counterexamples, that any fuel that we produce domestically, whether it is biofuels or enhanced domestic fossil production, will not materially affect the price at conceivable production

levels. It is a global market, anybody in business would be a fool to sell a fungible liquid fuel at other than the global price.

Have I got that right or is there something I am missing?

XXX: Well, I think fundamentally, XXX, I would agree with you.

It comes down in part to volumes, I checked a website this morning, at 82-1/2 million barrels a day global production many people think it has to get to 100 over the next several years, so a million barrels, even a million barrels a day would be a significant -- that is the equivalent of ethanol, current ethanol production, so its weight of that is not going to move the price anymore. In fact, demand outside of the OECD is the driver for the price of crude long-term, it is not the advanced economy.

So price is what it is going to be, I guess, is what is the basic statement.

Diversification, on the other hand, can have a material affect on your -- on the issue -- on what might be judged by investors as the risks associated with supply. You can change the risk profile even though the price itself which is set by a number of factors goes up and down and around.

And I think that is important because it is the risk profile in addition to the price that affects long-term capital investments.

XXX: But will not change the

consumer price at the pump materially, no.

XXX: If you can make it cheaper and sell it at world prices you would.

XXX: By and large I agree with what XXX said, I don't think anybody can really accurately predict what is going to happen, it is a combination of factors, you know, we have got demand increasing, particularly in the developing countries, the United States is embarked on a program whereby we hope to at least drive down domestic consumption along with electrification that is going to have a hopefully big impact so as demand goes up in the developing world hopefully consumption will go down somewhat, and then we are dealing with a limited resource that in many cases it is depleting.

So it becomes a balance, and I don't think anybody can predict how the balance is going to work out, other than to say it is going to remain volatile.

XXX: Well, for local markets I think it is a combination in terms of the industry is going to be driven to the lowest cost of manufacturing source and you sell to the price where you are going to get the highest price for your product where government has an ability to influence that, of course, and it gets back to the policy, where there is tariffs, incentives, and mandates aren't going to influence the price, the local price point of the

product, whether you keep the product where it is locally produced and how do you catalyze that local production gives you the opportunity to influence it more strongly.

XXX: The government can't influence the price in various ways.

XXX: It seems to me the basic dynamic, I think this was already said, whatever is produced in the largest amounts will dominate the price. And as long as that is petroleum then any alternative fuel will sell into prices determined by petroleum.

For those of us who look to the time when that is not the case anymore, which I believe is quite possible physically, then the dynamic shifts. When petroleum becomes the minority player it won't dominate the price anymore.

Just to comment, this is part of where the very attractive margin for some of these things is.

Interestingly, if you track the price of corn in dollars per gigajoule which is remarkably similar to oil. Now, I am not saying either one of those is an unfettered market. If you look at the price of cellulosic biomass it is about a third of the price of oil in the dollars per gigajoule basis.

So what that means is if you can lower the processing costs one can sell into this oil-dominated market and the prices will not be

oriented to your production costs and so that is, again, on the other side of the hump when the thing becomes self-sustaining, and I couldn't agree more, the government steps out of it and says, look, we have been a midwife but now the baby has got to grow and become a full-standing adult.

XXX: I am going to open it up. We have had I think a good half hour with substantive remarks on a number of different topics. I am just going to open the floor up to all of you to talk with the panel about things you have heard, things you agree with, disagree and so on. Things you didn't hear, right?

XXX: I am XXX from XXX.

I have a two-part question, one on the science side and one on the policy side.

Just to make sure I am tracking with the panel I am trying to find if there are commonalities being what you said and I want to understand some of the verbiage that was used.

On the science side it appears -- if you think about the notion of pre-productive capital or pre-commercial capital, it seems that all of you seem to think that there is a role for the DOE to de-risk investment in those long horizon energy solutions that you think might have some promise based on a certain set of criteria.

What I was not too sure on the science

side is some of the words that I heard about implementation, deployment, the fact that the DOE -- no pun intended -- loses energy further down the chain, I heard some issues about supply chain and infrastructure, and then you put this all under the context of what the president said which is, you know, we seem to hit the snooze button when oil prices are low and then we seem to talk about a lot of R&D when the oil prices are high.

On the science side my question is do you have any thoughts of how the DOE or the government can take these de-risks or pre-productive or pre-commercial opportunities and create over a long horizon a sustained and substantial investment portfolio? I remember when I came out of college Fisher-Tropes and gas liquids and in situ gasification was all the vogue and then the price of oil dipped and off that went. That is on the science side or technology side, that is the question.

On the policy side if you look at everything that seems to be framed through economic competitiveness, energy security, and environmental and then you look at DOE, Department of Commerce, Department of Defense, there seem to be a lot of stakeholders involved and sometimes with competing, let's just say, objective functions.

So not that I am advocating an energy czar, but how do we bring all of these competing objectives into focus because, clearly, the DOE cannot

just implement policy on its own.

And so the question on the role of the DOE in policy and how does that get elevated to something, say, similar to a treasury secretary or an overarching economic constraint in this case viewed through that prism.

One question, just to repeat, on the science side relative to sustained and substantial investment through the cycle of oil and gas prices, what role do you see in terms of implementation and deployment because it is not really clear that you had a commonality of views.

And then the second on the policy side is how do you think this could be more efficient given the fact that there are so many stakeholders involved.

XXX: Anybody want to take a crack at either?

XXX: Well, maybe the comment of oil and gas price gets back into a vision and seeking the vision and I think through different parts of that we look back at on the strategic plan, the statements right back in the early '90s I think it was, of the visions that were important then are still important today, but we have lacked the continuity and force over that course in time. I hope that we are learning from that in that we figure out ways to push that forward.

I do think we need to do it somewhat

irrelevant of oil and gas pricing, that we have to keep pushing a portfolio of technologies forward so they are available to basically if when oil ends it is there; when oil spikes are you able to balance.

I worry about not having to choose between energy security and environmental parameters, I would like to see -- I think it needs to be an objective to do both of those together. The only way to do both of these together is making sure you progress through that innovation pipeline to the point they are commercially relevant so you are not forcing saying, oh, I am going to go be non-sustainable temporarily because oil is at $200 a barrel.

On the positive side, the presidential leadership, that is a tough one, how do you get everybody to come together and act as a happy family. You would like to do that in the U.S., you would like to in the world, what about China, what about India, the whole environmental factor of what we do versus what other countries are setting as standards; that is a challenging one. It is definitely starting with good presidential leadership is important, I think he is driving in the right direction right now.

XXX: I am going to break in with my own answer for a second or comment.

It is interesting to compare energy and defense. As already mentioned, the government is the sole customer for defense in many ways.

But even beyond that it has taken a number of steps to make sure that defense -- the defense mail gets answered more or less independent of the political situation. We have a uniformed service, we have a professionalized acquisition core, we have institutions like the Joint Chiefs of Staff and the office of Secretary of Defense who explicitly see it as their job to damp out the political influences. We have the National Security Counsel, we have special arrangements in the congressional committees, we have a Quadrennial Defense Review that has a five-year time arising.

If energy were as important as defense we do things like that in order to guarantee some predictability in consistence. We haven't yet.

In fact, you can go back and read the enabling legislation for the Department of Energy in 1977, and I read it, say, gee that sounds like the right thing, but somehow not much of it ever happened.

XXX: Briefly, I think you did hear agreement about pre-commercial capital that -- overall I believe that is the term you used or some equivalent, overall that is a good idea. I suspect in this or any other group you would have diversity of opinion about some of the specifics.

I think I can't fully answer the broader political question, except to note that as I have gotten to know both the private sector and the government, one of my sort of disillusionments -- I

think part of what it needs to do is understand the problem and then you can then better target the solutions.

I always thought abstractedly the government ought to act in a longer time horizon than the private sector, and I find it is actually often the other way around. And I think until that is remedied, and that is a very foundational fundamental thing, it is going to be tough.

Finally on the relationship of energy and defense, I think it was the 1997 PCAST report that noted that the threats to U.S. security from inadequacies of our energy supplies are likely to be greater than inadequacies of our weapon systems.

Another way to put that, and I challenged my friend James Woolsey to do an analysis of this with me but so far he has demurred, look at including all of the secondary spinoff effects the net economic impact of exporting weapons versus exporting renewable energy technologies. When you think about whether you are enhancing or undermining the security and financial stability and customers for our products and whatnot overseas, I actually think it is a no-brainer. I think that comparison is a very relevant one.

XXX: I am XXX from XXX, so I am a little bit defense.

Aviation has been absent both from discussion and from the framing document. I don't

know whether to be encouraged or discouraged at that because it has different characteristics.

It is about 14 percent of transportation fuels, I believe, but the vehicles don't turn over quickly, they have a 30- or 40-year economic life. We can't electrify them because the extension cords become troublesome after a few kilometers. It is the nation's largest manufacturing export by far, and when Boeing goes on strike our balance of payments fall precipitously.

And there is good news and bad news. And I think there is a role for -- I think people think it is a DOD problem because DOD uses so many airplanes. It really doesn't. The entire U.S. Air Force could operate out of Dallas-Ft. Worth, there is enough runways, supply tankers, taxiways. In terms of fuel consumption it is about fifth or sixth largest U.S. airline. So it really is a commercial aviation issue.

Our airplanes take off from New York and Chicago and they fly to places where they are going to be taxed next year for carbon taxes for fuels, so they are internationalized.

Here is the good news. The good news is aviation really needs a hydrocarbon fuel. Only kerosene of the things we know of has the energy density necessary for high, subsonic airplanes. So we need this, we can't use hydrogen or liquified gases or other things, we need kerosene-like fuels.

The good news is there is one, there is a

drop-in fuel that will be certified by the end of -- this year, I expect, all commercial and military airplanes will be certified for hydro-treated renewable jet, which is made from vegetable oil in conventional refineries. So it has great advantage in it doesn't need much capital.

So here is the challenge. It is made from vegetable oil. When I look at how much vegetable oil is produced in the U.S. and aviation consumes about 2 million barrels a day, I think, we need about 700 percent of the arable land in the country to grow biofuels.

So while we have taken care of the capital, we have taken care of the vehicle technologies, what is missing is the basic science that says that 100 gallons per acre per year, I think that is about .05 percent solar-to-fuel conversion, that it is plausible that we can get enough biofuels.

About 70 percent of the U.S. aviation fuel is used in only 30 locations. So distribution isn't a problem, the airlines would love to buy it and buy all they can. The question is where is the basic science to provide credible amounts of fuel so that as the aviation industry plans for 10, 20, 30, 40 years out we can say, yes, it is credible, we can convert to these sorts of fuels.

XXX: I think comes back to the scale issue.

XXX: Really biomass or efficiency.

XXX: Can you grow enough stuff.

Somebody want to address that?

XXX: I think the key point there is that there are alternative ways to make fuel aside from petroleum.

One of the things we haven't talked too much about is the conversion of other sources like natural gas. There are technologies today, one can argue about their capital efficiency, there are big plants being built to convert natural gas to hydrocarbon liquids. I am confident that this issue of conversion technologies of diverse sets of feedstocks, like natural gas, potentially coal, all of these things, could be converted and make jet fuel.

I think that I am personally not too concerned about that. Unless your requirement is that it be biologically-based.

XXX: No.

The requirement is that aviation has committed to CO2 neutral growth for the next 40 years. So as aviation grows five percent a year, and we want it to because it is our biggest export, over the last 50 years of jet aviation technology has given us about two percent a year, so the only solution to low carbon fuel.

So we need a low carbon fuel, I don't

care how it gets made, you can make it in nuclear reactors, but it has to be low carbon and presumably we want it to be domestic.

XXX: But the low carbon has to do with the feedstock and the production process. Ultimately the combustion is going to be the same way however you make it.

XXX: As much as I love technical detail, I would like to keep this morning to higher --

XXX: Maybe just one point in terms of there is a lot of those six frameworks, the important part was raised in terms of within deploy alternative fuels, how are you going to manage the portfolio between diesel alternatives, gasoline alternatives, diesel -- between long-haul diesel and aviation, so I do think there is a lot within that one bucket as an important point. Versus you look at electric cars there is a lot more, it is almost like that is a predominant theme in the strategies.

Exactly how you are going to manage the portfolio between those six buckets becomes an important decision.

XXX: I just have a couple of -- I just have a couple of comments.

XXX: You should tell everybody who you are.

XXX: My name is XXX at XXX.

I guess the first point I would like to make is that we have to be very precise about what the

national energy goals are, and a lot of terms are being thrown, some of them are actually not feasible in a global economy, like foreign oil imports, and to the extent we propagate those loosely-defined terms we are kind of fooling ourselves and then we just pick what we want to pick by latching onto the goals which pick those solutions.

And then, secondly, is how do we prioritize those goals because there are very few solutions that are ready that do not -- that meet all the goals in a cost effective manner.

The first point is just more definition and preciseness around goals.

The second point is time scale.

Technology development takes a decade, as XXX said, political changes takes two years, four years, six years. And that is why coming back to XXX's question, the time scale for DOE is smaller than the time scale.

One way to approach it is to say what port of your portfolio is less susceptible to political changes because in research moving it up and down is actually very counterproductive.

XXX: Basic research is apolitical, we can fund support for basic research everywhere all the time basically.

XXX: The third point is competitiveness.

Competitiveness is more than energy. In fact, if you look at last three years, four years, the oil price is disconnected from gas price. There is renaissance, a renaissance in chemical industry, chemical industry is relocating to the U.S. There is a renaissance in oil export -- energy intensive exporting commodities, and that is because of natural gas.

And you say what role did government play in that? I am sure in the early phases there were some DOE funding, I acknowledge that, but when I look at the QTR document shale gas is almost treated as a combatant because it is a competitor to renewable energy. If the goal is competitiveness, then that is -- it will reflect on that.

Lastly, I will just say technology is used as a policy fix rather than as a policy supplement and there are tremendous dangers in that.

Four points.

XXX: Let's go in the back.

XXX: XXX from XXX.

I found the discussion on jet fuel very, very interesting and would like the panel to comment on the prospect of some of the barriers for ethanol expansion and I will relate it back to jet fuels in just a second.

We pretty much are at the blendwell of ten percent and if we wanted to develop additional supply, regardless of what that supply is, we have

known conversion technology to make ethanol and we have examples where ethanol is used as a fuel and up to 100 percent.

Yet if I want to go to a gas station, one, my car was just totaled, I am trying to find a new car and some of the models that I want to drive flex fuel is not available, many of the models, I can't even go and buy a flex fuel vehicle for particular model that I want. If I want to go to a gas station and I want to fill up I can't choose as a consumer to dial between zero and 100 percent ethanol or zero and 85 percent ethanol and I can't do that under a canopy of a major oil station.

So when you talk about the role of government and everyone says, well, it is the early stages, yet we are seeing large barriers and I am seeing where the National Labs and NREL is an example have done a lot of work in terms of certifying vehicles and qualifying them, yet we have these small engine issues. I would kind of like them to look at that.

When we take it to jet fuel why not displace more of our current fuel and transportation where we have known technology that can compete in an economical manner with ethanol in the future and allow more of the oil to then be converted into petroleum. So we have the concept of offsets that are I can buy green credits for my business or why not kind of think

about it in terms of a broader and more comprehensive type of goal. Thank you.

That is a question for the panel.

XXX: If I take your two comments together, and it is not a total answer to either of you, but I am sure my colleagues will fill in, I think we need to understand what the most important barriers are.

With respect to biomass I lead something called the XXX, we held meetings in every continent in the world last year and we are not going to prove it this morning or even this year, but it is my feeling that there are redundant ways to provide for the world's mobility several times over from biomass, not producing vegetable oil crops. We could go into the details, and I don't think we want to, but I think clarity on that sort of question would be extremely useful in strategic framing. And there is a certain dynamic that DOE doesn't want to mess with often things having to do with agriculture and USDA often doesn't want things to change so these important discussions don't happen.

I think that we need to understand that realistically commercially you can't do too many new things at once. If you ask people honestly how long is it going to take before we move to these potentially very large feedstocks with good environmental attributes and also make something

compatible with jet engine, the answer is going to be a decade.

And, yet, we seem to be focusing on new molecules as the most important challenge in bioenergy. It is not. The most important challenge in bioenergy is getting to better feedstocks.

And we have to be willing to pursue those in parallel and really have clarity about that. I see a fair amount of fog around that issue.

So with respect to both the resource possibilities and with respect to bringing these two things along in parallel, I think if we were clearer about where we were going we could proceed much more effectively.

XXX: We were talking, just to add on the last question, to make a quick point, is there is choices between the molecule you make and things like how much ethanol is blended. We were having an offhand conversation here about at least in XXX we find E85 a much better alternative than, say, E15 just to be able to -- the infrastructure challenges with ethanol maximize getting it out there, getting the maximum value for E85. Also looked at alternatives with drop-in fuels, in XXX we have spent a lot of time working with butanol, which doesn't have the infrastructure limitations as much as ethanol. It is a question of choice of the molecules as well as the infrastructure in terms of blend ratio.

So there is a lot of choices there, you don't have to be forced through one door, there is a variety of doors that one could go through for that.

XXX:

I want to bring together a couple of points which I think are quite important.

First responding to the XXX comments with regard to the amount of land mass required to produce U.S. jet fuel.

We are developing a technology based on coal biomass that greatly reduces the amount of land mass required, it is not 700 percent of arable land, it is more like seven percent of arable land; with the technology combining coal plus biomass you can actually satisfy U.S. energy needs.

I don't want to go into a long pitch, but it can be economic, it is highly energy sufficient.

XXX: Technology comes this afternoon.

XXX: The point is in trying to advance that technology apropos this morning's discussion there is a law, Section 526 of the Energy Bill, that talks about the relative greenhouse gas footprint of a new alternative fuel versus petroleum. That law was written by Congress, it is to be implemented in part by DOE but you bring in the DOD, the USDA, the EPA.

And right now I defy any of you in this room to get a clear answer as to whether or not coal

plus biomass with advanced technology options does or does not meet Section 526. Therefore, that is an immediate impediment, we can't really move forward until we know that answer.

And it gets to the whole issue around satisfying policy versus the technical scientific assessment role of DOE and the interface between those two.

I am just giving you a real life example, ladies and gentlemen, of how one can be impeded and be innovative in helping U.S. competitiveness simply because of all those.

XXX: Clarity of definition.

XXX will go next.

XXX: Great framing document, enjoyed reading it. XXX, I was 18 years in the oil and gas industry and swallowed a lot of salt water, so I have been at XXX for 12 years.

The mission statement I agree is very well written and it ends with towards national energy goals and then it states three, enhance security, reduce environmental impact, increase competitiveness.

Unfortunately, it jumps right from there to -- I say unfortunately -- right into what I call picking winners and it goes right to clean, clean, clean. It seems to have a bit of a clean complex in it, to be candid with you not that I am against clean but --

XXX: Cleanliness is next to godliness.

XXX: I assume you understand the political drivers behind that.

If you are going to go right to clean I think it needs to be better defined. The president redefined it in the State of the Union this year and continue to be redefined, and I am not sure what it means. It used to be called green, now it is clean, and I am not sure where it is headed.

If that is going to be the driving piece of this document in what we do it really needs to be clearly defined.

My question to the panel is are there not other drivers that are of equal importance, affordable, available, reliable, efficient, a low footprint, high density environmentally, water, competitive.

Some of these are actually in conflict. And I think we need to carefully with this group that is assembled think about and maybe perhaps better engage in the conversation about what those real drivers should be and that can help frame where we go.

I would like to hear from the panel.

XXX: We heard a couple of comments which are, I think, singularly important.

The history of the United States Great Industrial Expansion has in many ways been technology built around low-cost, abundant energy. And I think

there is a question, and maybe this is something discussed in DOE, low-cost energy is, one, arguably a distinguishing characteristic of the U.S. industrial base, for example, the EU or Japan. And part of the reason, of course, is the U.S. has had this immense resource base to build around it.

But I think this question of affordability and the cost of energy and that impact on U.S. competitiveness cannot be diminished. And somebody mentioned, for example, that you mentioned that, you know, how the chemical industry is coming back because you have abundant with high predictability of low gas prices, that is a significant effect. I mean, the chemical industry really started in the U.S. because you had all this stuff you didn't know what to do with that came along with the oil production.

I think this question of cost affordability is a huge competitive issue for the U.S. and really needs to be -- I would agree with XXX needs to be a fundamental driver that you are going to continue to have, arguably, the lowest-cost energy system among the major industrialized economies.

XXX: Listening to what XXX said, I think he is correct, but that gets in my view down to having a way of making those decisions, and so if you think about decision grid and you just decide what is the weight of those various factors, then you

can put the options for the alternatives and weigh them against that same set and that will help prioritize those opportunities.

XXX: I agree. To the prioritization process you will find where you are finding conflicts between important variables that is where you can use your targeted research dollars to basically target those conflict areas and with time most likely eliminate them if not reduce significantly. I think that is an important process.

XXX: Last question and then we will take a break.

XXX: Thanks to the panel. My name is XXX.

We have spoken a little about emission, a number of technology things this afternoon, interested to see how much towards both kind of feedstock-related things and even product things it might dovetail into that.

I think it was instructive to read the mission statement, and I would like to go ahead and do that as we kind of close in the discussion.

To facilitate the invention, refinement, and early deployment of meaningful technologies that enable options for scale in private sector towards national and energy goals. I agree, I think overall it is a great mission statement.

What I find interesting juxtaposed against in the last five or six years of DOE behavior

as we perceived in the alternative fuels space is we started with trying to incent large scale projects, we then backed off and then went with demonstration scale projects, and then a larger portfolio project scale project, and now we are maybe a bit more towards R&D incentives and consortiums. I find it a tad ironic relative to where we tried to put the money.

At least where we are at now with some of the constructive things is very consistent with the mission statement. I think that will hopefully be very effective moving forward.

There are a number of parties in the room, I am going to dovetail towards the HRJ comment and the ethanol comment, there is a number of parties in the room, Virent is one of them, and we also have some great leadership here on behalf of the National Advanced Biofuels Consortium.

And I just want to state if you are not familiar with it, I do think it is very constructive framework for private parties to work with National Labs and universities. I personally think the DOE should be probably taking more of their dollars, particularly in the budgetary constraints, and putting it into more tools like that as opposed to cutting it into a bunch of small pieces where any single party can't get very far.

I think incenting constructive R&D consortiums and I will be blatantly honest I am in the

R&D contracts office and I have a high degree of confidence and compliments for being able to put that all together, so, again, if you are not familiar with it please take a look, because that is all about technology aligned with what I am going to say are quality products. These are products that people currently use and they went.

And you have to think about that relative to the HRJ conversation, you have to think about that relative to the ethanol conversation. I personally think in past commercial experience, both at large corporations, as well as environment for the last several years, if you can generate technology that is conducive to making quality products you are going to have a much, much easier time for longer amounts of sustaining power to try to get to -- let's face it, there are all kinds of winds that blow in all kinds of directions and if you can't figure out a way to sustain through all of that it is going to be very difficult.

A very advantaged way to keep yourself relevant through all of that is to keep your eyes on the prize and our opinion the bright, shiny objects are the quality products. So over time you will develop your technology, you can cut down the technology ramp curve.

If you are fundamentally making your own products you will then get into issues of do I have the right infrastructure in place, how do I change it,

how do I do all these things, those are all very big issues as we touched on in many much different ways.

So I guess maybe with that I will open it to the panel an opportunity if they want to comment on kind of the notion of quality products.

XXX: We are running over time, but if anybody has got a brief response to that.

XXX: Maybe the brief response is driving consortium, I think, is really important and I do think that drives success. The more we can drive consortium and collaboration across industry, across academics, across government laboratories, the better off we will be and, also, keep our joint lawyers and transfer office at bay here so we don't get the intellectual properties that is created through the DOE distributed through so many enterprises that it winds up going nowhere because it gets fragmented out. I think it is a challenge for us all.

XXX: I can't resist since I get to be in charge of the schedule asking one more question of you all relevant to consortia and researching funding modalities and so on.

A few years ago the Department established three bioenergy research centers, you all know the locations so I won't recite them for you. They serve as the prototype and model for the hubs that we are also establishing in non-bioenergy areas, building efficiency, fuels from sunlight -- and what

is the third one -- nuclear model and simulation, this community then has had the longest experience with the hubs.

Just some thoughts on whether that is a productive way for the DOE to be spending its dollars, have you seen any benefits, how do you all in the private sector or in academia interact with the hubs? Just some reaction, thoughts, on now a couple years experience with them.

XXX: I have been able to interact with all three and I think it actually is a great modeled for the DOE in terms of driving that consortia.

What I would say is getting back to the intellectual property to somehow as we propagate models like that figure out a way to get government money in there but not having trapped within the university, IP transfer offices, so I think that to me from an industrial perspective a continuing frustration that doesn't allow to get to commercialization and we have got to change that.

XXX: I will just say that I think this adds a new species to the ecology of energy science and I think that is useful. I think in the world it is today we need multi-dimensionality in terms of the kinds of organizations and how they interact, and this adds another dimension.

I am quite optimistic of what I have seen. It has enough critical mass sustaining power to

address problems of substance. It is not a substitute for traditional university research, it is not a substitute for the labs or industrial research, but I think it adds another element that I am quite encouraged.

XXX: As you may know one of the ongoing problems the Department has is explaining the differences between RPE and the hubs and the EFOC's and the base programs to our pay masters.

Anybody else? Okay.

XXX: I am XXX, a recovering DOE program manager.

XXX: It should be finished by now?

XXX: No, no, no. I won't get -- I won't answer the specific question you posed at the last, but I think it is relevant to what I wanted to say in response the earlier questions and points that were raised, and that is about what is DOE?

Many of you are articulating views that keep referring to DOE as it is a monolithic system and many of you actually include the National Labs of being part of DOE. That I think is a mistake. Especially when you want to articulate the catalytic role that DOE may play and many of the objectives -- the brain trust on the panel is huge, but I don't think any of you have been on the other side within the DOE system.

I served for the government for 17 years, and I can tell you one thing with respect to interactions with the private sector, DOE can in fact accomplish a lot of the objectives that you have set with respect to coordination, goal articulation, implementation of programs.

The private sector cannot do anything. When people refer to the private sector, in the private sector, somehow you feel as if you can get organized as a private sector and feedback to the government. Forget it.

The private sector is very amorphus, very disjointed, very broken up. So the notion that you would have a private sector presentation or pool as a community is chaotic at best.

On the other hand, on the government side, if you understand how DOE functions, if you understand the ins and outs of DOE, the interactions within the Federal government and also with the Hill you can accomplish good things if you put the coordination in place. We got an expert and a veteran of a lot of these coordinated programs, and of course one dwells mostly on the experiences that they had.

And I will mention, too, at least in my career in government, one was the U.S. Government Exchange Program, which brought 13 agencies together for a common objective. One can argue it is not an important one if you don't believe in climate change, for example; regardless, it put together a program

that integrated and implemented as only the government can do.

The same thing would be said about DOE and the internal functions. It is very important to understand nobody had mentioned it except in passing, the OMB as being the first recipient of the document.

Convincing OMB about a specific importance of the specific program and its importance, its relevance to competitiveness, its relevance to national goals is a huge challenge, but it can be done because it has been done in the past.

The Human Genome project was another such example, it also included significant interactions with the public sector -- private sector. Again, it was a case where the DOE and another agency got together and did things that only the government can do and you would never expect in the private sector.

The DOD, as XXX has expressed, has a lot of experience with is a special case.

I emphasize and I urge you to look more carefully into the intricate mechanisms within the Department of Energy, within the technology offices and the Office of Science, between the DOE programs managers and the National Labs, there lies many keys that can give you the success that you need.

Thank you.

XXX: Thank you for that note of optimism.

I think it is time we took a 15-minute break.

XXX, what happens after the break?

XXX: After the break we will convene next door. There are round tables with little numbers and flags on the tables. If you pick up your name tag on the break it has a breakout session number on it and you can go to that appropriate table.

We tried to make interesting and diverse conversations. Hopefully you won't know too many of the people at your own table. And then we will discuss over there for a little while and then come back over here.

XXX: In 15 minutes reconvene in the other room and pick up your name tags.

Thanks, it was a great discussion.

(Recess taken.)

(Break-out sessions were not reported.)

XXX: If we could get going, please.

I think it is great the conversations are going on, everybody seems engaged. We do want to get through a little bit more of the formal program.

The goal for this session, which shouldn't take more than about 20 minutes or so, is to hear briefly from the rapporteurs for each of the five groups what the rapporteurs heard. And, again, I don't want to hear anything about agreement or

consensus, I just want to hear what you heard. And if we do it smartly, we should be able to wrap up in about 15 or 20 minutes.

I don't know who was Group 1 rapporteur, why don't you just use the mic over here or you can come up here, take the podium.

XXX: We had a fairly broad ranging discussion, a little hard to pull out some salient points, but I think in terms of maybe what DOE should do or what should motivate our portfolio, there is this question of sort of technology push and the traditional way of viewing the programs, we are funding things upstream, really focus on the early stage of R&D and there is this handoff of the other sort of way of potentially thinking about how you would optimize a portfolio independent of TRL stages might be looking at, you know, trying to focus on choosing problems that will catalyze public/private investment and sort of a sequential choice of things, so after you achieve something you sort of go on to try to identify the next thing and there is less a sense of trying to keep a set of technology just moving forward or a set of options moving forward.

There was a comment that we might be a little too focused on breakthroughs and less focused on the sort of incremental advance that is necessary to actually change a system as big as energy.

In terms of criteria that we might be

able to use back to a comment that XXX made during the session before and that is set a stable set of criteria against which all energy technologies would be judged and then you are sort of managing the portfolio based on how well something sets up against that less in terms of setting up particular performance goal and then reorienting a portfolio to that and then somebody else comes in and chooses another portfolio goal and you try reorienting to that.

Let's see, I think some other visions of how the Department could see itself and then, therefore, manage its portfolio would be that the Department should be the organization that helps identify and lead a transition to a different energy system and then that becomes the organizing principle for things.

Alternatively, the Department, I guess, sort of an option-value approach to analyzing the portfolio, and that is sort of keeping a set of plausible alternatives available and then the private sector does the down select from that.

And that might be an approach to the other, and I think this is a little closer to the -- one of the earlier comments, and that is trying to find these conflict points in a technology, again focus on that, once you have resolved that, again, next conflict point, resolve that and move on.

XXX: Anybody else wanted to

amplify or correct XXX? Good.

Who is No. 2?

XXX: As with all of these I am sure our conversation was very wide ranging and engaging across a whole slough of these things, again, just to echo XXX's apology for any comments that don't make the cut out of my notes, please feel free to add in when I am done summarizing.

So we started off talking a bit about broadening the concept of what material might mean in terms of deciding making cuts and deciding what is in and what is out, what to prioritize, thinking about making sure we look at the full life cycle of a technology, understanding not just that this particular technology can meet in isolation some target, but understanding the ecosystem, the full energy system into which it is going to plug, what are the infrastructure requirements that would go along with a particular technology, et cetera, and so to really understand what we mean by expectations of materiality.

We also talked a little about costs versus externalities, and sort of the idea that at times when energy is cheap then people start to get concerned about externalities, when energy is expensive people start to get concerned about quantity and availability and trying to get the cost low and trying to figure out how to keep both of those in the

backs of our minds at DOE as we are trying to decide how to apportion our effort that really the economic impetus of having cheap, available energy has a real U.S. competitiveness push to it, but not competitive necessarily in energy technology, but competitiveness in all the other technologies that can benefit and industry can benefit from that cheap available source of energy, and so there is that push, but also making sure that with DOE as a public interest entity that we are also -- we are the ones who always have to think about the externalities regardless of the price and trying to understand a little bit of how to make those kinds of balances.

We talked a little bit about the diversity of the energy system, the diverse ecology and the change, perceived change that lasted a while from several big players really down meaning to really throw their weight around doing their own R&D versus the more vibrant, multi-scale economic ecosystem around energy and how that that actually has changed where the R&D needs to happen, how hand-offs might happen, compared to historical precedent.

Let's see what else. Definitely a request that DOE should definitely listen better and understand better industry and how that ecosystem actually works.

We talked a little bit in particular from a fuels context about part of understanding that industry is understanding what is going to make money,

as XXX likes to point out, a fuel molecule is a fuel molecule, it is hard to tell where it came from, it is a commodity, a low margin product, which is hard when you have a small -- particularly for smaller companies trying to figure out how to make profit to survive. So trying to -- DOE should pay more attention to coke products, chemicals, other parts of what is going to actually enable that ecosystem to continue to do its thing.

And then at the end of our discussion we talked a bit about demos and how folks seem to think that there was a role for DOE for sure in early stage development, but that there is a fuzzy line around where is the demo and pilot scale where cost the share issues and how do you actually do a demo that is going to have material impact on whether something actually gets taken up and taken downstream, the importance of clarifying and understanding what the expectations of a demonstration would be, is it about cost, is it about risk, is it about -- so a demo should have really -- it should be glaringly obvious at the end of the demo that someone should be able to make a whole lot of money off -- the risks have been driven down, costs driven down appropriately, so it can be really taken off and really make a business proposition to make it actually work.

That is just a few comments from it. If I left anything out please, the rest of my table,

speak up.

XXX: Who was 3?

XXX: Group No. 3 spent a lot of time talking about what DOE can provide, and I know you don't want to hear about consensus, but pretty much the thought was that sound scientific and techno-economic bases for enduring insights into technologies is critical.

There was a great deal of discussion about how DOE can conduct and provide such analyses while avoiding technology advocacy. There were many analogs proposed, one was that the DOE is the referee to the different technologies, that DOE should pull together information and provide a framework for gathering information and collecting information from the community to formulate these techno-economic analyses, but that the DOE somehow needs to provide these enduring technology insights without being construed as advocating for a single pathway versus another.

Along those lines when discussed what is DOE really good at doing, I heard back that we are great at providing techno-economic models and tool sets and pilot plants for validation and verification of these models and these performance characteristics, and that is something that DOE can provide across the range of technologies.

When asked what DOE should focus on developing for these analyses the response was very

similar to what we are good at, it was models and experimental setups.

So when asked how we could prioritize the different DOE activities, something that I heard is that we need metrics and we just need to make them known publicly and the metrics should be something deeper than GHD reduction and those metrics that comport with our national goals.

There are metrics from availability of feedstock to water consumption to use of current infrastructure and primary energy requirements for this production of a product and the difference between what will happen and what might happen along the lines of any of these technical pathways.

When asked about what DOE needs to do better or what DOE has done for you, heard some discussion about technical consortiums, whether or not -- we didn't mention them in the QTR framing document and it is the R&D technical consortiums that perhaps provide that opportunity and pull together information from the community and provide some insulation against the referee-versus-advocate assessment of what DOE does.

One thing that I heard is that DOE is not doing a good job at all of stem education and if we look at how that feeds into the innovation pipeline we are failing.

And, of course, the other thing that DOE

does very well is collaboration with other National Labs and what that allows industry to do.

Again, if I missed anything from our group, please do speak up.

XXX: No. 4, XXX.

XXX: It was interesting listening to the different groups.

My group focused a lot on how fluctuations in policy and priorities really hamper any sort of progress. A lot of that is not just industry can't make any investments if there is too much fluctuation, but also that it affects how good the laboratory -- how well the laboratories can do the research, the workforce actually at the laboratories.

And so to get a more consistent framework we need to really define our goals more precisely. We can have a role in establishing the scientific basis for a lot of these goals and just the language that goes behind them.

And a lot of that also goes with the same thing about metrics and figuring out exactly how to measure whether we have success or failure, and even what success and failure means, is it commercialization, is it a certain number of barrels, is it whether a certain area is sustainable, so just defining that success and failure would be really important in the DOE policies or DOE going forward.

DOE should also inform policy more broadly. Like Group 3 said, I guess, it has a lot of

really important roles in techno-economic analyses and getting reports on different technologies out there, but one problem with current -- with how DOE is doing right now, sometimes these are delayed so much that they can't really inform policy so they are not timely. A lot of times they are rear-looking and they need to have a more forward-looking visionary but consistent framework to build on.

And so in doing all of this DOE really needs to generate just for the consistency not only in forming policy, but also establishing a framework and there have been recent efforts by DOE to build the sort of framework to judge all technologies by, but a more economic systems view has to be put into all of these frameworks used to evaluate technologies.

I also heard a lot that there is a big gap between applied and basic research in terms of there is an innovation gap. There is also a gap in knowing what metrics you are going to use to evaluate both, the metrics you use to basic research is vastly different than you do for applied research, so how to make the technologies move more consistently through that and how you develop a portfolio of low versus high risk opportunities of investment.

And then one thing we got to more at the end was that on the international collaboration versus competition question it seemed that collaboration was good for many reasons, for the economic security of

the U.S. and also to not be left behind for a lot of the technologies that the U.S. is not a leader in anymore.

And those are the main themes that I heard. Again, if I am missing anything, please don't hesitate to add.

XXX: Anybody else?

Alison, Group 5.

XXX: So Group 5 covered lots of ground -- much of which has already been mentioned, but in terms of recommendations for DOE, definitely leaning to identifying and address barriers and infrastructure availability across all the alternative fuel options, make sure not to abandon liquid fuels research in favor of electrification. The group felt individuals within the group, not as a consensus, felt that liquid renewable fuels, there was definitely a place for that as well as fuel cells as well as electrification for different uses.

One thing that we discussed is the need to consider consumer wants and needs and, therefore, behaviors. It didn't really seem like anyone within the federal sector is focused on the social aspects of alternative fuels and that is a need.

Working effectively with private industry came up several times. As has been mentioned earlier, having consistent standards to evaluate all the technology options, fossil as well as alternative fuels. Potentially utilizing a partnership with the

Department of Defense to get over a commercialization hump with new technologies. Utilizing a stage gate strategy with a standard set of criteria and metrics was something that was mentioned.

One key need was tracking where DOE has been a catalyst, where DOE funding has initiated breakthroughs, IPO's, patents, et cetera, that is something that a need was identified there. Being able to vet models and analytic tools that DOE is developing with experimental data. Also not focus on the conversion technology R&D and also feedstock as well as end use. The end game is equally important when creating research portfolio. That was Group 5.

XXX: We are about to break for lunch. There was some consistency but some diversity from what we heard among the groups. Hopefully we have given you enough this morning to continue thinking and talking over lunch.

Lunch is back in the other room. It should be ready. And we will pick up here at 1:15 to get more into the technology issues.

(Lunch recess.)

XXX: For the second half of the day we wanted to focus on a little bit more of the technologies. This is in some way a generic problem for the QTR process.

As I mentioned this morning, we need to be complete, cover not only the things we want to do,

but the things we don't want to do, in order to be able to explain to people why we are doing one versus the other. But the range of energy technologies is extraordinarily broad and the whole exercise started out with something like 25 different technology groups that we have managed to compress a little bit.

And so the discussion today of alternative fuels is necessarily not as deep as one would like in terms of the presentations, we will be able to get in more depth in terms of the breakouts. The plan is to spend about 45 minutes or so hearing from three of the tech team folks and then go immediately next door for breakouts for an order of an hour, I guess, and then come back and wrap up pretty much for the day.

I will remind you we are interested in some balance of assessment of technical potential, how far cost might be driven down, scale, policy barriers that exist, and so on.

I think I will just turn it over to xxx who is going to start and then there are two others to follow you.

XXX: Thank you, XXX, and welcome back.

Before I start I just want to make a confession, and that is that my first two slides I have stolen from XXX's presentation. They are excellent slides and they really say what I want to say.

XXX: Not this one.

XXX: We will get into the technology a little bit. And this is really I think a shared activity and I have two cohorts who without it would be impossible to do this.

XXX: Could I say something while you are fiddling with the microphone, this discussion is not meant to be a validation, judgment, critique of our own current program.

XXX: No.

XXX: It really is meant to be more blue skies a little bit, what could things be, rather than what are you doing now and is that good or bad.

XXX: Right, absolutely.

The way we will handle this is that I will walk through the biofuels portion and then XXX will take over for the natural gas portion and XXX will take over for the rest.

We had some discussion this morning on aviation biofuels and other sectors, and I think this slide, this is the one from XXX, really presents the issues really well.

In terms of energy density, liquid transportation fuels compared to, say, hydrogen or batteries or other things have a significant advantage in the transportation sector. And there are certain elements of the transportation sector, like aviation,

like rail and shipping and heavy-duty trucks, where you just don't have any alternatives. So this is kind of our motivation for looking at alternative fuels, et cetera.

This is just to give you some idea of what the EIA forecast is for the U.S. demand to 2035. This is not meant to be an endorsement of the EIA or any other forecast, there are many different kinds of forecasts, but you can get an idea of the type of mix of fuels that EIA considers in a business as usual scenario, so kind of not extraordinary high crisis or anything like that and continue more with economic growth, this is the mix.

So one of the key issues that came up in our discussions during lunch, and I think is worth getting some feedback from the group on, is that you will notice that a full 70 percent of it even by 2035 is petroleum.

So if we are looking at alternative fuels and we are looking at only that top portion it is a baseline question, right, do we need to have some thought about what the petroleum baseline is going to look like 20 or 30 years from now.

Again, I think that this is something that we can think about as we go into our breakout sessions, which is kind of this baseline issue of where do we start from in terms of the identifications of our reliance on petroleum.

I am going to go into the biofuels as I

mentioned and I will run through these fairly quickly so that I give you enough time for you guys and we have I think a total of about 45 minutes between Q&A, so I think probably most of you already know this, I am not going to go into a lot of detail, but about 13 billion gallons of ethanol, ten percent by volume, about six or seven percent by energy content, and we have been funding a variety of projects as well as some projects that are being funded by USDA, and of course there is increasing interest of the DOD and from the aviation community in exploring these alternative fuels, this is kind of the wave of the land of where we are today.

So I will spend a couple of minutes on this slide. This is really kind of our roadmap slide. You can see the top box up there are kind of the conventional technologies and that is not the area that we are working in. So DOE has no involvement of those, of course, to set the boxes all the way from the left to the right.

And we have been funding a variety of projects, as well as some projects that are being funded by USDA. And, of course, there is increasing interest from DOD and from the aviation community in exploring these alternative fuels. So this is kind of the lay of the land we're in and where we are today.

So I will spend a couple of minutes on

this slide, because this is really kind of our roadmap slide. And you can see that the top boxes up there are kind of the conventional technologies, and that is not the area that we are working in. So DOE has no involvement in those first two sets of boxes all the way from the left to the right.

Our main focus is in the middle, which is delivering feedstocks into the fuels, and then Kevin and Tom will go into the bottom layers, but I will mention a couple of things. And this is, again, food for thought for your sessions in the afternoon.

You will notice that in the top row, there is this downward sloping line, which is the clean sugars to jet or hydrocarbon pathway. So this is the pathway that LS9 and Amyris are pursuing, proposing to use clean sugars from Brazil.

We are not currently involved in that area, and there is a lot of discussion and thought at DOE internally, and we would love your input on this, of whether we should be involved in that area or not.

We are hearing from people that that could be the low-hanging fruit for the hydrocarbon fuels, if you have clean sugars. We are not involved in that right now because we are focused on the cellulosic sugars, but if

that is the low-hanging fruit, if clean sugars are the low-hanging fruit, then should DOE have a role, or should we simply stay out because of the sustainability issues and other issues. So that is kind of one aspect that I wanted to bring up

The other aspect is you will notice this line on the far right side, which is a little bit different than the other lines, and that is the Gevo process that they are proposing, which is converting an existing corn ethanol plant to butanol, to butenes, to hydrocarbon fuels.

Again, we have no involvement in that area but would like some feedback and opinion on what, if any, our involvement should be.

That has a number of different implications, which are very, very complex, right, because, you know, you could potentially get -- you could potentially retrofit some portion of your existing corn ethanol plants to produce renewable hydrocarbon fuels, which is attractive.

But the question is what happens to the DDG, right, the animal feed that the plant produces? Does that also now get converted into fuel, and that has food versus fuel implications.

So because of those reasons, we have not

involved in that top part at all, and, you know, I think it's worth, you know, thinking about what our involvement should be, if anything, you know, in those areas.

So this is kind of our best estimate for cost of production, and this is very controversial and very misunderstood. So let me just spend one minute explaining this.

So this is just conversion cost excluding feedstock, just conversion cost, and this is producing ethanol using the cellulosic sugars. So basically, what we are saying is that we're at about, you know, $1.50 to $1, $1 to $1.50, something like that, but this is for an end plant, not for a pioneer plant but for an end plant. So there is a whole bunch of assumptions built into this.

So I don't think that it's wise to get too worked up about these numbers, but the numbers help to us set targets for where we need to go in the future and to plan areas where our cost reduction is going to happen.

XXX: I am just curious. The title is cellulosic sugar cost targets.

XXX: Right.

XXX: The metrics are ethanol, ethanol in gallons.

XXX: Right. Right.

XXX: I would love to see in

terms of the cost of the sugar, not so much focus on the gallons of particular product.

XXX: Right. We have that detail, and we will work with you on that.

XXX: So it's now 2011.

XXX: Right.

XXX: We are pretty close to 2012 already.

XXX: Yes.

XXX: Yes.

XXX: We are.

XXX: And at what cost will it be to start building it? Do you have a view on that?

XXX: So that's a very good question. Right? That's the difference between the pioneer plant cost and the end plants. Right?

And, you know, from our integrated biorefinery projects that we are funding, as you know, they are having difficulty raising capital to finance those plants, to replicate those plants and to even build those plants.

So we are not there yet in terms of the pioneer plants with respect to being cost-comparative with gasoline, even at today's $100 a barrel. I think that's probably all we can say.

A similar kind of story for the thermal chemical platforms. So this is the same gas to

mixed alcohols to ethanol, not a whole lot different, so we are not going to spend a whole lot of time here.

So the other new area is pyrolysis. So now in the pyrolysis process, we are actually producing a diesel. And so this is now on dollar per gasoline gallon equivalent basis or diesel to gallon equivalent basis, and this is, again, for end plant 2010 per day, but this is roughly where we see the costs today and where we see the progression of the costs going into the future if we can indeed realize our R and D successes that we are hoping to achieve through our programs.

Okay. So this is just a map of our projects. I think we have the website there so you can see where they all are, and this is kind of our investment, and you can see that we are focused really on -- we are trying to balance the portfolio between ethanol and hydrocarbons, and, you know, it used to be exclusively focused on cellulosic ethanol, but we are trying to balance that.

And then we have a loan guarantee office, which is meant to provide loans to commercial facilities, and this is the first loan that they have given to a biofuels facility, which is Diamond Green Diesel, and there are several projects that are being

processed through the loan guarantee office at the moment, but this is the one, the first one that has been approved, conditionally approved by DOE.

There are three other loan guaranteee project that have been approved by USDA, and those are all cellulosic ethanol projects. So those are Coskata and INEOS and Enerkem, and they are also smaller-scale projects.

And then algae is our new portfolio, relatively new. We have spent quite a bit of money in algae over the last few years, and basically we are just getting started in this area.

This used to be something that we used to find back in the '80s, and so we are kind of learning a little bit on where we are with respect to algae since we left the program back in the '80s.

Now, so one of the first things that we do when we get into a new area is look at the resource potential. So this is a study that we have just published, and it looks at -- it does a GIS-based assessment of the algae resource, basically. If you look at the land availability, the sunlight, and temperature conditions, and you do a GIS-based analysis of the U.S., this is where the algae ponds can be

located.

And the bottom line from there is that about 10 billion, greater than 10 billion gallons of algal fields is technically feasible, but the question is sustainability and water and nutrients.

If we did greater than 10 billion gallons, we would use up quite a bit of water, and so we would have to find some kind of a solution for that, if we wanted to get to those types of levels of algorythms.

I think that that is all I had. So are there any questions on biofuels before we move on?

XXX: Is there an investment in KiOR? There was an announcement at KiOR.

XXX: Yes. So the KiOR announcement is also a conditional loan guaranteee, and both Keyor and Diamond Green Diesel were funded under Recovery Act funds, which means that they have to break ground by the end of this fiscal year. So the question is on both of those projects, they have to meet that criteria in order to be able to avail of those funds.

XXX: Thank you.

XXX: Okay.

XXX: Let's go on. Gas is next.

XXX: Me? Sure.

XXX: Yes.

XXX: All right. Okay. And does that work? Okay. I can probably shout if need be.

So when XXX said he needed some slides on natural gas, he asked me for one or two, so I kept it to four. I figured I wanted to give you a real quick run-through of what I thought might stimulate some conversation, and then you are welcome to quiz me as you like.

I think one of the reasons, the main reason to me, that the -- by the way, I'm from the vehicles program. I'm the team lead for fuels and lubricants and freight, and the main reason to me there's been renewed interest in natural gas is no surprise here, the large expansion of gas reserves in recent years due to shale we have to frac it.

So basically, looking at the cost and the size of the resource, we've got X. What do we do with all the gas? Well, I would submit that it is a very good chance that some of it is going to end up in the transportation sector.

Now, we could figure about how much there is, 100 years, 200 years, 50 years, but if we just assume that there is a lot and some of it is going to end up in the transportation sector, that leads to a major issue to me.

How do we use it? Should we use CNG or LNG, GTLs of various sorts, and obviously diesel, gas or liquids diesel comes to mind, but feasably increase gasoline or do we use another alternative fuel, possibly propane, which isn't typically made by GTL process. If it was refinery products, I'm sure all the oil company people know; or even do we revive methanol from the old methanol days, and I imagine that one we can safely, probably, put off the list for a while.

The other alternative and one of the department implicitly, I think, is making a big bet on with respect to light duty is we can turn it into electrons rather efficiently and then use it for light duty. There may be other issues or other possibilities that we haven't thought of. We are certainly open to talking about that.

Now, in terms of utilization, I can't speak to the fossil energy budget, Tom can perhaps, but natural gas is really a tiny part of my portfolio, but given the significance of the resource, and given some of the recent remarks by the President, I think it's a safe bet that we will be considering this for a while.

So I wanted to briefly talk about our

current activities. In 2010, we made some awards in medium and heavy-duty engine and vehicle integration, about $5 million of DOE money, $8.5 million of co-funder money from California, and then another $8 million or so from co-funding from ORD. So we are talking about about a $20 million program. We have four projects with multiple phases taking us through vehicle integration so we get an actual package there.

The big motive for us was to structure it so that we could get an update -- we call it an update -- of some of the heavy-duty and medium-duty engines, but specifically in the greater than 9 liter space where there really is not much competition. Well, there is no competition.

So looking to the future, I would submit that LNG really only makes sense for heavy-duty, if it makes sense at all, but I would also like to suggest that if we could have what I like to call a pipe-in hybrid vehicle or a pipe-in vehicle, it's not really hybrid, but you get the idea. It's a range-limited bifuels.

There's a lot of bifuels on the market in Europe, some in Asia right now. They sell really well in Europe. However, these generally have about a 300-mile range on natural gas and another 200 or so on gasoline. I don't know if anybody is making a diesel bifuel with natural gas. It's just too expensive for a first purchase cost. It might make sense if you are a cab driver, perhaps, but we don't see a market for that in any of the manufacturers.

You might have heard recently that Chrysler has announced they are bringing in their Fiat bifuel product, which is a really nice vehicle. It sells a lot in Europe. So arguably, there is no, you know, real role at this point for DOE, but I would say that we have a reasonable case here that whether it's DOE doing anything or not, that we might have a reasonable light duty alternative using CNG with off-the-shelf technology that could help supplement the diversification of the light duty fuel market.

Real quick, it's pretty clear that it's more efficient overall with -- I would encourage you not to worry too much about the specific numbers. These aren't isentropic numbers. They are a little bit less.

But it's pretty clear that in terms of full-cycle efficiency, you can do the best with electric. However, for heavy-duty, as several speakers have pointed out, that is really not an option. There is really no electric option at this point.

I would say there probably never would be, but people have at least talked about solid oxide fuel cells directly reforming either natural gas or diesel. I don't know.

The LNG option here -- and, actually, I was surprised when I played with the numbers that it actually didn't come out quite a bit lower than CNG, but my point here is that this is current technology. We don't see a lot of changes for the most part, some compression or liquefaction. However, there is room to improve on the vehicle side.

So as an example, I wanted to use an LNG non-hybridized, so a internal combustion engine-powered LNG truck circa 2020 using the goals of our recent awards under ARRA for SuperTruck.

And as you can see, the use of this technology would be strongly dependent on improvements in engines, as we go from, I think, the prior slide was about 30 percent to about 48 percent. These are average efficiencies. Peak

efficiencies, of course, would be a lot higher.

Drive train efficiency, not much change, if any. Nothing really in liquefaction. This is just a schematic of where we can store the necessary tanks, because you got to carry a lot of weight and a lot of volume.

However, the payoff comes here (indicating), and this really makes the point. The only reason that an end user would use natural gas in transportation is that this bar, the operating cost, is so much less than this bar (indicating).

So in the event that we want to use gas in transportation, other than as a fungible liquid that's been, you know, converted, there are options, and actually some of them are cost-effective now. You might even notice that the diesel price is really pretty low here.

There is clearly an infrastructure problem in terms of fueling vehicles like this, but these are problems that can be managed.

Yes, sir?

XXX: In addition to heavy trucks, have you thought about the diesel for the trains, replacing that with what you just mentioned.

XXX: Yes, I haven't done that analysis the here, but that is certainly an issue. I mean, then you get sort of a

double-whammy of displacing the diesel and doing a mode shift. So you get more efficient movement of freight.

There's a lot of things you could do. You could also use it for boats in a -- you know, tug boats and things in harbor. There's a lot of possibilities, but that's what I put together, and I am hoping that it will help stimulate some discussion.

I have a handful of various other statistics if people are interested in where we are today, but I didn't want to dwell on that here.

XXX: So one of the questions I would ask is there is only a limited amount of gas you can get out at a certain rate. Right? And gas looks attractive for a number of different uses, displacing coal in the power sector, new power, gas, firming renewables, transportation.

If you go through just the quads and count up, you want to do any significant impact in transportation, there's 20, 30 percent increase in gas production required above what is already projected. And the question is can we do that.

XXX: Yes, that really is the question. Thank you for pointing that out. I mean, and the answer could very well be, huh, we

are doing the right thing. We want to make it most efficient and make it into electrons. I don't know.

XXX: All right. Sir?

XXX: So seeing the presentation, which you acknowledged was current technology, and you compared the battery mobilities and the electricity, the electrical mobilities of the supply chain to the natural gas ones reminded me of the things we used to see in about 1980, all about how we needed to have much, much cleaner vehicles, and we had all these alternative propulsion and fuel systems that were going to get us these cleaner vehicles to lower emissions.

And basically they compared this future very motivated scenario to current not motivated scenario, and voila, they did better. What actually happened?

Well, the vehicles are about 20-fold cleaner than they were in 1980 because the status quo improved. But I haven't done an analysis for natural gas, but I have done it starting with biomass.

And so if you are realizing that it is a big transition to go from an electrically powered vehicle fleet on both the vehicle, the distribution, and the energy storage site, if you compare a comparably motivated internal

combustion engine hybrid, advance hybrid type of thing, and you start off with a ton of biomass, and you ask which can you drive further in a light-duty vehicle, the answer in a comparably motivated scenario is very roughly the same.

And so we have to avoid always comparing these motivated future technologies or scenarios to these unmotivated current scenarios, but, "Ah, yes, that's the most efficient one." We have made this mistake before. Let's not make it again.

XXX: Fair enough. I guess I would just say that -- I would say it's relevant because we have made a really substantial bet as, you know, a department, as an administration, as a society on electrification of the light-duty sector.

So I think we have a certain amount of motivation. I can't say we won't be whipsawed in the future, but I take your point. I don't disagree with it.

XXX: I was just going to make one more comment.

XXX: Yes.

XXX: In the light duty sector, natural gas can compete with electrical cars, and then if you publish this in TRV, when you do an apples to apples society cost, CNG in cars wins

hands down compared to BEVs.

XXX: Clearly.

XXX: Okay? As a petroleum displacement object --

XXX: Compared to what, you were saying?

XXX: EVs.

XXX: Well, compared to BVs, electric cars.

XXX: Clearly.

XXX: When you say EVs, is that BEVs, PHEVs? Do you have a --

XXX: BEVs.

XXX: Oh, BEVs. All right.

XXX: You can even talk about BHEVs, because -- and if this is, you know, you can compare today's technology, you can compare -- and this is where we come back to what we discussed in the morning. What are your goals?

If your goal is petroleum displacement, not foreign oil displacement, because that is not an achievable goal in a global economy. If your goal is petroleum demand reduction, more precisely, not displacement, then how about the CNG kind of wins hands down compared to EVs.

XXX: It's all about price.

XXX: If the goal is green house gas, then you need multiple miracles in EVs. You will need EVs and at the same time a low carbon,

and that could save you something. But CNGs will not get you there. So it really comes back to goals, what is a goal, and that goal should drive a decision on a cost-effective manner.

And one of the things we talked about in the team was to really have energy systems analysis with transparent society cost methods. And that's not then the DOE, because the lab says headquarters, so that's cost, and the headquarters cost is not transparent.

XXX: Interesting.

XXX: One quick point. I was at a Wall Street Journal conference on a panel with T. Boone Pickens a year and a half ago. He was speaking to this topic, and he said that when he grew up, his father taught him the three rules of alternative fuels. The first rule is if it doesn't make money, the other two rules don't matter.

And I think when asked to expand on that, he very much supported what XXX just described. You need to do holistic modeling and really understand how your option fits in context to all the other options, not as we tend to do just in single dimensional analysis.

XXX: So you think -- and I think I have heard this several times -- DOE is afflicted with that disease?

XXX: Yes. Yes.

XXX: No. No. I want to expand. I'll be bold. Our society right now is afflicted with that across a lot of different boundaries, and DOE is a member of that society.

XXX: I think a good example of others' political enclave that has done this analysis have not actually claimed it, because other enclaves were also promoting about the action, is the European JEC study. It has gone through five iterations, all the cost data is transparent.

The cost for meeting a societal objective of dollars per ton of green house gas avoided is calculated across all the pathways. The societal metrics for dollars per dollar of oil saved is calculated and transparent.

Now, you can disagree with that, but it's all there. So when a policy-maker comes and says, "This is the favored solution for this year's State of the Union Address," we have all the analyses there up front.

XXX: As you may know, there is a national petroleum counsel study under way. We have some people involved here that are supposed to be looking at the same sorts of things with an equally independent eye.

XXX: Good afternoon, everyone, I am XXX from the National Energy Technology

Lab. I work in the Office of Strategy Energy Analyses & Planning, so we are the non-program arm that does economic and technoeconomic analyses within NETL. And I have spent the last couple years looking at coal liquids, coal and biomass liquids in various forms.

Here are just a couple of the different pathways that I am sure you are all familiar with. There is indirect liquefaction through gasification, whether you want to go through methanol gasoline or through tropes. You have also got direct liquefaction, which we haven't looked at as much recently.

I am going to focus on low temperature pressure tropes with an iron catalyst. Here is the general PFD. We primarily focus on recycle cases, so maximizing our field's production, although we have looked at some polygeneration cases, and in our systems now, it seems generally we are producing diesel fuel, naptha, we are now looking into the economic to upgrade that naptha to gasoline.

The diesel fuel, as you know, is a drop-in replacement and fungible with today's fueling infrastructure, so we view that as a net bonus. We can also produce jet and jet -- 50/50 blends of jet with normal, though as a JP8 in the military spec. Most Air Force aircraft are

already certified for that. We are getting there.

Why are we looking at biomass or co-utilizing coal gasifying coal and biomass? Well, we feel that coal can act as a flywheel, so we know that coal is going to be available. We are not going to have issues with seasonal issues where the biomass may not be available.

If there are cost issues, delivery issues with the biomass, we feel that coal will still be available. Again, coal is cheap, we know the price of coal, and we can achieve economies of scale, which I will talk about a little bit more.

This is from the national academy studies on alternative fuels. The national academies looked at biomass availability at various sites around the country. And so on the X axis, we have the amount of short tons per day. They can be produced at each one of these sites ranging from 800 to 2200 all the way up to greater than 7,000 dry tons a day biomass.

As we can see -- and this is all non-food competing biomass. Only the top four now could supply these 4,000 dry tons a day. So we limit our biomass feed rate and our CB kill plans to 4,000 dry tons a day.

And as has come up earlier today, when we have renewable energy standards that come

into place, even these sites that can produce large amounts of biomass per day, they are probably going to be splintered as demand directs.

So how does this affect the economies of scale? If we are looking at plant capacities, generally we look at up to 50,000 barrels a day in CTL plant capacities. If we are just doing CTL, we can do about 50,000 barrels a day. Again, up to that 4,000 dry ton a day limit of biomass feed if we're mixing 15 percent by weight of biomass, we can still achieve that 50,000 barrels per day.

But as we go up into greater feed percentages of biomass, we see that drop down, and for a BTL plant, we can only do about 5,000 barrels per day. And as you will see, that is going to affect the economies of scale and the economics of these options.

There has been a lot of talk about green house gas emissions from these fuels. We look at venting the CO2, but we primarily look at CCS for these facilities. There has been a lot of talk about Section 526, which essentially says the government can't buy a fuel that has greater emissions than petroleum dry fuels or conventional fuels.

So what we found, that coupling CTL

defeats gas in a recycle facility, and we can get below the baseline, about 5 percent below the baseline, although there is some wiggle room in that. As we add more and more biomass, we March down curve. Again, at 30 percent, we're about 60 percent or 65 percent below the petroleum base.

But here is the trade-off. When we get into adding biomasses, we have talked about the economies of scale, there is going to be an economic trade-off. So again, here is our green house gas emissions relative to petroleum dry fuels with zero being equivalent to petroleum dry fuels, and as we see, CTL without CCS is above the petroleum baseline, and as we march down through CTL to CCS with an ATR, a more aggressive CCS case, 8 weight percent, 15 weight percent, 30 weight percent. And then BTL with CCS, we see that even though our emissions profile -- or pardon me, BTL without CCS.

Even though our emissions profile drops dramatically, we see from our other Y axis that the incremental cost per barrel of these options increases. So first, if we use CTL with CCS as our baseline, there's about -- which is economically viable at about $95 per barrel of WTI crude, and that is assuming about a 20 percent internal return on equity, if we just vent the CO2, there is a small delta in cost.

We are already removing that CO2 as part of the process, so venting it doesn't bias anything from costs perspective.

The key take-away with regard to that is CTL plants are good demonstrations for CCS. It's a low cost demonstration for CCS. You are already capturing the CO2. There is not a lot of extra cost to go and sequester that from a large-scale demo perspective.

As we go to a more aggressive CCS case or low amounts of biomass, 8 percent, again, there's not much of an incremental cost, because we still have that economy of scale, and the biomass feed stock cost isn't having as much of an impacted in our plant economics.

So, again, we go about $6 a barrel or more, or we're about $100 or $105 a barrel of crude oil equivalent, but as we get into BTL, we see that cost skyrocket, mostly because of the economies of scale.

And this is just some economics: On the right, we have the -- or on the left, we have the recycled or the fuels only case and then also with polygeneration. The take-aways from this are that we are generating a lot of CO2, 30,000 tons per day, we are consuming a heck of a lot of coal at 20,000 tons per day, which is just a lot.

These are 50,000 barrels a day plants. And, again, the empty liquids are not quite as -- they don't quite have the amount of BTUs per barrel as the petroleum dry fuels uas. So it's about a 47,000 barrels of petroleum fuel equivalent.

And here's the real zinger is the economics. Why are we building CTL plants other than the fact that there is uncertainty with regards to the green house gas emissions? We're talking about $6 billion dollars for a plant, maybe 6, depending on what type of plant you are doing. So there is just a large, large capital outlay.

And, again, if you are talking about installed capital costs per daily barrel, you are talking anywhere from 115- to $150,000 per daily barely installed, whereas for GTL, maybe you're around 80,000. For some of the petroleum refining, you are probably down around 25 or 35, depending.

Again, this crude oil equivalent price and this required selling price, we are talking about 330 a gallon. That is, again, a 20 percent return on equity, and that is assuming a carbon tax is in place, so we integrate a carbon tax into that and assume that we're competing with petroleum. If there is no carbon tax, we are probably more up around 350.

So what are the hurdles to commercializing CTL? Well, we have all the technologies. They've been demonstrated. We have gasification. We have Fisher-Trope synthesis. CCS has been demonstrated from ER perspective. But we haven't integrated all those technologies, especially with current technologies.

I mean, all the existing CTL capacity is using large gasifiers. So we need to do an updated, integrated, commercial scale application. Again, economic concerns: Where is the oil price going to be, you know? Is it going to be $100? Is it going to be $50? We can probably compete with around $80 a barrel, but it's going to be tough.

The environmental issues, CO2. CO2 is a big issue. There is a lot of uncertainty with regards to regulations, or regulatory uncertainty. Water use, we are talking about five to eight barrels of water per barrel of fuel produced. That is a lot of water. So the plant setting is going to be important.

And, you know, there are other issues with regard to we don't have the know-how to build these plants necessarily anymore. Labor, our labor force is not educated. That is going to take some time. And there is going to be a

lot of bugs to work out as we move forward with this.

So what we have found in a lot of our studies are that to move forward, we feel that CTL or CBTL is a near-term technology. We feel that it's a kind of a safe bet. There is a lot of bugs and issues to be worked out, but it's a bridging technology.

We can go forward and produce fungible fuels that we can just drop into our existing infrastructure. The cost is going to be high at first. There is uncertainty with regards to the economic risk, but not as much with regards to technical risk.

It can be a great way to demonstrate CCS if we are committed to demonstrating CCS and going forward with that on that pathway. And in general, we just think it's a good step. And that's all I have.

XXX: That's good. A couple questions on this before we --

XXX: Yes. Well, I would like to offer a direct comment, semi self-serving. I always like to be up front. Our group, as you may know, has been working on advanced CBTL options, and we bring in a new direct link with action-flat form to replace FT. We use carbon capture and recycle rather than CCS.

And we will be willing to share with

you -- I think we don't even need them as yet and we can just share it with you -- the study we just completed for the State of Pennsylvania. It will show significantly lower investment numbers, thermal efficiencies between 60 and 70 percent overall on a high even value basis and a corresponding LCA study that we did in partial collaboration with NETL that will show that we can also achieve the kind of numbers you are looking at with CCR.

So we would be very interested in having the DOE have a look at that, giving us an objective opinion of that, and seeing where we might take it.

XXX: That's good.

XXX: So listening to all of this and the range of things that we covered and some of the things that we haven't touched on, I am struggling with -- and maybe this is a good place to start conversations in the next room -- how do you get your arms around this?

We want to keep pushing basic research on cellulosic decomposition or for feed stocks, we want to put money into catalysts and demonstration plants. You know, given that the government has, you know, in round numbers a billion dollars a year to invest in alternative fuels, what does the optimal portfolio mix look

like? What should we be pushing on?

XXX?

XXX: Just a quick comment to add, and I had the opportunity to look at some of this down in Louisiana and then went up to New York with switchgrass and shrub willow and a little bit of this had this up there, and then visited the experimental facility with Larry Walker.

We were looking at a million and a half of dormant acres in New York at that time and started thinking about the conversion that was possible within energy. We did the conversion facility, the experimental one down in Louisiana, and I guess I would be interested in people here discussing too kind of the above-ground challenge of converting the hybrids to hydrocarbons through these conversion facilities and whether places like New York at the scale that is going to be needed would welcome 30 new biorefineries, if they don't want natural gas or drilling or wind turbines.

And I think that's a real challenge. I think there are some real above-ground challenges here when you go to scale, and I would like to hear the collective wisdom of the group on that kind of thing.

XXX: Yes?

XXX: Well, just in answer to your question in a general way, if you

think about these programs, there is kind of a cone of complexity, if you will, as you go down the early stages with anything like commercialization.

XXX: Please speak up a little bit.

XXX: I think of this as a cone. There is a cone of complexity. As these programs go from the earliest stage to anything near scale of commercialzation, that cone gets wider, and these programs get more complex in a sense. They get more expensive, there are more people participating in them.

Just looking at all of these, this whole ensemble, one thing I pose to you at the DOE is where are your competencies in that cone of complexity? Are you most skilled at the narrow end on the front end? How many of these complex things can you balance and actually manage as they get more complex and the cone thing opens up as it gets to commercialzation?

I am just struck about all of these, that your skills probably sit somewhere differently. They are not at the top of the cone. They are down lower somewhere, or maybe some blend in that cone.

XXX: That's a good way of framing the question. I don't have an answer, but that's a good topic.

XXX: I would just say in follow-up to that, just like another comment I made this morning, that once you figure out where your skills are, that doesn't necessarily mean that that's what you want to do. It's more a matter of figuring out your identity and mission and then developing your skills around that rather than the other way around.

XXX: Yes. That's right. Looking for the key where the light is, et cetera.

XXX: Just one more point, and this is -- I will just use biofuels as an example, which is, I mean, if you look at -- well, let me just take this as an example -- normal butanol produced from biofuel. Normal butanol is a chemical commodity today. It's produced on propylene and CL. And it runs today as twice the price of gasoline and 2 percent of gasoline volume.

If someone produces normal butanol as a biomass, it's going to be first displacing chemical grade butanol. And when the technology evolves from that cost to the fuels cost, it is still unknown. So in all of these technologies, especially if there is a market which is independent and a higher value, it will go to it, and there will be lots of mile markers along the way as we progress towards fuels.

And so you might want to think about,

you know, how far are we from these mile markers.

XXX: We had some discussion at the breakout group I was in about to what extent should/does the department consider coproducts beyond energy related as we think about these technologies, and the answer at the moment, I think, is not much.

Department of Products and Energy? Was that -- well, all right. You can make your own acronym.

Yes?

XXX: Just a generic comment.

XXX: Louder, please.

XXX: Just as a generic comment about above-ground challenges as it relates to agriculture, since I am from XXX, and that is more or less the field that I am in.

I think that there is a challenge in growing food, and I was looking at the stuff that Zia put up with a little bit of interest, because it's hard for someone from agriculture to differentiate between feed and fuel, and when I see things like corn stover, I think of some of the excellent feed studies that have been done showing that that's feed.

When I look at corn, I think of feed and fuel. When I look at a crop like

switchgrass, I can see it easily being used as an animal feed and actually being used. So I think some of the differentiations may be political and not really based on science.

My other comment is when I kind of look at some of the above-ground challenges from an agricultural perspective, I'd say that one of the things that is missing in this room is more people, if we are going to talk biofuels, with agricultural experience, and I think that that would help and suggest maybe at the next review or at some of the future ones -- and I thank you for inviting me, so I'm not saying that it's not present here, but I am saying that maybe at some of the future ones as you go around to get some feed stock experts would be very useful and could be pulled from the USDA also.

XXX: We do talk -- I mean, not to make an excuse, we need more such people in the room, but we do talk quite a bit with USDA. It's one of the better interactions, I think, the department has.

XXX: You can continue building on that, I would say, as you think about it.

XXX: XXX, what happens next?

XXX: So we should just continue this conversation but in smaller groups. Next door, again, rather than -- this is a complicated space, and we fought round and round about how

to try to divide people up into five groups that would make any sense. We considered all the different kinds of axes, and then realized that we couldn't. Actually, we didn't know enough about you as individuals to know which group you all would fit in regardless of assigning you.

So I think that in this crowd we have, if we try to divide it into five groups, we would have either one or two sort of more fossily oriented groups and three or four more bioey oriented groups, and then rather than this morning we explicitly tried to put you with folks who you might not ordinarily sat at the table with, I think for the technical discussion to help us get a real technical understanding and inform the tech assessment teams that are trying to wrap their heads around this space, if you actually sit with the people who are like you as best you can, perhaps there are various people who think feed stock can rally and find a common table so that we can have an informed discussion amongst folks who are experts in similar things.

It is a little bit of an experiment, so mix amongst yourselves and try next door, and let's try fossil at the ballpark table 1 and then everybody else at tables 2, 3, and 4, and we will see how it goes. I'm sorry if I'm a

little bit fuzzy, but we're sort of making this part up.

XXX: Perhaps describe the four or five people.

XXX: Yes. Sorry. So XXX showed a slide earlier about what kinds of things need to show up in our -- we think we need to be able to do assessments of the techologies in order to really get a handle to do the rest of the QTR. This included understanding of headroom, what is the size of the resource, understanding of current industry, different actors within that industry and their different roles.

What role does DOE play or should DOE play in different technical aspects? I am particularly interested in your thoughts about going forward. Careful not to tell us trade secrets, but your thoughts about where there are future milestones in the field in general and also if there are particular barriers that you see, whether they are policy barriers or economic barriers, commercialization barriers, identifying those and really trying to make them concrete for us to be able to really understand them and go forward.

XXX: And what is the timetable now?

XXX: Timetable? Ideally, we were supposed to be back here at 3:00, but let's say

3:10, and then we will do a short set of report-backs from these groups. And then basically at the end of the day, it's --

XXX: Is there a break before?

XXX: Yes. So, I'm sorry, we will break at 3:10, reconvene here at 3:20, 3:25-ish, 3:30, and then get some report-backs and go into open discussion.

XXX: We are headed toward the home stretch here. Again, at least at the table I was at, we had a really good discussion, of course about technology, but also fading back towards some of the discussion this morning, which people seemed to have an appetite for. I gather at some of the other tables there was a similar phenomenon.

I thought again we would go through report-outs from the various groups and then just throw the floor open for more general discussion and probably just wrap the day up that way. I will try to make a few summary comments toward the end.

I was sitting at Table 1 and was the rapporteur by defaults, but I am not going to go first. So I don't know who was sitting at Table 2, and I will finish up at the end.

Who is prime rapporteur for Table 2? Okay. Well, let's move on to 3 and then we will

come back. Who was 3?

XXX: 3? That was me.

XXX: All right. Come up.

XXX: So Group 3, we had quite a diverse set of opinions and a wide-ranging set of comments. A couple of the things that we discussed were technically derived but very high-end level.

So, for instance, food versus fuel, there were a lot of comments on this, but any refinery in the conventional transportation fuel industry would look to maximize profitability and therefore maximize products that come out of, you know, the barrel, so to speak. So because of this, we should allow this for biofuels as well.

There was a healthy debate about whether the DOE should start looking into bioproducts as an avenue of research, but one of the things that I have heard which made a lot of sense was that at least the deal we should allow for co-production of fuel and products in their demonstrations and that that will help change the conversation of food versus fuel when it is understood and explained that it's not an either/or, they can both result from the same feed stock.

But another important note, and I think this stems to or this leads to the conclusion

that DOE has not been as successful as we would like in our education and outreach activities. What I heard was that agricultural yield -- sorry, agricultural land use has declined in this country over the past decade or so, and that's not well understood.

So when people consider the environmental impacts of biofuels production, they start talking about land use change and other sustainability issues as though we are always talking about green field production, and we are not. There is a lot of agricultural land that is no longer in production.

So now moving on to some of the technical issues. The question that I posed was what is more important, agricultural yield from a feed stock perspective or densification. The responses varied, but essentially, I get that both are important. You know, and DOE has done research on both of these challenges, but they have failed to enter the marketplace.

I know the department has a lot of work in both of these areas, and some people in my work group were even unaware of some of the ongoing DOE work in areas such as biomass densification.

If we go to metrics, cost per gallon is a unifying metric, but it fails to address

important externalities, sustainability, and water, each of these other metrics that some of the people in Breakout Group 3 thought should be included in the valuation of potential DOE funding and RFPs for projects.

There were a lot of other discussions, but I think some of the closing points that the members of my group made would be interesting for all.

One comment was that DOE needs to make cellulosic ethanol happen, and that is a rallying cry that might be somewhat different from others that have been laid out.

Another is that we need to get DOE innovations integrated into feed stocks. So this goes back to the facts that we have -- you know, the DOE has funded work in agricultural yield improvements and feed sale densification, but that has not penetrated the marketplace yet.

One of the members of this group mentioned that the DOE has spent $350 million on bioresearch centers, and if they are to be meaningful, then the innovations and developments created as a result of that funding must enter the market.

Another comment was that DOE should take a step back, and rather than focusing on individual conversion processes, individual feed stocks, and individual products, the department

should take a step back and look at some holistic metrics and economics, energy security, greenhouse gases, and of course then we go to some of the others that were mentioned earlier, such as water and sustainability.

And there was a variety of viewpoints on gaining buy-in from end users. So, for instance, what does drop-in mean and how drop-in is drop-in. So we have, as XXX said earlier, 240 million vehicles on the road, we have an entire built infrastructure, does creating a molecule that classifies as drop-in compatible, does that really mean we just mix it in with the current product stream and continue to use it without any changes?

And the final set of comments, I think, were about education and the role of the Department of Energy as a not only a convenor but as a communicator and as an educator regarding these technical opportunities and technical challenges.

One individual mentioned, lamented about the change in public perception of biofuels over the course of the past few years and that it was largely a product of public misunderstanding of both the challenges and opportunities that biofuels present and that the DOE needs to do a better job in the course of

their RNA funding of also educating the broader public on what is possible and what is being done.

Anybody from Group 3, please correct.

XXX: Okay. Yes, 3.

XXX: There was an idea voiced, not my own, which I may have mentioned, to the effect that energy and -- well, bioenergy anyway transcends the boundaries of the DOE and that it would be desirable to -- what was the phrase you used, XXX?

XXX: I guess mobilize the whole -- many more agencies of the total government.

XXX: Sort of a cross-agency initiative, and that was mentioned by more than one person. I just didn't want to lose that.

XXX: The goal in these things, it's a complicated system. Anybody else from that group?

Okay. Let's go back to Group 2 and XXX, I guess.

XXX: So I'm going to just quickly summarize, and I won't cover all the comments, so I apologize if I leave anything out.

I think -- I was very interested in a discussion on what the role of DOE should be in terms of the fuels, which is the notion that I brought up of the LS 9 and the Amyris, you know, going from clean sugars and so forth.

And I think that we had a lot of discussion on that, and it seems that there is a lot of interest in DOE being involved in some way with a wide variety of fuels, not just the same emulsifier fuels that we are currently working on, but also the potential new routes that we talked about, which is kind of the clean sugars to biofuels route as well as the potential for retrofitting existing corn ethanol facilities into hydropower fuels.

So it seems that there was a lot of interest that we should be -- we need to dabble in a wide variety of fuels. That was the phrase that was mentioned, and I think that's a very interesting way of putting it.

I think we have been focused, at least, on cellulosic ethanol for many, many years and then lately expanding that to hydrocarbons from cellulosic biomass. So I think there is a lot of interest in a broader DOE involvement in other areas.

But, you know, we recognize that this is, of course, something that is controversial and is going to require careful thought and planning as we move forward. It's not something that we can just do.

And it's not also sure to what extent DOE should be involved, doing studies and doing

bench mark analysis to determine what the cost of production is, what the greenhouse gas implications are. You know, that doesn't imply that we are supporting a pathway, but that's one possible role for DOE.

Another role could be a sort of a matchmaker, if you like, to bring together the suppliers and the fuel buyers for these kinds of products. So those are ways in which we can be involved without actually financing plants and building plants.

I was very pleased to hear that one of the comments -- or one of our participants mentioned that they rely on DOE as an unbiased source of technical information, and that's very nice to hear. We really appreciate that. We try to do that very consciously.

We have tried to be thorough and methodical and transparent in the modeling work that we do at our national labs, at Argonne and Enrel and other places. We publish our reports. Everything is available online.

And, you know, we are not looking for, you know, glory and publicity and all that, but we are looking for sound technical data to back up these assumptions.

So those cost numbers that I put out, the technical target numbers and so forth, there is a lot of work that went on behind those

numbers. You know, there are big reports that have been written up. So they are not just something that we have kind of scratched out on the back of an envelope and put up on the Web.

So that's something that I think we need to continue to do and continue to strengthen, in other words, be a source of information that industry and other agencies and Congress can rely on, you know, to move forward and make decisions.

So in that vein, one of the things that will resonate with my office was a comment about the resource assessment work that we have been doing, which is the so-called billion ton study. We published, as you know, in 2005 the billion ton study. We have since been working on an update. The update has not yet been published. It's been in the works for at least a couple of years, and I think one of the take-aways that I got was that we need to publish that very soon.

And we have recognized that. It's just that it needs to go through an OMB review process, and I think we really do need to expedite that as much as possible, because I think that people will rely on that data for quite a lot, for even policy directions, which is interesting.

So I think it was a very useful

discussion, and I was very glad to have the people in my group, and if I left anything out, please chime in. And, you know, I think it will be -- we will move forward with some instructive solutions.

XXX: Great. Any people want to say anything?

XXX?

XXX: Okay. For Table No. 4, I've sort of distilled this down so it will be done quickly.

Discussions of roles of the Department of Energy: Certainly, I think it came up a number of times that the value of the position of the department was quantitative, disinterested technology assessment, that in the area of life cycle analyses that DOE should focus on pulling in as much data as it possibly can get, proprietary data, and then further developing the methodology of life cycle analysis, not just focus on sort of running further analyses, but spend some time thinking about how to do that better.

There was discussion that the department should focus on the development of infrastructure options in the sense that we should be thinking about sort of a centralized system versus distributed systems, that we should -- the comment was made that it was probably better to focus on small capital

requirement technologies and potentially stamp out more of them rather than work on technologies that required scale-up to large capital investments or single unit capital investments.

On how to think through where we made our investments, there was some discussion of sort of what the driving goal was, and then the comment was that if it's just about energy security, sort of do it with fossil; if it's a greenhouse gas issue, then biomass is preferable, but then you run into lots of constraints on resources.

The discussion then touched on issues in the area of biomass that our efforts are not leading on logistics issues and they are not particularly well coordinated with USDA, that the department focuses more on conversion technologies, USDA focuses more on production issues, and that for the biomass arena, logistics logistics, logistics may be the Achilles heel. So a coordination and thinking through a multi-agency approach may be required.

There were lots of discussions of markets and where we were trying to focus attention. You know, there was a question about which market segment should be the one that we focus the portfolio on, and so is it a question

of aviation was a comment and/or, you know, drop-in fuels for light-duty vehicles. As one person mentioned later, you know, voters drive cars, not trains.

And there's this -- back again this issue of the debate over the problem being solved whether it's a greenhouse gas environmental problem or an energy security, and then someone mentioned that there was a perception that the department doesn't focus enough on drop-in fuels.

XXX: Anybody wanted to comment on that one?

XXX?

XXX: So I'm from Group X. I don't actually know what our table number was, but I am going to echo a couple of the things that I have heard from some of the other groups that came up in our group.

The technological analysis, the life cycle analysis was a really high value thing that the DOE does, though there was some desire to also have some behavioral kind of analysis, the similar kinds of studies.

And also, another echo is the inter-agency cooperation needs and especially with USDA and the Department of Transportation and the Interior.

But the conversation really started out

with getting better metrics for comparing different fuels, and many in my table thought maybe dollar per unit sugar or sugar equivalent would be best because, you know, then that levelizes you at some single node when you have different feed stocks coming in and different processes going out, but even having that single sugar equivalent brings up issues of standardization, and not every processor uses the same kinds of sugar, and quality issues.

And then, basically, any sort of end process, the best thing you can do is to use the widest variety of input quality that you can, and that will really drive the economics.

And then there was some discussion on how you value byproducts, so what do you with the liquid, and do you process it for higher value products, or do you just burn it to get the electricity, and then how those byproducts go into your dollar for dollar equivalent or metric, if that's what you are using.

And then there were some discussions of, you know, what do you do with scale, and there were a lot of, you know, the MB sort of problems, how different communities would object to growing lots of feed stock for fuel, that in these areas that are not used to that sort of agricultural and having a plant every -- you

know, just dotting the landscape.

And then there were issues with, you know, decoupling, if you could, possibly, to handle food versus fuel and how that was not likely along a lot of the pathways that we are thinking of. And also on the scale issue, even where you find the acreage for fuel testing feed stocks, that was brought up.

There was also a lot of discussion or some comments on international cooperation and strategic alliances and how that will be very important in maintaining the feed stocks.

And, yeah, that's pretty much all I had. And if anybody has any comments from my group, please add them.

XXX: Okay. I was sitting at the self-designated fossil table, because somebody had to do it, and we actually had a great discussion. And let me try to summarize some of that, and then, as I said, maybe we will open the floor up for some corrective discussion.

We started out by talking about various conversion technologies, coal liquids, gas to liquids, coal biomass to liquids. The general consensus was -- well, no, opinions. I'm not sure there was consensus.

What heard from some people who supposedly know, not much opportunity for new catalysts, the new chemistry. That's pretty

well piled-over ground.

Efforts going forward are to reduce the carbon footprint, cheaper oxygen and cheaper hydrogen in the processes, again, rather than getting at the nub of new chemistry.

Several of the people thought that thinking through these kinds of facilities has been too conventional, that there are integration opportunities not yet captured, carbon capture and recycle rather than carbon capture and storage, integration of algae with the system, polygeneration, some new thinking probably will pay off a lot, several people thought.

The general class of technologies benefits from cheap feed stocks, whether it's gas or coal, which we have abundantly domestically and pretty cheap, but suffers from both volatile oil prices and high capital costs, as we heard a little bit here.

As somebody said, it's not enough to break even at $80 a barrel; the question is can you ride through $50 a barrel per month, which is in the end the way the big companies think.

Someone suggested that we look at coal to liquids or gas to liquids as kind of benchmark costs for fuel production and that we shouldn't be funding anything that's going to be

more expensive than that in the long term, because that is the backstop, the baseline.

Several people asked, "Where will the capital come from?" We saw some example of the enormous capital costs. A million barrels a day of CTL is $150 billion. Who would lend you that money? And if you were a company and had access to that kind of capital, is that where you would put it, given the return on investment? Several people said just go upgrade your refineries, or something like that, for much cheaper.

And, again, having been involved in the oil production business, boy, the upstream's got a tremendous return on 550 billion. You could make a lot more money by going out and extracting oil than you could by basically running a chemical plant or turning coal into liquids.

Another complication is it is hard to get an offtake agreement for fuels beyond two years, someone said, and that was a suprise to me. You know, in the power business ten years, you could get maybe more, and you could then get that kind of certainty in the economics where the fuel business is much more volatile.

In terms of feed stock, there was a consensus that gas could do it. One could imagine ramping up gas by another 5 TCF a year, maybe more, but it would mean the

industrialization of the countryside. As somebody put it, 100,000 wells, and are we ready for that or not in some regions of the country.

Somebody mentioned jobs, cheap natural gas as incentives, but, of course, the other people talked about the despoiling of the countryside.

Shale oil was mentioned briefly. I think there were mixed opinions about the economic viability of various reputed shale oil extraction technologies.

More generally, there was a plea again, someone said the magic word "systems," and a duck dropped from the ceiling. But holistic systems, marked "holistic," another one of those words, system modeling, emphasized really that it should be be a DOE role to sit above industry and try to help understand and guide that activity.

Someone said one of the unexpected systems things that could happen is let's use gas for power and then use the coal and biomass to turn it into liquid fuels instead of sending the coal to China, which is probably what we would do with it.

Someone else posed the interesting question of what would the DOE portfolio look like if the department's role was to help buffer

fluctuations in energy prices rather than be a truly transformative agent for the energy system, which is the way we talk about the department now. If you were just going to be a buffer, what would you do differently? No answer to that, but I think it's a good question.

I think there was some concern also about the notion of a technology roadmap being a little bit misleading. This gets back to the social science discussion. The social science considerations, whether it's politics or culture or economics, will be as important as the technology developments in determining what the energy system looks like in 20 or 30 years.

Information technology was cited as one thing, whether it's smart grid or traffic control systems, as being a really important thing that isn't quite within the DOE's radar screen right now, and with that notion, perhaps the six strategies are a little bit too simplistic and that we are going to start seeing couplings between them that we haven't really thought about yet.

And then finally, it being the fossil table, someone noted cheap energy is the best route to jobs and competitiveness, and we have not in the DOE perhaps been as focused on the cheap energy part of the equation for

competitiveness as some people think we might have.

So that's what I had. With that, I am going to open up the floor for reactions to any of that that you have heard in the last 20 minutes or more general comments. Yes?

XXX: Let me add a general comment. I work at XXX, and I thank you for inviting us here today. I really appreciate it. I know you came to talk to our leadership, and they enjoyed the conversation. We are supposed to work with you on this.

But the way that we evaluate technology like this, energy technology, is for its ability to affect our missions. And so when you think about drop-in fuels for our legacy platform, it's a -- we think of it as a long-term, because we are going to have our ships and planes for a long time.

But when you think about that, you know, we are going look for cost-competitive type fuels. Where the department may be willing to spend more money and pay the premium is when you can think about, you know, the situation we are in today in Afghanistan. How could we have fuel that we can generate onsite? And that has the ability to affect the way we do our missions.

It has -- we can trace the financial costs, but it has other very important costs inherently, and we mitigate in terms of soldier, sailor, Marine, airman lives in terms of how they spend their days fighting versus moving around logistics.

And so that's where I think marrying DOD requirements to the DOE capabilities becomes really important for us, and so I appreciate that this process is looking at that.

XXX: Good. So let me ask in that context -- and I am now going to step outside of the box a little bit. The DOD is working hard on biofuels. It is hard for me to imagine sitting around waiting for crops to grow in Afghanistan, you know, but –

XXX: So the fact that some of your colleagues -- and so we are particularly excited about something like electrofuels and the potential for that, for something being very localized, you know, the fuel cells. The Army is deploying ethanol and --

XXX: So let me give you one sobering number, okay, in this comparison of just how much energy density or how much energy there is in fuels. Right?

If you took the electricity that comes out of a gigawatt nuclear reactor, so a gigawatt, that's the fuel equivalent of 14,000

barrels a day. So that's probably the scale of the reactor that you've got on an aircraft carrier, you know.

So if you took all that energy, and converted it with 100 percent efficiency, you would get 14,000 barrels a day. You'll know what the tactical needs are, I don't, but the answer is it's awfully hard.

So electro fuels, you got to get the electricity from somewhere. Where are you going to get that?

XXX: Well, and that's why we think of them as long-term challenges, and we are spending so much more.

XXX: All right. Yeah, efficiency works really well. Okay.

Anybody else? Yes?

XXX: So XXX from the XXX. So maybe this will come later, but there is something in the QTR framing document that we didn't talk about today, but I think it's critical when you look at all of the slides that we have seen.

Energy is critical to the future of this country, as a citizen and all the way up through industry and military and everything we do, but we don't seem to be able to make a case that is significant research investment in energy development compared to the GDP.

So maybe we need to discuss it. Maybe you guys are going to discuss it later, but have we given you the kinds of things that can get to a place that is better than you are now? And if not, how do we help you get there? If you think we need to be better than where we are in the GDP mix.

XXX: So better in the --

XXX: Well, see, you make a case in the document, or I have seen you make it in your talks, that a fraction of the GDP that's in health care is very different than the fraction of the GDP that is in energy. And you may be perfectly happy with where that number is, or you may not be, but if the number needs to grow, have you gotten the technical --

XXX: You are talking research funding?

XXX: Yeah.

XXX: Yeah. I think it comes later. Some of the things we have heard today can help make that case, but, you know, could I get some big new piece of armament, to use the DOD language, today? No. No, not yet. Okay? You know --

XXX: But fuels are going to be part of -- fuels are going to be maybe not one sixth of that equation but a significant part of that equation.

XXX: Fuels are much higher on the agenda now than they were six months ago, and I think the challenge we have is to carefully articulate our R and D and DOD program that really is going to address some of those problems in some reasonably short time. You know, it's not going to be six months, but five years, that would be nice. Okay?

XXX: And, hopefully, it will be politically independent. It will be independent of who sits on Pennsylvania Avenue at the time.

XXX: I would like to think that if we do a good job on the QTR process that that will endure, I would hope.

XXX: Are there limits to research spending? Because the previous question is we need to do research spending, but the number of researchers are kind of a stock on the floor problem. It takes 15 years to build a scientist, 30 years to harness it.

XXX: Yeah. Yeah. And after that, it's, you know -- it's administration.

XXX: It's all good.

XXX: Like a good wine. Yeah, right.

XXX: So just increasing the funding, you know, I mean, what you do is you get monuments of buildings and demonstration plants.

XXX: And you get messing around. You

know, I think we could justify the same or increased funding if we say this is really the plan to solve the problem. All right. Solve the problem.

XXX: Yes. I would even say there is a little bit of overcrowding and an inflation that creates it too.

XXX: XXX?

XXX: So you mentioned something, a statement in your presentation about the fossil table that we were sitting at. One of the parts that I did not hear, and it depresses me a little bit, is there was no consideration given to unexpected scientific breakthroughs, you know, whether you call them black swans or whatever, and a review, such as the one you are contemplating, some time needs to be devoted to this. Now, presumably that was one of the reasons brought up, it may be, or --

XXX: Yes. Yes.

XXX: It's a question, sort of, but shouldn't that be integral to --

XXX: So, yes, and actually at the fossil table, there was this discussion that you can't predict, but, you know, black swans start out as black signets, and they take 15-20 years -- well, you know the timelines as well as I do.

So I think you have got to watch for

the birth and so on, but you can't predict it, and it's going to take a long time. It doesn't mean -- you know, you shouldn't count on it, I guess, is probably a good strategy.

Yes?

XXX: As one of the retired black swans, there is another aspect of holistic modeling that I think we missed today. It relates to molecular management, what we used to call molecular management, and a lot of different folks talk about a lot of different options, and if we are in the liquid fuels arena, I will tell you from our experience with DOD, it's very important to keep that in mind and the consequences of the nature of the molecules that you are producing, whether they require off blending with petroleum or not, whether you can produce them fully from domestic resource or not, et cetera, and just as a retired black swan, I think that should be noted.

XXX: Okay. Anybody else? Yeah, XXX?

XXX: So I got four kids ranging from 21 to 10. After we have glorious conversations, we both go away thinking we have communicated, and then we come back.

So one of the things I think that I

have heard and communicated also, tried to a little bit in some of the groups, is this thought that to transcend political administrations and changes, at least on the basic research side, maybe even pushing out a little bit into something more bite-sized is that to set the divisions at things like clean and efficient and affordable and reliable and then not pick fuels but let everything compete within that framework, because most elected officials are going to have trouble saying, "I want it dirty, I want it expensive, I want it unreliable." So it will be hard to disagree with some of these things.

The document as written now, even as a strategic plan, is sort of like that but not really. I will be bold and say there are some political things in it requiring me to say just go out and picks some winners. Is there a chance that can change, or what is the result of some of the inputs on this in the subsequent five sessions that you are going to have, and shall we go home and try to continue to provide you input, and will it matter? Is that worth my effort, or should I talk to my kids?

XXX: Right. We can talk about a cost benefit in both of those dimensions or activities.

Well, what we would like the QTR to do

is set a credible analytic framework and resulting priorities for what the department does about energy. Speaking as a scientist and technologist, I would like to get to the right answer or set of answers that are not modulated by the political winds, because the political winds are shifting maybe even as we speak. All right?

That doesn't say that the document in the end will not have some of the sharp edges rounded off a bit, but, you know, I think that's okay in what will in the end be a public document.

You know, the document we will produce is a report on the QTR in the sense that hopefully this is an ongoing process. Advice between now and June, July much appreciated, particularly from people who have been involved in the workshops, and will be listened to and folded in as we go along.

Just listening to people in Washington, there is a lot of appetite for this kind of thing right now or what are we really doing about energy, both because of the energy oil prices and because of the sense that government resources are shrinking and we need to get the maximum bang we can for the buck.

And when I go around and say, well,

tell me what the department's strategy and principals have been on energy, and I don't get any answer, that's because nobody has ever really thought about it before. That tells you that it's probably the time to do this. It won't be the first time -- well, it is the first time, but it won't be the last.

XXX: Just a minor kind of nit. Energy prices are not increasing; liquid fuels prices are increasing.

XXX: Thank you.

XXX: Because gas is actually at substantial amounts.

XXX: Thank you. And, of course, if you measure it in something other than dollars, it will increase especially.

Yes?

XXX: XXX (phonetic). I'm from the XXX. I have two questions or comments. Throughout the day, we haven't talked about energy conservation, so is it part, is it in the scope of DOE, or is it beyond the scope of DOE? I think we can meet some of these energy needs by just having auditors which are more particular with energy conservation.

My second comment and question was can DOE take a more complete role in locating - you have 10 billion of funding and you go ahead and look at standard design technologies which evoke

by design. You have the tools to make spot decisions rather than going through all of these --

XXX: Tools to make -- I'm sorry?

XXX: Spot decisions.

XXX: Oh, yes.

XXX: Other than going through all this political process which takes a lot of time to -- which are not essentially going to be the same thing.

XXX: So let me take the efficiency first. Efficiency is very much on the agenda for the DOE and for the QTR exercise. You probably missed this morning. There are six different things we are using to describe what we do. Efficiency is two of them, but that was not the subject of this workshop, which is why you don't hear it discussed very much, but it is very much on the agenda.

The second is spot decisions. Spot decisions are incommensurate with government, except in times of crisis. All right? And we are not there in terms of crisis in the energy.

So the system is slow. It's got all the political overlay on it. It's Washington, it's federal money, public money, and so necessarily we do not move as quickly as one would like.

XXX: But have you changed?

XXX: Crisis is what drives the system to change rapidly. You can invent your own crisis.

Yes, XXX?

XXX: Just I was thinking about today and looking at the mission statement in the framing document, the first thing that I didn't see in there, and it was a surprise, is kind of energy in the national interest, if you will.

It seems to me that if I were looking at this, the DOE is all about in some sense energy and national interest, whatever that is. So you may define it in terms of economics and environment and whatever they are.

So my question is how clear is that to you? How much does the QTR actually help the definition of energy in the national interest? Is it still a dialogue?

Once you have got that kind of set that it is some agreement, political agreement, that may set a but for that if there is beyond administrations, let's say, which is a prerequisite of it. So how clear is it to you that we have a sense of what energy in the national interest means and how --

XXX: You know, that's really an excellent sort of question, perspective.

You know, there are of order a dozen

different agencies in the federal government who are involved with energy in one way or another, ag, interior, on and on. Right? So energy in the national interest is really a government-wide thing.

The DOE focuses by either history or capabilities or OMB guidance. We focus on technology development, basic research, and a little bit of policy having to do with appliances, and hopefully inform, as we have been talking about today, a lot of the other policies.

So I think the energy in the national interest is really a QER topic. We can maybe use it as a frame for QTR, but I wouldn't go too far with it, otherwise we won't have the impact that I think we should. We have got to get the QTR done right.

XXX: But that also imposes a constraint on your part.

XXX: Yes, it does. Right. You know, it's both a useful and somewhat annoying constraint. The useful constraint is it bounds the job to something we might actually get done in the time we have allocated. The annoying part is, of course, as we have been saying all day, it is not about the technology alone.

There was a question or a hand?

Okay. Great. Thank you all very much for participating today. This is, as I mentioned, the first. It's an experiment. I thought it came out pretty well for something that, well, we didn't quite make up as we went along but almost did. There was some playing.

I would appreciate your feedback not only on specific matters of substance that we touched on today, but also issues of process. We will run another four subject-specific workshops like this and then the capstone in June, and hopefully they will improve with your suggestions as we get a little more experience with them.

So thank you again for everything, and travel well.