1 DEPARTMENT OF ENERGY

2 QUADRENNIAL TECHNOLOGY REVIEW

3 VEHICLE EFFICIENCY AND ELECTRIFICATION WORKSHOP

4

5

6

7

8

9

10 TRANSCRIPT OF PROCEEDINGS

11 May 4, 2011

12

13

14

15

16

17

18

19

20

21 Location: 401 W. Summit Street, Knoxville, Tennesssee

22

23

24

25

1 DEPARTMENT OF ENERGY - QUADRENNIAL TECHNOLOGY REVIEW

2 VEHICLE EFFICIENCY AND ELECTRIFICATION WORKSHOP

3 Wednesday, May 4, 2011

4 Welcome and framing remarks - XXX,

5 Under Secretary for Science

6 XXX: Thank you all for

7 coming. My name is XXX. I work for

8 the Department of Energy in the Secretary of

9 Sciences Office. I have the pleasure of

10 welcoming you and also running through the

11 paradisiacal stuff before I hand things over to

12 the Under Secretary, so some of that dry stuff.

13 Participants of this workshop are not members

14 of the Federal Advisory Committee, nor do we

15 intend to use this group as a Federal Advisory

16 Committee. We are not seeking group decisions

17 or consensus view with respect to the issues

18 before you that is assessed today or as to any

19 action the federal government should take.

20 We're after your individual recommendations and

21 advice and we're looking forward to a

22 productive day. In addition, we note that the

23 participants of this workshop should bear in

24 mind the antitrust laws and restrictions, to

25 check with your counsel, before engaging in

1 certain activities, such as collecting or
2 discussing non-public data, evaluating public
3 data about future prices or costs, discussing
4 topics -- or discussing topics of whose
5 legality you are unsure. We ask that you
6 refrain from disclosing proprietary company
7 policy, supply, or price information or any
8 proprietary company information. And lastly,
9 we want to stress that we do not intend by this
10 workshop to encourage any specific cooperative
11 activity in nonparticipating companies that is
12 not fairly authorized by current law.
13 One of the commitments that we have
14 made as part of this quadrennial technology
15 review process is a strong commitment to
16 transparency. Among the ways that we're doing
17 that include a publicly accessible website
18 which, if you probably all visited, energy that
19 comes (indiscernible) QTR. We are releasing
20 all communications from external parties
21 through an ex-project communications process.
22 We published a request for information in March
23 with a framing document and it received at
24 least 60 comments in response to that, which
25 we're in the process of looking through. And

1 we've got quotes from some of those. And some
2 of you in the audience submitted your comments,
3 and we really appreciate those. We're also
4 running a number of focus groups within the
5 government outside, and workshops like this
6 one, running through mid-June.
7 It is important to note that notes and
8 the attendee list from this workshop will be
9 published on the project website. Your names
10 will be redacted from the comments so you --
11 it's sort of pseudonymous in that sense; you're
12 present in quotes, but not names associated
13 with the words, per se. So as I said, we're
14 doing a series of workshops of which this is
15 the second. We were in Chicago last week to
16 talk about alternative fuels, and starting two
17 weeks from now, we will get the stationery side
18 with efficiency May 17th in Pittsburgh, the
19 grid May 24th in Tempe, Arizona and
20 Cleoenthisity (phonetic) June 7th, in Denver,
21 Colorado and have a (indiscernible) workshop
22 June 21st in Washington, D.C. So in just a
23 moment, I will turn this over to Under
24 Secretary Koonin who will go through some
25 introductory remarks and help frame the day.

1 Then we'll have a panel of folks whose names
2 are here come up and discuss some of the
3 prospect questions. Then we'll open the floor
4 for discussion on those questions, have a short
5 break, and then move on to break-out questions
6 on those and similar questions.
7 We'll break for lunch at 11:30, come
8 back at one, for technology roadmap
9 presentations from DOE Headquarters' experts,
10 and then go into some break-out sessions to
11 discuss those roadmaps. Then we'll close the
12 day with report-backs from the technology
13 break-outs, report-backs from the morning
14 discussion leading into concluding the day with
15 full-group back-discussion on those big
16 cross-cutting questions. So with that, I will
17 turn things over to Under Secretary Koonin.
18 XXX: First, thank you all for
19 coming. I know everyone is really busy, but we
20 believe this is an important exercise. I am
21 spending a good fraction of my time on this
22 right now, and I appreciate all the help you
23 can get from what has to be an inclusive
24 process that involves many people. Let me talk
25 about what it is we're trying to do and where

1 this exercise, this meeting, fits into the
2 broader scheme of things. We are trying to
3 provide through a report we will generate, but
4 perhaps more importantly, through the process
5 itself, a context and robust framework for the
6 Department's Energy programs and also the
7 principles by which we should be formulating
8 multi-year program plans and budgets. And so
9 the way I like to think about it is if the
10 Secretary, or I, or some other government
11 person were testifying before some committee
12 about the DOE budget and program, what is the
13 few-minute answer you can give about why the
14 Department is choosing to work on the following
15 technologies, and why is it not choosing to
16 work on some of the others. And when I say
17 "work on" I mean both the budget and the
18 program itself. And the fact that one needs
19 such a story to tell through both the external
20 communications beyond the Department as well as
21 internally, is simply illustrated by going
22 around and asking people, what are the
23 principles by which the current set of
24 activities have been determined. And when you
25 do that, you either get giggles or silence.

1 And so somewhat to our surprise, nobody's every
2 tried to do this before and frankly, the
3 Department's programs pretty much are a
4 patchwork of things that have been justified on
5 an ad hoc basis and/or are there because of
6 inertia. And so what we're trying to do is to
7 go through a process that is associated with,
8 first of all, framing the energy challenges,
9 just what is it we're trying to do, what are
10 the challenges we're trying to address; what
11 are the optimal roles through the various
12 players -- the government, industry, national
13 laboratories, and universities, in transforming
14 the energy system. Notice this is not just
15 about energy innovation, inventing cool stuff,
16 but actually getting the system to change.
17 What are some of the roadmaps for the key
18 technologies, system and sectors. Again, the
19 principles, some discussion of how we do or
20 don't do demonstration projects, and
21 importantly, the connection between energy
22 technology and energy policy. A little bit of
23 timeline here, I'm going to spend a few minutes
24 at the beginning just to tell you a little bit
25 about what it is we're trying to do. Back at

1 the end of November, a PCAST subcommittee
2 shared by Ernie Moniz and Maxine Savitz
3 recommended that the government as a whole do a
4 quadrennial energy review analogous to the
5 quadrennial defense review that for the last 20
6 years has guided the Defense Department. This
7 is a document that gets issued every four
8 years, at the second year of an Administration
9 typically, or the end of the first, that said,
10 you know, these are the threats out there,
11 these are the fore structures we think we need
12 in order to be able to respond to the threats
13 and contingencies, this is what it's going to
14 take to support that fore-structure ensuing. A
15 quadrennial energy review will amount to a
16 national energy client which clearly is some
17 complicated mix of policy, economics,
18 technology, special interests, and so on. And
19 if you sat down to do it, which the government
20 has not yet decided to do, it would probably
21 take a couple years and again involve 20
22 different agencies across the federal
23 government as well as across the private sector
24 and academia. So the PCAST committee,
25 recognizing that that was going to take quite a

1 while, they said, in the interim, DOE, you go
2 off and practice and do your own quadrennial
3 energy review about DOE programs. After about
4 two months of back-and-forth with the White
5 House and the Department, the Secretary finally
6 decided, okay, we're going to do it and Koonin,
7 you go make it happen. But the scope has been
8 restricted, in my mind actually appropriately,
9 to talk about energy technologies and the
10 policies that are associated with their
11 development and demonstration. So we can talk
12 about and should talk about the benefits of one
13 technology over another, or weigh in the
14 technology development chain the government
15 should most effectively play. But we should
16 not be saying there should be a lower ethanol
17 tariff or something like that. That's clearly
18 a policy decision outside the scope of what
19 we're doing. I'd say it's appropriate that we
20 restrict it, both because nobody's even done
21 this before, even for the technologies it's
22 hard enough, and secondly, you probably need
23 the technologies as a foundation for a broader
24 energy review, which hopefully the government
25 will decide to do in a couple years. We put

1 out a framing document in mid-March. There's a
2 small team of people from my office, and other
3 offices within the Department, and public
4 comment period closed April 15th. There is a
5 website. We have now about 65 comments,
6 perhaps. Sixty came in in the formal period
7 and a number of others afterward. We're still,
8 of course, accepting comments. It's just that
9 we don't have to respond to them. We're not
10 obligated to respond to them now. They're up
11 on the website as I mentioned. Now through
12 June, as Asa said, we're holding workshops to
13 discuss various sectors and strategies. We
14 hope to use all of that input to submit a
15 document that's been cleared within the
16 Department, send it over to the White House to
17 put into the formal concurrence process, and
18 issue before the end of the calendar year.
19 Again, in my own mind, the value is much more
20 in the process and discussion than it is in
21 whatever document one puts out. I want to talk
22 a little bit about the logic flow here so you
23 can understand how we're thinking about this
24 process. There are three strands that come
25 together to try to create a set of priorities

1 and the resulting portfolio. The first is,
2 again, just the energy context. What's the
3 energy system. What are the challenges that
4 naturally leads to the six strategies that
5 you've seen articulated in the framing paper.
6 I'm not going to go through this. You probably
7 all know the U.S. Energy System well enough, so
8 let me not talk about that. But we have talked
9 about the three challenges. One, energy
10 security associated with our coupling to the
11 global oil market with the economic and
12 geopolitical issues that that brings. U.S.
13 competitiveness is another issue that we have
14 tried to frame. The fact that we don't
15 manufacture as much in this country as we used
16 to, and also the fact that the federal
17 government does not have as much money as it
18 used to. And then the environmental issues
19 associated with greenhouse gases and their
20 potential impact on the environment as well as
21 other environmental issues. So the second
22 strand that one needs to go through here are
23 technology assessments. We understand what the
24 problems are. What are the technologies that
25 we, in principle, have available to us to

1 develop and perhaps deploy. And we have set up
2 a set of 14 teams, 3 of them associated with
3 vehicles, that are meant to look at the status
4 potential, technically, economically, of
5 various technologies, and then what are the
6 roadmaps for their further development. The
7 milestones on those roadmaps, cost, schedule,
8 who should be doing what. In some ways, I view
9 those technology assessments as, and you can
10 pick your metaphor, the basis factors from
11 which will form the solution, the palette from
12 which we'll paint the picture, the ingredients,
13 we'll make the stew, on and on, right? Okay.
14 So these are meant to be in some sense almost
15 advocacy or at least a good non-biased look at
16 the various technologies. And then the
17 discussion comes in the center column which is,
18 frankly, the most difficult, and where I'd like
19 to spend certainly most of the morning. Some
20 tracks in the afternoon. What are the
21 different players and what are their roles.
22 Private sector versus government. Within the
23 government, what does the DOE do relative to
24 other agencies. What is the relevant potency
25 of technology, economic and policy levers. So

1 in the transportation sector, for example not
2 that I'm advocating, but you can imagine,
3 should we just keep raising Cafe standards
4 centers and let the private sector respond
5 appropriately, or should we raise the price of
6 fuel and let the private sector respond
7 appropriately, or should we be working hard on
8 the technologies to drive down the costs of
9 either fuel or increase efficiency or both, or
10 none of the above and just let the free market
11 play out as it should. And then how do we
12 think about the different roles of the lance
13 (phonetic) in the private sector and academia.
14 What you'd hope is that that discussion leads
15 to a set of portfolio principles for the
16 Department. For example, work on earlier-stage
17 things rather than later-stage things, or the
18 reverse. Or don't work on anything that isn't
19 going to have at least a prod of impact over
20 the next 20 years, or maybe you should, or
21 maybe you should leave all the short-term stuff
22 to industry and work on only the much
23 longer-term things. So what are the principles
24 by which we should be thinking about the
25 Department's Research Portfolio. In an ideal,

1 platonic world, or Euclidian world, those three
2 things come together: What problems, what
3 tools, what are your principles to form
4 something like a set of priorities and a
5 portfolio for the Department that's bXXXced
6 within the strategies and across the
7 strategies. That should inform the budgets for
8 the Department. This is not the budget
9 exercise nor is it the program planning
10 exercise. What I'd like to say is it's kind of
11 a one to one-and-a-half-significant digit look
12 at what is the mix of energy technology
13 activities the Department should be pursuing.
14 Frankly, we will have been successful if we can
15 more broadly promulgate and imbed a frame for
16 thinking about these, and get something like a
17 sense of what's more important than other
18 things for the Department over the next five
19 years. The six strategies which key nicely to
20 the Sankey diagram. I'm not going to go
21 through them, other than to say what we're
22 about today is the two boxes in the lower
23 right, the progressive electrification of the
24 fleet. And I say that -- we've been using the
25 word progressively not necessarily to imply

1 temporally, but just to remind people that
2 there's a whole spectrum starting from
3 non-electric vehicles all the way through to
4 fully electric vehicles with the continuum in
5 the middle, depending on how you hybrid it in
6 one way or the other. And of course, increase
7 vehicle efficiency, which is about the vehicle
8 as a whole as well as the internal combustion
9 engine. So we want input on the roles of
10 various layers, we want input on the
11 principles, and we want some discussion of the
12 connections between energy technology
13 innovation and energy policy. I'm not going to
14 go through in any detail the comments we have
15 received specific to vehicles. The whole set
16 of comments makes for really interesting
17 reading. It's up there on the website. We
18 have wireless access in the room. And so as
19 you get bored with the discussion or have some
20 quiet time, you might read through some of the
21 comments. So these are some of the specific
22 cross-cutting questions that we thought would
23 be useful to discuss this morning. And again,
24 this morning is meant to focus on the
25 principles, the big questions. This afternoon

1 we will get into the technology specifically.
2 Let me just read them because I'd like to make
3 sure we stay focused on them. There are lots
4 of pathways to reduce oil use. Should we be
5 making bigger bets on a few things or smaller
6 bets, each supported with fewer dollars. What
7 are the rules for entry, allocation, and exit
8 in the vehicle's portfolio. How should DOE
9 decide what to work on. If it can't be
10 material in, say, 20 years, should we work on
11 it at all. Or maybe if it can be material in
12 20 years, we shouldn't work on it, "we" the
13 DOE, because the private sector will be doing
14 it. And how does the posture of the DOE change
15 as the technology becomes more mature. In
16 other words, what drawing does the DOE provide
17 to you, hopefully in a positive sense. What
18 are the benefits that you've seen in your
19 involvement with DOE and, you know, what
20 lessons can one draw from that to try to make
21 the government more effective in making energy
22 transformation happen. Another question is
23 what happens if oil prices drop. We had one
24 example of that already back in the early '80s
25 where there was a big flurry of government

1 activity, oil prices dropped, and everything
2 stopped. Synfuels is the code word for that
3 situation, I think. So what would happen now
4 and conversely, what would happen if oil prices
5 went up to $200 an ounce and stayed there. How
6 would it alter your priorities, the
7 organizations you're involved with, and how
8 should DOE's portfolio change in response to
9 oil prices, and to where it counts, if we pay
10 it all for oil prices in the set of acuities
11 that we do. Another question is how we bXXXce
12 our effort, the DOE, across the six strategies.
13 Particularly, between alternative fuels,
14 electrification and efficiency, that transport
15 line, never. You know, we put about $4 billion
16 a year into energy technologies of various
17 sorts, some signity (phonetic) infraction of
18 that into transportation, on the bottom. How
19 do we bXXXce that. Could we spend our dollars
20 more effectively in fuels rather than vehicles,
21 or spend our dollars more effectively in the
22 vehicle side rather than the fuels. I think
23 you can go through some numbers, I'm not going
24 to take the time now, that suggest that that
25 answer is perhaps not optimally answered at the

1 moment, that question. How do we bXXXce
2 security versus environmental impact versus
3 competitiveness. And as we move into a more
4 global world, how do we bXXXce the competition
5 cooperation in government programs in energy
6 technologies? So what we're going to do is put
7 together a panel discussion for the next half
8 hour or hour. And let me ask those folks to
9 come up, and while we do that, and take a seat
10 at the table, and I'm going to go around the
11 room just so that everybody can introduce -- or
12 just say who you are and what organization
13 you're from. So let's start over on the right
14 while the panels come up.
15 (Participants introduce themselves off mic')
16 So as you can see, we've got a really
17 interesting mix of people from many different
18 kinds of organizations that are relevant to
19 this discussion. I am willing to start off
20 just by allowing each of you a minute or two
21 both to say who you are, what your background
22 is, and just give some initial thoughts on the
23 kind of questions we've posed and then I'll get
24 into some specifics. So XXX, if you want to
25 start, just a word about who you are, what you

1 do, and some reactions to the general set of
2 topics we're talking about.
3 XXX: Okay. I'm XXX
4 . I head up -- I'm Vice President of
5 Research and Technology for Cummins and
6 responsible for developing our engines, really
7 for the next decade. We've been recipient of
8 DOE plans for many years now and very thankful
9 for it. I really applaud what you're up to
10 here. I've been very concerned for a number of
11 years around how the various initiatives are
12 aligned or not aligned. And I think as we
13 could gravitate toward what I'll call an energy
14 policy and avoid the ups and downs as
15 administrations change, would just be
16 wonderful, because it's really difficult for us
17 trying to have continuity. And we can't change
18 on a dime. I mean, you talk about, hey, if oil
19 prices go up, what would you do. Well, it's
20 not like we can develop a new engine in two
21 months. I mean, we don't react that way and
22 can't. So having some longer-term thinking and
23 coordination I think was just wonderful.
24 XXX: XXX from
25 University of California, Davis Campus, and

1 with the Institute of Transportation Studies.
2 I've been there over 20 years, now working on
3 issues primarily for the State of California.
4 We've been working on alternative-fuel vehicles
5 and primarily for air pollution in the 1990s
6 and earlier. Now, we've become a lot more
7 interested in climate changes here relative to
8 personal transportation as well as fuel
9 security. I direct the Plug-in Hybrid and
10 Electrical Vehicle Research Center there which
11 is funded by the State of California in which
12 we work primarily on issues of consumer
13 acceptance as well as modeling of the emissions
14 and issues relative to batteries. I'm an
15 anthropologist; probably a lot of you are
16 engineers, so I come from a little bit
17 different background. I worked a lot on
18 project demonstrations with consumers using the
19 technology and their responses.
20 XXX: XXX. I'm Vice
21 President of R&D globally for General Motors
22 and I thought I would just issue some reaction
23 to some of the questions which I think XXX,
24 in his note, asked us to do. First is the
25 question of the portfolio bXXXce in the

1 absence of an energy policy of the country.
2 Look, we manufacture and sell vehicles around
3 the world; we deal with the lack of or the
4 existence of energy policies and other
5 countries around the world. You could argue
6 it's a chicken and egg problem. Do we know
7 enough to create an energy policy. And if we
8 do, do we have the stamina and the social
9 structure to enforce it. I would say
10 independent of that we, as a company are
11 pursuing every option and we're not doing it
12 because of various energy policies around the
13 world. We're doing it because the winner is
14 not yet clear. We know there won't be one. I
15 personally believe we are pursuing too many
16 options at this point, but we're not willing to
17 take any off the table. And the thing to
18 recognize is governments can do what they want,
19 and alternate energy sources can come online
20 and do anything they want, but in the end, in
21 most countries around the world, the consumer,
22 despite policies, despite incentives, is going
23 to be the decision-maker here. My personal
24 view is we're entering a decade of
25 experimentation where we are now putting these

1 alternate vehicles in the hands of customers,
2 and we probably have about a 10-year period of
3 seeing which other ones they play. So
4 unfortunately, I think the question's going to
5 be how are we going to collectively all the
6 options while we're figuring this out. The
7 bigger question of what's the role of the
8 Department of Energy, federal government, the
9 bXXXce of industry, and others in getting this
10 done. One thing which I think was not
11 particularly emphasized in the paper was it's
12 not just the R&D and technology game. There
13 was a little bit about the ability to offset
14 investment and I think a terrific example of
15 upkeep technology, which is not just designing,
16 but making batteries is now being done in this
17 country. And the only reason it's being done
18 is because the incentive program that was put
19 in place, a great example how fast we can act.
20 The question is are we doing enough to get the
21 marketplace in. So it goes beyond the Gen 1
22 initial play. It's a Gen 1 through Gen 3
23 valley of death and there is a collective role
24 on that. The last one I'm going to be a little
25 controversial on and it's about trying to

1 bXXXce your six strategies. And it's a little
2 bit about the assumption of differentiating
3 time constants in trying to sync this. The
4 fact is we can't play with it in bXXXce at a
5 time constant to the infrastructure solutions
6 and the transportation product solutions.
7 Accepting that one industry is sitting there in
8 an infrastruction takes 50 years to change.
9 And a vehicle, you know, can take four to ten
10 years. Why aren't we challenging the way to
11 get those time constants synced. And what I'd
12 put as a, you know, an example in our industry,
13 in the glory days of the '50s and '60s, we used
14 to have an 18 to 24 month product site. When
15 the oil crisis and the safety requirements hit,
16 we had migrated up to six years, and they
17 probably power train one larger than that.
18 We've used tools of simulation plant
19 flexibility to get that back down to about
20 three years. And now we're trying to figure
21 out how we can get that synced with the
22 electronics time constant (inaudible). Why are
23 -- and I started my career in GE. You know, my
24 first project was transformers and I think I
25 understand the dynamics of those investments.

1 But why are we accepting such a long-time
2 constant for the infrastructure to adapt when
3 in fact it paces it. And, you know, one of the
4 big examples, you know, which I'll point to is
5 electrification is not just a grid; it's
6 hydrogen. If we have the same vehicle
7 solution, which is running electrons to motors,
8 why can't we sync both the grid and the
9 hydrogen industry. So I thought I'd put some
10 stuff on the table.
11 XXX: XXX. I'm a
12 Senior Fellow at the International Council on
13 Clean Transportation which many of you probably
14 have never heard of. A new organization
15 directed towards, primarily actually towards
16 developing countries and helping them catch up
17 with standards. I am ICCT's technology expert
18 and I'm also the U.S. policy leader. The
19 reason I'm up here is probably because of my
20 previous careers, which were eight years at
21 Chrysler in Power Train Engineering, thirteen
22 years in ETA writing regulations in the vehicle
23 industry, and then eleven years at Honda, being
24 a liaison between R&D and Environment Energy
25 Affairs. Like XXX, I do have a few opening

1 remarks I'd like to make. Some of them are a
2 build on what he was saying about the customer,
3 you know, like General Motors, there's a lot of
4 companies out there whose very existence
5 depends upon properly assessing what's going to
6 work and when it can be implemented. And these
7 companies -- basically DOE, can't compete with
8 these companies, both in the assessment of what
9 might well work and in their ability to do
10 pilots and to test them out. But also in the
11 money that they can bring to the development
12 once they decide that is something they want to
13 work on. And so for the most part, if DOE
14 tries to work in these areas, they are going to
15 be simply wasting money. And there's also a
16 couple traps that are very easy to fall into.
17 One is timelines; trying to say, well, we need
18 something by 2025, therefore, we're going to
19 work on this now. Technology development -- is
20 the pacing development that is impossible to
21 predict. And as XXX also said, there are an
22 awful lot of different competing technologies
23 that are being worked on, and it's very unclear
24 which of them is going to succeed. The other
25 trap is paying attention to the fuel prices.

1 Fuels prices are going to go up and they're
2 going to go down and nobody knows how to
3 predict that. But even more important is that
4 if DOE does their job, then we're going to
5 reduce oil consumption, and that's going to
6 have a -- it's going to pressure oil prices to
7 come down. So anything the DOE does should be
8 with the eye towards they're going to have to
9 compete with actually fairly modest low prices.
10 And if the technology can't compete with that,
11 then there's not much point in working on it.
12 So the primary thing to do, what we can do is
13 work on pre-competitive R&D. Companies don't
14 do basic research, for the most part, simply
15 because it's almost impossible for them to
16 protect the results of those [sic] research.
17 So they put in the money and their competitors
18 can benefit as much as they can. So this is a
19 whole DOE, the (indiscernible) can be extremely
20 helpful. These are things such as hydrogen
21 creation and storage, next-generation
22 batteries, and that's not just high-energy;
23 it's also the ability to be recharged in three
24 to five minutes. Carbon-fiber manufacturing
25 techniques, so we don't have to handle the

1 earth and get the cross-down, and biofuels that
2 don't compete with food. Now these are the
3 areas that DOE can really make a difference on.
4 We also need DOE to provide infrastructure
5 support. The challenge there is to determine
6 when that support will be useful. You do it
7 too early and you don't use it; you waste
8 money. Do it too late and you stymie the
9 technology. So we shouldn't be looking at
10 timelines; we should be trying to figure out
11 milestones that you can set up that will guide
12 you as to when you bring the infrastructure on.
13 And the last one is to help capitalize domestic
14 manufacturing. And here, though, it should be
15 really looking at it more like the way venture
16 capital firms operate. So I'll leave it at
17 that for now.
18 XXX: Okay. Good. Lots of things
19 there from you, want to ask about. But let me
20 start by talking about, as you said, if DOE
21 does its job, we should see a drop in demand.
22 Separate question about what effect that will
23 have on oil prices. I'd like to come back to
24 that. But, you know, I think it probably
25 emphasizes the fact that there's indirection

1 among those three boxes on the bottom. It is a
2 system, as we keep hearing all the time, and
3 let me put to you the notion that if we can get
4 vehicle efficiency up significantly and, you
5 know, you read in the paper about ordinary ICE
6 cars that'll do 50 miles to the gallon. Now,
7 not very big ones, but still, and beginnings of
8 electrification that'll get you 50, 70 miles to
9 the gallon depending on your trip mix. If we
10 do well enough on all of that, do we need to be
11 working on the supply side at all. If we can
12 cut oil use by 50 percent in the LDV sector
13 doesn't that solve most of the problem?
14 XXX: Okay. I've already answered
15 this because I've actually talked with you.
16 The people out here who have seen my
17 presentations know that I'm actually fairly
18 strong about this. That there's a lot more
19 coming in conventional technology than most
20 people realize. By the time you add up the
21 benefits of lightweight materials, new-engine
22 designs, hybridization, and accessory
23 reductions, and some other things,
24 transmissions, the equal efficiencies from
25 about 2008 is the biggest line, will probably

1 triple by the 2030, 2035 time frame. So, yeah,
2 it's not just small cars getting 50 miles per
3 gallon; it's mid-size sport utilities that
4 might well be getting 50 miles per gallon. So
5 this is a two-edged sword. We're going to get
6 faster reductions in oil use and carbons than
7 most people realize, but it's also going to
8 make it more difficult to move to genuine
9 alternative technologies. In the long run, we
10 do need to move to these alternatives. Why?
11 Because the world is not going to stop growing
12 in population and growing in economic growth.
13 Both of them are strong drivers to use more
14 energies. So these near-term technologies will
15 help us stay ahead of the curve, hopefully, but
16 that curve is not going to stop in 2030 or 2035
17 and carbon, global warming is not going to
18 stop. So like I said, the good news is, we can
19 get faster carb reductions and energy then we
20 think, but we also need to be realistic about
21 what that means about moving to alternatives.
22 We can't stop work on the alternatives. We're
23 going to need them, at least in the post-2050
24 time frame. So the point is the curve is just
25 not going to stop; we're going to have to

1 continue.

2 XXX: Would anyone else want to

3 react to the efficacy of efficiency to solve

4 most of the problem?

5 XXX: Yeah, I think -- I don't

6 know that I call it an opposing view, but I can

7 put another factor on it. Look, our customers

8 around the world care about fuel economy.

9 Thirty years ago it was low on the agenda. Now

10 it is high on all their agendas. We're a

11 highly competitive industry and we react to

12 consumer demands. Yes, I can, well, I don't

13 know about the triple, but I produce a vehicle

14 in the lab with well above 50 percent proven

15 fuel. If I could do it at a cost that the

16 consumer would even close to rational at zero

17 cost of money justify making that purchase, we

18 would be doing it. Not just General Motors but

19 the rest of the industry. The problem is

20 hybridization has all the elements of battery,

21 electric, and fuel supplement which means I

22 need motors, I need power electronics, and I

23 need batteries to do it. Likely, there's a

24 very simple calculation you can do, which is

25 the top price of gasoline in dollars-per-gallon

1 you can recover at a value to consumers, just
2 interesting math that the units worked out this
3 way, one time English units went over SI, and
4 dollars per pound saved, meaning depending on
5 what the price of fuel is in dollars per
6 gallon, the consumer should be willing to spend
7 X dollars. If it's $2 a gallon, they should be
8 willing to spend $2 to take a pound off a
9 vehicle. And the fact as an industry, we do
10 all of those. The problem becomes, well, the
11 technology is available. It is not yet
12 affordable to value to consume. And so on the
13 other hand, at least our estimates, and I
14 always put the caveat that it's much easier,
15 you know, for a tank-to-wheels expertise
16 company to make value judgments on well-to-tank
17 and visa versa.
18 Many of the alternate fuels, whether
19 it's natural gas, whether it's cellulosic
20 ethanol, or maybe even coal-to-liquid appear to
21 be a better, lower-cost solution for the
22 weaning of petroleum and being with it. And
23 you don't let either off the hook, but I think
24 the idea that the vehicle efficiency is the
25 only route, look at what the cost to the

1 consumer is.

2 XXX: Well, in California we've

3 pretty much have seen efficiency as getting use

4 about half the way, I think, and so I agree

5 with -- that efficiency is going to get us half

6 of the way to our goals. But we're shooting

7 for 80 percent, so it's not going to get us

8 there and maybe California isn't going to grow

9 as fast as other parts of the world now, so

10 maybe we'll have that -- we'll have slower VMT

11 or maybe we'll have less VM. In the future.

12 We're also working on that, so that's also

13 coupled to this. And I think we have to not

14 just think of this problem in terms of vehicle

15 technologies, but also the land-use plan, and

16 we're trying to couple land-use planning and

17 fuels, and vehicle technologies all together.

18 They have to be fused in a single plan for the

19 State and organize it that way.

20 Also, but if you want to say -- agree

21 with XXX that we've served in this explosive

22 experimental stage where a lot of technologies

23 are coming out, from the work we do with

24 consumers, we do see consumer response to

25 details in pieces of sort of all the

1 technologies that are merged in PHEV's, PEVs,
2 battery, electrics and hybrids and there are
3 things they like about each of those. And so I
4 think we have a marketplace now with competing
5 drive fields and fueling systems that will
6 emerge and provide a broad sense set of -- but
7 there's -- we see research in each of those
8 areas in lightweight materials and improvements
9 that'll have to be made pretty far in the
10 future requiring some R&D in all of the whole
11 portfolio.
12 So I support the idea that we still
13 have to keep -- I see all the auto companies
14 having to do it all, and I think we have to
15 keep doing it all, with all different --
16 XXX: So I want to challenge this
17 having-to-do-it-all thing, but I'll give Wayne
18 an opportunity once to weigh in on the
19 efficiency question.
20 XXX: I'll weigh in coming
21 from a company that supplies engines for
22 commercial applications and of course
23 efficiency's been our concern for a long time,
24 so we're not going to quibble. I mean, it's
25 not going to happen because we've been at this

1 for a while. But certainly, you know, 20, 30
2 percent is possible. We're looking at
3 improving freight efficiency. You know, you
4 can pick the metric but it's all around doing
5 whatever our commercial products need to do and
6 some significant increases there, so those
7 things are possible. But the other point
8 always to remember in the commercial world, I
9 mean, people are real clear-headed why they do
10 things and that's because they have to make
11 money for their stakeholders. It is very
12 simple. They are not going to do anything
13 other than what's going to make their
14 stakeholders happy, and that's making a profit,
15 and so that's what it's all about. But the
16 other piece of this is the greenhouse gas
17 piece. You know, they go hand-in-hand and they
18 kind of don't. I mean, we can do things, you
19 know, from an oil security standpoint; we can
20 do things there that actually don't help us
21 much on the greenhouse gas initiative and it
22 actually distracts us from our greenhouse-gas
23 goals. So I think that's an important
24 dimension that we can't forget. And the third
25 piece, you can talk about a system is that, you

1 know, we can really worry about, hey, I'll
2 reduce my greenhouse-gas reduction out of my
3 engine a little bit and add a whole bunch on
4 how I manufacture my engine to get there. So
5 you know, at least at our place, we're trying
6 to be really thoughtful about how we design our
7 engines, looking at the whole system, not only
8 from a wells to a wheel of the engine and
9 vehicle but also the amount it takes to
10 actually manufacture, deliver, and the whole --
11 that aspect of it as well.
12 So it is a very complicated picture
13 and, you know, my boss says, will you please
14 design an engine that does all that. And so,
15 you know, I'm trying to figure out how to do
16 that; it is complicated. But it all has to go
17 together or we won't be successful and that's
18 where I think why we can't take our eyes off
19 alternative fuels.
20 XXX: So let me ask about the
21 thousand flowers, or at least the bouquet
22 blooming, rather than having to down-select.
23 So, you know, I appreciate that we have as yet
24 incomplete information in order to decide on
25 one pathway versus another, and that's great.

1 Can you, any of you, paint me a scenario?
2 Eventually we're going to have to down-select.
3 I think you can't support four or five
4 distribution infrastructures for fuel, whether
5 it's CNG or hydrogen or electric. How does the
6 down-select happen? Is it just consumer
7 preference? I don't think so. The government
8 plays a role here.
9 Obviously, the corporations play a
10 role. VHS versus beta is an example where a
11 down-select happened. Some would say not
12 technically optimal, but it happened, and I
13 frankly don't know the details how, but it did.
14 Blu-ray formats, et cetera, at least these are
15 of course not energy but nevertheless are
16 illustrative of how technologies get
17 down-selected. So somebody paint me a scenario
18 if we go out 10 or 15 years after some of these
19 flowers have sprouted or whatever, how does the
20 down-select happen?
21 XXX: Well, I think one would
22 happen, the price of batteries in the area of
23 electrification. I mean, we don't get
24 reductions in price of battery that we are
25 hoping for right now the people are projecting.

1 That would be a set-back in electrification.

2 XXX: So for our

3 electrification, I can believe plug-in hybrids,

4 maybe not. Depends how far you go, right?

5 XXX: Right, yeah. I mean, to go

6 back to your beta max analogy, I mean, that was

7 different manufacturers competing in a

8 marketplace and this goes back to my opening

9 comments about DOE can't play in this game.

10 They're not going to have any influence on it.

11 And so from that competing point of view, from

12 a technology point of view, when it gets to

13 that stage, and DOE role is over. However,

14 when it comes to electric vehicles and fuel

15 cell vehicles, there's an additional element

16 that was not present in the beta max wars, and

17 that is infrastructure.

18 And the manufacturers don't have

19 control over infrastructure. This is a role

20 that DOE needs to play. But I do believe very

21 strongly that the initial deployments need to

22 happen on a targeted small-scale basis. And

23 only if those deployments are successful should

24 a large-scale role-on of infrastructure happen.

25 So they need to be coordinated. I'm not sure

1 how to properly set up the milestones, in other
2 words, what are the trigger points for taking
3 each step on infrastructure --
4 XXX: Do we have clear metrics
5 for success?
6 XXX: Yes.
7 XXX: Usually not.
8 XXX: Right, and -- but my primary
9 point on these metrics for success or in
10 milestones, whatever we call them, is don't
11 make them time-based. You know, you have to
12 have something that they are actually based
13 upon and then you can apply that to hydrogen,
14 and electricity, and natural gas, and whatever
15 else.
16 XXX: I think there's also going
17 to be the impact of the laws of physics. The
18 fact is, there's still a variety of recording
19 medium, depending on the quality in, you know,
20 the beta max one, and the length, and whether
21 you're making 3D movies. The same thing
22 applies in automotive. It's because of the
23 nature of how people use their vehicles, the
24 interurban versus the cross-country hauling,
25 and the size of vehicles. From what we know

1 today as all these alternatives play out, there
2 are likely to be more than one solution
3 required, and what we see them grouping into,
4 and I think pretty much consents roadmaps, is
5 large long-haul is likely to be a diesel fuel
6 done in a very efficient way as much as
7 possible, because that's the best way we know
8 to do energy. Smaller vehicles, interurban,
9 likely to go electric and then the fuel cell
10 and the map there. And so the way we've looked
11 at the world is how do you rationalize it, so
12 between the energy companies and the vehicle
13 companies, we all don't go bankrupt and take
14 away mobility from the marketplace. It's the
15 rationalization of the energy carriers. So the
16 world going forward, you know, while it's more
17 complex than today, will probably rationalize
18 to a liquid fuel or a number of compatible
19 limit liquid fuels, electric and hydrogen. We
20 then have to -- and that balance will depend on
21 region, even maybe within the U.S. and, of
22 course, regions around the world. How that
23 will occur will be which of those plays walks
24 down the cost-and-value curve highest. But the
25 idea that there's one infrastructure and that

1 the liquid fuels will always be from petroleum
2 is sort of ludicrous. I mean, it's amazing to
3 me that an industry has matured over one
4 hundred years, and developed a monogamous
5 relationship with one source of energy and
6 despite that, has been so successful, and only
7 now a victim of its own success, to many, the
8 problems are emerging. But we know we need --
9 the issue is the idea that we'll go monogamous
10 on any energy supply for mobility. I think
11 we've learned that after a hundred years we
12 made a mistake, so you've got to play on all
13 ends of the spectrum.
14 XXX: So let me come back to a
15 point you raised earlier and then I think we'll
16 throw it open for general discussion. Oil
17 prices of US&N drops because of improvements in
18 efficiency, penetration in biofuels or other
19 alternative fuels to run transportation. It's
20 not obvious to me that oil prices will go down
21 in that eventuality. We've got growing demand
22 from other countries. We've got a cartel
23 running oil markets that have a growing
24 interest in the income that it derives from
25 them. So you know, I wouldn't be so certain

1 that the prices will stay -- will go down.

2 XXX: I completely agree with you,

3 but there are two aspects here. One is, if you

4 reduce demand, you're at least going to reduce

5 the prices from what they would have been if

6 you had done nothing.

7 XXX: Assuming the cartel doesn't

8 act.

9 XXX: Yeah, and the other thing

10 that happens is that very high oil prices give

11 rise to development of all kinds of

12 alternatives. I mean, coal-to-liquids becomes

13 profitable. All kinds of things become

14 profitable. And that's why it's very difficult

15 to maintain a high oil price over a long period

16 of time. But the other factor here is, assume

17 success. Assume a next-generation battery or

18 some breaking in hydrogen storage creation and

19 all of a sudden this becomes very competitive,

20 very cheap and half the vehicles in the world

21 convert to them. What happens to the demand

22 for oil at that stage? So this is another case

23 in which you can become a victim of your own

24 success. And in the long run, I just think DOE

25 is the safest to assume that, you know, you

1 need to develop policies that are going to be
2 effective, even at relatively modest oil
3 prices. And if they're not affective at
4 relatively modest oil prices, you're just
5 playing roulette.
6 XXX: Now, in a free market,
7 economy like the U.S. if our objective, whether
8 you're driven by CO2 or by energy independence,
9 is to wean a country off oil allowing the price
10 to fluctuate in a time-constant that neither
11 our consumer and definitely the infrastructure
12 and definitely the vehicle manufacturer cannot
13 keep up with. And it is a national and social
14 agenda to wean off petroleum. We all know its
15 cost to pull out of the ground and process has
16 very little to do with what we're paying.
17 There is a role for governments, and in
18 particular this one, that other governments
19 around the world seem to do, which is provide,
20 whether it's through some policy, whether it's
21 through a tariff, whether it is through
22 taxation, a floor price. So if your goal is to
23 reduce the use of a commodity, increase its
24 price.
25 And if the right way to do that for

1 the social agenda is through a taxation of
2 government policy, why is that off the agenda.
3 And then let the marketplace drive in all the
4 alternatives so you don't have stranded
5 capital. You know, the real debate seems to be
6 around regulated rather than price it to where
7 it needs to be.
8 XXX: So I have mentally
9 written that down very carefully and will
10 convey it to the political folks in the White
11 House.
12 All right. Why don't we just open it
13 up for more general discussion and comments.
14 And I've put the six seeding questions up, but
15 I think we can take the discussion anywhere
16 people feel it would be useful. So the floor
17 is open.
18 XXX: I'm XXX with
19 Daimler and I'd first like to state I come from
20 the regulatory point of government in
21 alternative energy for 30 years, over 30 years.
22 But I'm now regulation. I think that's a part
23 that is not taken into consideration enough at
24 the Department of Energy. There is a floor.
25 We're in historic negotiations right now on

1 Cap A, the greenhouse gas reductions. The auto
2 industry is the only industry that are in these
3 discussions for greenhouse gas reductions and
4 by September it will be announced what the
5 goals for 2025 will be and it'll be a challenge
6 and it doesn't matter what the price of oil is.
7 I say, take that -- I agree with the panel.
8 The price of oil has nothing to do with the
9 future vision of what DOE should be working on.
10 It should use regulation as a reference point
11 the greenhouse gas targets, because it's going
12 to be tough for our industry to meet. Also,
13 criteria pollutants. We have, we're finalizing
14 level 3 on California and that'll be a national
15 standard. We're historically going with
16 California to EPA and saying, let's take
17 criteria pollutants out of the equation by
18 2022. But that's going to be tough because
19 it's counter-balanced. As you take criteria
20 pollutants out, it usually affects fuel
21 economy. So we need to keep an eye on what I
22 want to say is the bouquet approach. We need
23 clean diesel. We need the work that you are
24 doing on right now on light-duty and heavy-duty
25 diesel to make them both more efficient as well

1 as keeping the criteria pollutants down. But
2 also the future vision is to be the Holy Grail.
3 It's the electrification of the vehicle which
4 is both the battery and hydrogen. That is our
5 company's belief. It's many of the other oil
6 companies' beliefs. That's the path we're
7 working down if you really want to get off oil
8 and reduce greenhouse gases and, by the way,
9 it's another regulation California is
10 requiring. So keep regulation in mind while
11 you go down the path.
12 My final statement is, I believe I
13 heard work on everything right now. Don't make
14 a down-selection. We are in the testing period
15 but we will be forced to move down, probably I
16 would say, through regulation more than oil
17 prices.
18 XXX: So it is the government
19 in the end that will --
20 XXX: Energy prices, energy
21 policy is in place. It really is. It isn't as
22 though --
23 XXX: We have an energy policy.
24 XXX: Yes, it's through the
25 back door; through the back door.

1 XXX: Yeah, it's what the
2 people had voted for. Let me just make one
3 comment on the Department's role in this
4 regulatory story. We don't hold a regulatory
5 pen for vehicle standards, but we have a lot of
6 input. Some of the people in this room, in
7 fact, are heavily involved in discussions with
8 EPA and DOT on the technical aspects.
9 XXX: I am heartened to hear
10 that, because DOE I was hoping would be in the
11 room where we're negotiating the 2025
12 regulations, and they're not. And we keep on
13 saying, we need the infrastructure, we need
14 DOE's support. But we don't see that, and it
15 heartens me to know that you are following.
16 XXX: So as I said, we're one
17 voice in the discussion.
18 XXX: Yeah, so are we.
19 XXX: So regulation, and how that
20 plays a role in going forward.
21 XXX: I just wanted to make a
22 quick comment. It may not make you feel any
23 better, but EPA admits they are in the process
24 of finalizing standards for heavy-duty
25 vehicles, so you'll no longer be alone.

1 XXX: Oh, no, no. Daimler is
2 heavy as well as light-duty. I was talking
3 from both perspectives, heavy-duty. It is.
4 It's the only industry, transportation, that's
5 regulated.
6 XXX: So I'm hearing a
7 different message from you than I heard from
8 some of the folks before and that is, in the
9 end, the government will play a significant
10 role in --
11 XXX: Absolutely.
12 XXX: -- pruning the bouquet.
13 XXX: I mean, I think the
14 regulations in this country and that indirect
15 energy policy is just a function of you
16 operating the country and the light surtax is
17 hidden.
18 XXX: XXX, can I ask you to put
19 your six strategies up? I think it was a slide
20 or two ago. I come from a background; I spent
21 a lot of time and a lot of years at General
22 Motors in advanced engineering and fired up our
23 team, fired up the fuel-cell project and then
24 the EB1, of course. That led to the USABC and
25 US (indiscernible) and did the

1 hundred-mile-per-gallon ultra-light car, all
2 carbon fiber, what, 1990 or something like
3 that. So getting high fuel economy is not the
4 problem. I think it goes back to, I think XXX
5 was commenting about the cost, and my personal
6 concern, now I'm working in an engine company
7 now, but I've been a big fan of
8 electrification, and batteries, and so forth,
9 and still advise two battery companies, is
10 basically one of national competitiveness. And
11 my own belief is it is proven that the cost of
12 moving people and goods is a big deal in the
13 competitiveness of a country. And so in your
14 slides here, I believe in the term I point a
15 thousand years ago, an economic gravity, and
16 that is, that it will prevail, and that is,
17 that people and business people, people in
18 their own self-interest, looking to move
19 themselves around, business people, but they're
20 companies and moving goods, primarily, will
21 seek out and buy the low-cost solution at the
22 end of the day. And it has proven that way for
23 at least a hundred and fifty years, that I know
24 of. They will seek it out, contrary to the
25 document that says they don't have enough

1 information. I'll tell you, when 70 million
2 people show up with their own money around the
3 world, they find the low-cost solution. The
4 market is efficient. And so I think it's
5 important that in this chart that cost
6 effectiveness of each one of the six boxes
7 becomes a headline. Until it does, nothing's
8 going to happen. You can deploy clean
9 electricity only if it costs less than dirty
10 electricity.
11 XXX: You ignore portfolio
12 standards if you say that.
13 XXX: No. I'm just saying you
14 can get it out there when it becomes
15 economically viable to do that.
16 XXX: No. You can mandate as
17 California does and say 30 percent of your
18 electricity's got to be cleaner.
19 XXX: Having been a supplier
20 for 15 years --
21 XXX: I'm not going to say that.
22 XXX: -- a lot of our
23 profitability had to do with the law, so.
24 XXX: So it is this interaction of
25 the law and economics to get those.

1 XXX: I don't know if there's
2 anybody from Bosch, but Bosch always says, you
3 know, most of our profitability came from the
4 government test flaws and emissions and all
5 kinds of stuff. And frankly, on electrifying
6 the fleet, it's a good idea if it costs less
7 than the fleet you are currently replacing.
8 One of our main investors has been up coast and
9 he calls it the Chindia price, that's a good
10 thing. I call it economic gravity. Increasing
11 vehicle efficiency I think accurately and some
12 of the other ones say it, it works when you
13 can -- when it pays for itself, unsubsidized.
14 You can subsidize anything into existence but
15 it's not a long-term thing; it's just a
16 walk-around. So I would ask that that topic of
17 economic gravity, or cost, or what have you, be
18 a bigger part of your thinking and so forth.
19 The goal of electrifying a fleet, I don't care
20 whether it's electric, or diesel, or gas, or
21 what have you. I do care if it costs less
22 because that cost of transportation ends up
23 getting into all kinds of things, like personal
24 ability, the cost of goods and food, and all
25 that other stuff.

1 XXX: But then you have the
2 externality cost that people talk about, right?
3 CO2 cost, impact, the cost of deploying troops
4 around the world --
5 XXX: Yeah.
6 XXX: -- in order to make sure
7 the oil keeps flowing, et cetera, et cetera.
8 XXX: Yeah, but you know --
9 XXX: So what costs are we
10 talking about?
11 XXX: I'm just, you know, I'm
12 talking about all those things that are out
13 there right now. We have a defense budget and
14 whether it should be half that and go to
15 something else. It gets too complex for me to
16 get into that, I think.
17 XXX: So you're right, though,
18 immediate consumer cost is in the air, quite
19 possibly.
20 XXX: Yeah, I think it's a big
21 one. Then the consumers will step up, use
22 their own money, you don't have to muck around
23 in that thing. And so work on jointly with the
24 companies that have interest. I think USABC
25 was a bad model in terms of getting --

1 XXX: Okay. Anybody got a
2 reaction to any of that?
3 XXX: Money rules in the end.
4 XXX: Money does rule in the end;
5 I completely agree with that. However, I do
6 have to disagree with the statement that the
7 market is efficient. It is efficient, but we
8 need to recognize that most consumers severely
9 discount the future fuel savings, and this is
10 because of risk-and-loss aversion. A couple of
11 economists won the Nobel Prize for this theory
12 in 2002. And basically, it says that the cost
13 of the technology you pay now is very known and
14 certain. The fuel savings happen in the future
15 over a long period of time and they're highly
16 uncertain as to what those benefits are going
17 to be. And therefore, more consumers severely
18 discount those fuel savings. So as long as you
19 recognize this and take that into account, then
20 what's left, you have a market that's
21 efficient. But that's actually the case for
22 things like Café standards or my favorite
23 program, EBASE.
24 XXX: And then I'll add to that, a
25 lot of our commercial customers look at a

1 two-year payback. I mean, that's how they make
2 their decisions. And then that vehicle gets
3 sold and their decision on purchasing that is
4 totally different, right? And so a lot of this
5 gets lost in all those commercial transactions.
6 So I think it's very important the DOE keep a
7 long-term view around efficiency because I
8 think the market will make mistakes.
9 XXX: That was actually a perfect
10 segue because the way I put it, nobody ever
11 bought a hybrid car by accident. I don't know
12 if you ever noticed but nobody ever say, you'll
13 like the style and hear the radio on that car;
14 I didn't realize it was a hybrid. That never
15 happens because everyone who bought a hybrid
16 today is pretty much an ideological purchaser.
17 And the only way you actually move the needle
18 on the macro issues is to get beyond the
19 ideological purchaser to the general purchaser
20 which I think is only going to be when the cost
21 is lower than the existing product. Which
22 leads me into something I think XXX said
23 about -- that they -- then you have to -- the
24 government has a role to play in infrastructure
25 of deployment but that it should only be done

1 to a certain level to see if the consumers
2 actually show up. And in fact, I think there's
3 a conundrum in that and there's not enough
4 infrastructure that will deter the consumers
5 from showing up. A better place is actually
6 going ahead and doing full-country deployments
7 across Denmark, across Israel, and most of
8 Australia beginning next year, precisely to
9 offer the same freedom of mobility that people
10 are accustomed to today to be able to go
11 anywhere, anytime. And as a part of that, also
12 viewing the battery as not part of the car,
13 actually, but part of the infrastructure, a
14 cost that we pay, which is how we actually get
15 the car to be competitive with existing gas
16 cars, in fact, cheaper than the existing gas
17 cars. So it all kind of comes together but,
18 you know, the two important points that I would
19 emphasize and agree with are that the actual
20 cost, as you were saying with regard to this
21 Nobel Prize theory, absolutely correct in our
22 experience. Cost of the car is much more
23 important than total cost of ownership for a
24 consumer and the infrastructure which we
25 consider to be the battery, the ability to

1 switch it, and to charge it, needs to be robust
2 enough that consumers have the same feeling of
3 freedom that they have today or you won't be
4 able to get started.
5 XXX: Anybody? Reactions?
6 XXX: I'll just make a comment on
7 infrastructure because that keeps coming back
8 to building an infrastructure. And I think in
9 the area of electrification there's a lot of
10 demonstrations going out there, putting
11 infrastructure. We still don't know exactly
12 where to put that, and how much of it, which
13 type, and so I think I want to go back when we
14 were in a period of experimentation. So
15 certainly to have that in place, it's too soon.
16 There's just a few vehicles out there. We've
17 really got to move in a very measured, sober,
18 data-driven way to develop that because we
19 really don't know exactly what that looks like.
20 There's no examples out there.
21 XXX: So I just want to comment a
22 little bit on the market as God strain that
23 emerged and just to go up a few levels, to
24 paraphrase Thomas Friedman, borrowing money
25 from the Chinese to buy oil from the Arabs to

1 burn and to ruin our environment, is clearly
2 not a sustainable transportation energy policy
3 for our country. So we need to retain that
4 perspective in what we're doing here. That is
5 not going to work for this country going
6 forward; it's not sustainable. If you apply
7 that to the market picture, it's important to
8 see that the incumbent technologies are all the
9 way down the cost curve. There's a hundred
10 years of de-risking and cost-down in these
11 technologies. Whereas, the new technologies
12 we're bringing in have got 10, 20, 30 years of
13 de-risking and cost-down. If we as a society
14 want to achieve a sustainable energy,
15 transportation energy infrastructure, we need
16 to make a consensus decision to deploy our
17 resources to de-risk and cost-down those
18 sustainable technologies. We don't need to
19 choose which ones right now. We can pursue
20 multiple ones. But we need to keep in mind
21 that what we're doing isn't sustainable. And
22 in pursuing something that is sustainable, it
23 may not be economically competitive today, but
24 we're a rich enough society that we can use our
25 resources to drive it down the cost curve and

1 make it sustainable and bring it to the Chindia
2 price. So five years ago I would've said
3 America's going to do that across the energy
4 landscape. We're going to deploy innovation
5 and drive it down the cost curve and sell it to
6 China and India as an economically compelling
7 choice. But what's happening is, we're
8 inventing it here and they're driving it down
9 the cost curve, and selling it back to us.
10 That's a different subject.
11 XXX: Okay. I want to segue
12 off of your reminding us about the bigger
13 problem. Don't leave the microphone because I
14 want to give you a chance to respond and then
15 we'll turn to the panel. The goal of this
16 workshop and the QT of our exercise is what
17 should the DOE do. Or perhaps more broadly,
18 the government. And for the last half hour
19 we've been, you know, the use of appropriate
20 phrase, we've been admiring the problems. At
21 some point, you've got to actually say what are
22 you going to do. So I'll put you in charge of
23 DOE vehicles, or fuels, or all of the bottom
24 line. What do you think you should do?
25 XXX: It's good to be king. My

1 ideal role for public sector support in
2 innovation is a barbell approach. It should be
3 relatively easy to get funding for fundamental
4 R&D, providing that it clears the bar of
5 originality, novelty and a big swing rather
6 than incrementalism. In the middle, it should
7 be fought over by the VCs and the angels and
8 the incumbents. And then at the end, the DOE
9 should help provide pull to demonstrate first
10 commercial instances so that the market can
11 then look at those commercial instances and
12 move them forward into mass deployment.
13 XXX: That's the right kind of
14 discussion I'd like to have for the next five
15 or ten minutes and then in the break-out side.
16 So that the panel, you know, you're in charge
17 of the government. You also have your private
18 sector academic NGO experience. What should we
19 in the DOE be doing, not so much specific
20 programs, but those kind of principles that
21 have just been discussed?
22 XXX: Well, I totally endorse the
23 three categories that were just put up. So
24 let's start with the pre-competitive research
25 agenda. I think there's a very good process to

1 create our technology roadmaps, which by the
2 way, tend to be costing volume-capable driven,
3 through the USR, DOE, and other -- our tech
4 team approach. So it's a question of getting
5 the Hill to fund the priorities so that the
6 research can be done to achieve the goals
7 because that has to be a public-private
8 partnership. On the commercialization side,
9 there are, you know, beginnings of
10 incentivising the Gen 1, Gen 2 technology place
11 through tax incentives. I think one of the
12 underexploited areas is the federal fleet,
13 whether it's the military fleet, and we're
14 starting to do some of that now, but just the
15 federal fleet, why isn't that the market volume
16 play where that first and second generation
17 technology cost gets born as part of the thing.
18 XXX: Does the size of the
19 federal market, is it big enough to get your
20 attention?
21 XXX: Absolutely.
22 XXX: It is.
23 XXX: And particularly for some of
24 the Gen 1 plays. What has to happen is the
25 procurement on that side has to recognize that

1 they are playing a national agenda and look at
2 not just the cost of what it costs to move the
3 federal goods and people per mile, but the
4 secondary, and maybe you look at its primary
5 role is to get the technology out. So I agree
6 it's there. And then, again, some of the VC
7 play is beginning to make its way in.
8 XXX: Yeah, XXX and the XXX,
9 I'm not disagreeing with anything in them, but
10 there's an additional consideration here that
11 you have to be very careful about. And that is
12 really deployment is often not the issue.
13 There's a small segment of the market that
14 loves innovation and new technology. They're
15 not risk-adverse; they will pay money for these
16 things. And I think we often fall into the
17 trap of somehow thinking that that's a sign of
18 a mass market. Mass market customers are
19 completely different what they're looking for
20 in vehicles, what they're willing to pay.
21 Their level of risk-aversion is completely
22 different than these early adopters. And so,
23 in fact, it's even quite possible for
24 manufacturers to make money on leash markets
25 that will never move to a mass market. I mean,

1 fleet, it's a way to help build some volumes to
2 get some cost down but to the best of my
3 recollection, and I've been in this business
4 since '76, I don't know of a single successful
5 technology that's ever moved from fleets to the
6 mass market. It's a different customer. And
7 what you need to do to bring it to a mass
8 market is very different from what you need to
9 do to bring it to fleet. So as long as you
10 keep those considerations firmly in mind, then
11 the models that we've been talking about is
12 fine.
13 XXX: On the fleet question, a
14 similar experience, we haven't seen fleets lead
15 to a new technology or to a different market
16 because I think that sometimes the fleets are
17 not well understood so in California, when we
18 looked at fleets in the '90s, we discovered the
19 maximus of vehicles were in small fleets, not
20 in big fleets, fleets of five to ten vehicles.
21 The decision making there was a lot simpler,
22 the applications broader, and that's much an
23 area of interest that needs to be studied more
24 as an early market. In terms of the innovators
25 versus rest of market, I think we just, we are

1 obviously dealing with first buyers. Although
2 having worked in this, there are a lot more
3 diverse group of people than you might expect.
4 They're not necessarily crazy people. They're
5 people to do -- are interested in technology,
6 they're interested in environment, they're
7 interested in saving money, they're looking at
8 a lot of things. So it's a more diverse and
9 probably bigger than some estimations are of
10 that early market.
11 XXX: So XXX, I'm not going to
12 let you off the hook. You still haven't
13 answered my question.
14 XXX: Okay. What would we do?
15 XXX: Yeah, you're in charge.
16 XXX: Okay. Well, my experience
17 is not at the level of the technology decision
18 so much that I'm involved a lot in
19 demonstration projects and I'm very encouraged
20 in this demonstration phase. Some of the
21 demonstrations are coming out now, the
22 electrification projects, and would like to see
23 more of that, sort of living lab
24 experimentation for us for the next ten years.
25 Now that we've had some of these technologies

1 out, I'd like to see more development in an
2 area as university. That's where our students
3 could get a lot of benefit. I'd like to see
4 universities more involved in those areas in
5 innovation and more sectors pulled together for
6 that. We, in California, we're trying to
7 understand how to bring the electric sector
8 together with vehicles, also together with
9 multi-mobile solutions with a lot of other
10 applications of -- you know, young people are
11 interested in changing some of their ownership
12 patterns in vehicles. So I'd like to see a
13 rich experimental environment developed and DOE
14 involved in that.
15 XXX: Before I turn away, I
16 want to ask you, one of the recurring themes
17 that has come up in these discussions. and
18 we've now had probably about 14 and 15 of them
19 in groups of about a dozen or so, is that the
20 DOE does not pay sufficient attention to the
21 social aspects of the technologies it's
22 developing. And that we've not been very
23 successful integrating the social sciences with
24 the technology. Sound right?
25 XXX: That sounds right.

1 XXX: Okay.

2 XXX: Just a quick on that. I

3 think that there are -- we often focus on the

4 economic feedbacks, sort of the one we know

5 best, and we understand, and certainly it's

6 probably the biggest driver. But there are a

7 lot of social feedback routes besides just the

8 marketplace in the area of information alone.

9 You know, people don't have the information.

10 I'm surprised now, even in California, you

11 would think everybody knows exactly what a

12 Prius is. And you go out there, you do

13 interviews, you do work, and of people buying

14 cars that we give them a chance to drive a

15 different type of vehicle and they've never

16 driven a small car before, let alone a Prius.

17 And they didn't actually think that fuel

18 economy above 40 miles per gallon was even

19 possible. They really didn't believe it. They

20 didn't have friends, they didn't have family.

21 So there's social -- there's distribution of

22 information. There's a lot of things out there

23 that we're --

24 XXX: We'll have an off-line

25 discussion about this topic more. XXX, I'll

1 put you in charge.

2 XXX: Okay. So I'm going to

3 take a step up a little bit. Since that, you

4 know, I think near-term, mid-term, long-term,

5 and I think near-term the DOE needs to focus

6 very simply on energy conversion efficiency. I

7 would even discuss my job is to reduce oil

8 consumption or any of those kinds of things. I

9 think to be real clearheaded, that's the

10 objective. You know, try to stay away from

11 some of the policy things, because there's a

12 lot of other ways that you can deal with those

13 kinds of questions. But just focus on that

14 because I think it does three things. One, it

15 will get at oil consumption. Two, it will get

16 at greenhouse gas. And three, it will make the

17 U.S. more competitive. I think it does all

18 those three things in one fell swoop, right,

19 and it is competitive. So it's not something

20 that we want to share internationally. But

21 then when you start looking mid-term and

22 long-term, we do have to look at other sources

23 for energy, other than what we have today. And

24 I think there's a fantastic opportunity to do

25 international cooperation there. And we have

1 the CERC with China that we have going, as one
2 example of that, and there are others. And I
3 think there's a great opportunity for the U.S.
4 to be working globally in those kinds of areas
5 as you go mid long-term. Because we do, I
6 think if we -- my fear is that if we let the
7 market drive the development of alternative
8 sources of energy, it will be too late. And I
9 think the DOE has to pay a very key role in
10 there or it will not happen.
11 XXX: When you say new source,
12 I'm going to put back up the Sankey diagram,
13 you know, there's a finite number of boxes on
14 the left. You're not suggesting that there are
15 new boxes --
16 XXX: No.
17 XXX: -- that we haven't found
18 yet. Okay. It's about the cost and scale --
19 XXX: Yes.
20 XXX: -- of the boxes we have.
21 XXX: Yes, yes, yeah. I mean,
22 for, you know, I'll just throw one out there.
23 I mean, the whole thing around ethanol from
24 corn, right. I mean, it just, you know,
25 nonsensical, right, you know, from the

1 standpoint of the goals that I just described,
2 right? You wouldn't do that and it becomes a
3 distraction from where we're trying to get to.
4 And I think the DOE has to take ownership of
5 that and stop those things from happening. I
6 mean, they can still happen. Please don't, you
7 know, don't --
8 XXX: Look, the DOE, I think
9 our role is to bring a sound technical economic
10 perspective to this discussion. There are
11 other voices, as you just indicated.
12 XXX: Yes, obviously, and
13 those kind of things can happen. But, you
14 know, you can only manage what you can manage.
15 XXX: If we don't bring the
16 technical facts to the table, nobody else is
17 going to.
18 XXX: Right.
19 XXX: So one, as long as you
20 mentioned corn ethanol, it's worth putting up,
21 and it's got to do with the balance of supply
22 and demand in the transportation sector. The
23 U.S. government this year is subsidizing oil
24 and gas production through taxes at the level
25 of 4 billion per year, and you have heard the

1 administration talking about wanting to get rid
2 of that, basically. And one thing we don't
3 talk about so much is 8 billion a year going to
4 corn ethanol subsidies. So all together, 12
5 billion a year in tax spending is set in the
6 political arena for liquid fuels. And
7 coincidentally, it's about 8 million
8 vehicles -- I'm sorry -- 12 million vehicles a
9 year, so $12 billion, 12 million vehicles,
10 we're spending the equivalent of a thousand
11 dollars a new vehicle in liquid fuel subsidies.
12 If you took that same thousand dollars and
13 applied it instead to vehicle efficiency in the
14 new fleet, I don't know how much a thousand
15 dollars buys in terms of vehicle efficiency, 10
16 percent, 15 percent maybe, let the consumer
17 match it so maybe we can get 20 percent in the
18 new vehicles, which has been probably, I don't
19 know, 40, 50 percent more efficient than the
20 old vehicles they're replacing. So suddenly,
21 you've got a cumulative effect on demand by
22 spending the same amount of money and will
23 reduce demand proportionately. You know,
24 that's the kind of tradeoff, you know, where
25 that's one with it or not, we can go through

1 the numbers in more detail, but that's the kind
2 of tradeoff that I don't see happening at all
3 in the political discussions and speak of them.
4 Yeah.
5 XXX: I'll just remind you,
6 implicit in your -- the analysis you just did
7 is that, and let's turn it into cents per mile
8 driven, that the vehicle efficiency cost
9 amortization is the better solution than a
10 biofuel.
11 XXX: Well, that's what we're
12 talking about. If my goal is to reduce demand
13 of oil, I can either put it into biofuels or I
14 can put it into buying down vehicle efficiency.
15 XXX: What you did was compare use
16 of -- you know, rather than having the corn
17 ethanol to date, what happens if you do the
18 analysis for what cellulosic ethanol might get
19 you.
20 XXX: Well, you can do that
21 too.
22 XXX: And it's a question of where
23 do you make that investment, and our analysis,
24 you know, we've shared with them, says there's
25 a balance of the two with a cost per radal

1 (phonetic) puts it in. I mean, what you don't
2 want to do is just look at, you know, in your
3 strategies, the bottom line exclusively or the
4 top line exclusively, right? It's to deliver
5 the best value to society. Pretty much the
6 alternative, you do some from column -- box A
7 and some from box B, and cumulatively, you get
8 to the right place.
9 XXX: Right now we seem to do
10 all A or all B but don't -- okay. What is
11 going to happen now, XXX going to tell us, I
12 guess.
13 XXX: So one way of creating
14 cross-cutting groups is by alphabetically by
15 first name. I just did this and it worked out
16 pretty well into getting diverse sets of people
17 into these groups. XXX or XXX, I think,
18 because we have you by the name, your more
19 formal name seen in the last group, I
20 double-checked that one. But so we're going to
21 go to break, 15 minutes, and reconvene in Room
22 Summit 1 and with table divided out like this
23 so make a note of --
24 XXX: These are first names.
25 XXX: First names.

1 XXX: All right.

2 XXX: XXX, XXX, XXX,

3 XXX, et cetera. So I, XXX, will be at table

4 1 and, you know, have at it, and go to break

5 and see you in 15 minutes.

6 (Fifteen-minute break taken.)

7 XXX: We're going to begin the

8 afternoon session with a set of presentations

9 by the folks from DOE who are coordinating

10 technology assessment teams across the

11 technology areas represented here. So we'll

12 spend about the next hour concluding with some

13 time for questions for those folks.

14 Immediately following that set of presentations

15 we will break back over to the breakout room

16 and divide out by technology areas where we

17 explicitly tried to make cross-cutting groups.

18 But for the afternoon we really want to draw on

19 the technology expertise in the room so the

20 breakouts will be based on these criteria,

21 these areas, and I will put this back up at the

22 end so you can refer to it. But we'll -- the

23 point of this afternoon is really to dive into

24 these technology roadmaps and make sure that as

25 we try to understand what the, you know, colors

1 or the basis factors, or ingredients, or
2 whatever you want to refer to them as, these
3 technologies that we really understand them
4 well have them well-characterized so you can
5 understand, you know, how we might play in the
6 space. So hopefully we'll get a bunch of good
7 feedback from the rest of you over the course
8 of this afternoon. I'm going to pass it to Pat
9 Davis who will start off with technology
10 efficiency.
11 XXX: Okay. Let me know if you
12 can't hear me. It sounds pretty loud. So just
13 a couple opening remarks. I know this morning
14 there was a lot of talk about how DOE does its
15 work through labs or the industry or different
16 models. This afternoon, really we're starting
17 out about technology. So my presentation and
18 two others to follow are really more about the
19 technology; not really at all about how you do
20 your work. Another thing, you're going to hear
21 a lot about the kind of work that we do in the
22 vehicle technology's office, as well as some of
23 the cross-cutting activities outside of the
24 office. I just want to point out that I'm
25 talking about vehicle electrification. Other

1 technologies are very important to our office
2 including combustion and lightweighting.
3 You're going to hear about those subsequently.
4 And then lastly, I'm just going to open up with
5 a couple of slides about energy just to set the
6 stage and we won't do that for each
7 presentation. So if you're familiar with our
8 dependency on petroleum, over two-thirds of the
9 petroleum we use in the U.S. is in the
10 transportation sector and 80 percent of that is
11 on-road vehicles. So you really can't address
12 petroleum dependency without looking at on-road
13 vehicles. And when you look just at on-road
14 vehicles, that's the yellow pie chart there,
15 we're 94 percent dependent on petroleum. That
16 means right now, only about 6 percent comes
17 from either biofuels or natural gas. And then
18 the only other real stat on here that we like
19 to remind people of is that we've got a lot of
20 vehicles on the road, over 249 vehicles on the
21 road. Right now, selling new vehicles at a
22 pace of about 12 million vehicles a year, it
23 takes 20 years to replace that fleet. This is
24 a very busy slide, sorry about that, but I
25 think we can make some over-arching points

1 without going into the details. We do a lot of
2 analysis. What we've done here is look at a
3 bunch of varieties of vehicles and fuel
4 combinations, hybrid vehicles, plug-in hybrids,
5 battery, electric, fuel cell electric vehicles
6 apply to their petroleum use and greenhouse gas
7 emissions. I'm going to lower this a little
8 bit. And so we start out with a conventional
9 gasoline spark-ignited vehicle. That's today's
10 vehicle. The rest of these are future cases.
11 And just to point out, now we're talking about
12 electrification here. Why are we focused a lot
13 on electrification? The reason why is, if
14 you're looking at technologies that both
15 drastically reduce petroleum use and
16 drastically reduce greenhouse gas emissions,
17 it's these technologies that have the red
18 arrows connecting them. And they all involve a
19 degree of electrification combined with either
20 renewable fuel or low-carbon fuel. So whether
21 you're talking about, say, what's a good
22 example, here's a cellulosic E85 with
23 low-carbon renewable electricity as a plug-in.
24 Here's a fuel cell vehicle with a sequestration
25 or renewable hydrogen (indiscernible) obviously

1 is an electric drive vehicle. These are
2 vehicles that get you both very low carbon
3 emissions and very low petroleum use. In
4 addition to that, and this is another busy
5 chart, but an important one, we also looked --
6 this morning it was mentioned about the cost to
7 operate these vehicles so we also look at the
8 cents per mile. I really want to stress
9 there's a hundred ways you can do an analysis
10 like this; this is one example. In this
11 example, we presume that we meet all of our R&D
12 targets and so we've done other examples where
13 you don't quite meet the targets, or just
14 comparing today's technology, and of course the
15 analysis comes out different. That's not the
16 point. The point is we do this type of
17 analysis to understand, you know, where we are
18 from a consumer standpoint in a cost per mile.
19 In addition to that, you know, you have to make
20 a lot of other assumptions. What's the
21 discount rate. In this case, I can't remember,
22 it was either 8 or 10 percent. It is not
23 representative of how consumers make decisions.
24 But overall, this chart will tell you if we
25 meet all of our targets, that most of these

1 advanced vehicle technologies, whether fuel
2 cell vehicle or plug-in hybrid on a cents per
3 mile basis do pretty well versus a reference
4 spark-ignited vehicle or even an advanced
5 spark-ignited vehicle as their cost comes down.
6 So they basically all will pay for themselves
7 but emphasizing once again, a fairly low
8 discount rate. So as a starting point, what do
9 we consider as part of this QTR process from a
10 technology standpoint. And I would be the
11 first to say this is up for debate. We put
12 this out there because we need a starting
13 point. We consider hybrid, plug-in hybrids,
14 extended range vehicles, battery, electric,
15 fuel cell vehicles, infrastructure, so these
16 are all vehicle types. But then I'll have
17 another slide talking about infrastructure and
18 other critical components. And we fully
19 realize that you really need a variety of
20 vehicles, and a variety of vehicles are
21 included in our portfolio because they're
22 really needed to meet diverse transportation
23 needs, and recognizing that most appropriate
24 technology depends on the dry cycle and the
25 duty cycle, no one technology meets all those

1 needs. So then if you look a little bit more
2 on components and infrastructure-type issues,
3 so what's in and what's out? Batteries,
4 certainly the lithium, both today's lithium-ion
5 and future chemistries is in. We've included
6 nickel-metal hybrid, not because DOE is really
7 doing any R&D in nickel-metal hybrid, but it's
8 a recognition that that's what's out there
9 being deployed today in most hybrid systems.
10 Ultracapaciter as PEM fuel cell (indiscernible)
11 in the storage system. Those are sort of drive
12 training, kind of an energy storage components.
13 Then you look at the vehicle components.
14 Certainly, power electronics, motors, chargers,
15 and we're very interested in rare earth and
16 alternatives to rare earth materials in drive
17 train. Vehicle systems, control systems, I
18 haven't talked yet really about the difference
19 between light duty and heavy duty, but of
20 course we work on the span of vehicles from
21 light duty all the way up to class A trucks and
22 of course important for class A trucks and even
23 airplanes is auxiliary power units. And then
24 finally, infrastructure, charting
25 infrastructures included, battery swapping,

1 secondary use, recycling, all these concepts
2 are included. Hybrid production, delivery of
3 fuel cells, and finally truck stop
4 electrification as it means to avoid idling.
5 So I think you've gotten, you should know by
6 now, that this is very important to the
7 Administration. I just want to acknowledge
8 that. Most recently, President Obama devoted
9 an entire speech to energy when he spoke in
10 Georgetown at the end of March. At a State of
11 the Union Address, restated his goal for 1
12 million plug-in hybrids by 2015. And then the
13 day after the State of the Union Address, the
14 Vice President announced the community
15 infrastructure project proposed for 2012 that
16 involves $200 million to help cities establish
17 charging infrastructure. So let's talk a
18 little bit more about the 1 million vehicles by
19 2015. And I just wanted to point out the way
20 we think about it and the primary thing we
21 think about is 1 million easy goals a
22 milestone. It's not the finish line. Meaning
23 if you get to 2015 and you get to 1 million
24 vehicles on the road, have you solved your
25 energy problems? No. Have you made a serious

1 dent in petroleum consumption or greenhouse gas
2 emissions? No. But you have to get there
3 before you get the 5 million, or 10 million, or
4 20 million. And so I only bring this up
5 because we get this question a lot. You know,
6 1 million vehicles, it's not that much, so why
7 are you doing it. Well, we're doing it because
8 it's a critical milestone and we think the
9 pieces are in place to attain it. Tax
10 incentives; $7,500 for a light duty vehicle;
11 the Recovery Act manufacturing facilities;
12 supporting battery manufacturing; supporting
13 critical electric drive components; charging
14 infrastructure being established under the
15 Recovery Act, as well as the $200 million
16 program proposed for 2012; production
17 announcements made by OEMs; continuing R&D
18 that's accomplishing critical things, like
19 lower costs for batteries, lowering costs for
20 fuel cells; the existing CAFE standards as well
21 as what could happen beyond 2016; and finally
22 the ATVM loan program, the Advanced Technology
23 Vehicle Manufacturing loan program, which it
24 has up to $25 billion in loans to auto makers
25 to help establish manufacturing facilities

1 capable of producing advanced vehicles. We
2 feel like the pieces are in place. Let's move
3 on a little bit to talk specifically about
4 batteries. First of all, we're very proud of
5 DOE. We have our history in bringing battery
6 technology to market, so just to toot our horn
7 for a second, our work in the 1990s on
8 nickel-medal hybrid led to the batteries that
9 are in hybrids today. The batteries that are
10 in the Prius, in Honda vehicles, in General
11 Motors vehicles are an extension of that work.
12 We've moved on from the early 2000s to work on
13 lithium-ion and that work is really what's
14 enabling a new generation of HEV plug-ins in
15 the U.S. today. And then finally, we're
16 working on next-generation chemistries, both
17 improve lithium-ion chemistry, as well as
18 what's beyond lithium-ion. They gave us a
19 substantial improvement in energy density.
20 We've got targets, many targets. I've just put
21 a little slice here so that you see it. We've
22 got targets for HEV batteries, plug-ins, EV
23 batteries, and then even sort of as you drill
24 down into components such as nanos and
25 cathodes, we have our targets for that. The

1 plug-in battery cost, let's look at that a
2 second, because it gets a lot of attention.
3 Battery cost, you always hear about it, major
4 barrier because where are we today versus where
5 we think we need to go. Last year, 2010, we
6 were -- our cost modeling was shown that we
7 were about $800 per kilowatt hour. We measure
8 that cost in useable energy and we believe that
9 we are on track, and see a route to get to
10 about $300 a kilowatt hour in the middle of
11 this decade. So we feel that costs are coming
12 down they're coming down dramatically. But we
13 have to recognize and be realistic that even at
14 $300 per kilowatt hour, if a vehicle needs a 10
15 kilowatt hour battery, it's a $3,000 component.
16 This is a very expensive single component for a
17 vehicle. Just to go into a little bit more
18 detail, sort of how we see the landscape moving
19 forward to 2020. Today we're working on
20 lithium-ion technology. It's fairly standard
21 graphite and layer cathode with a practical MG
22 density of about 150 watt hours per kilogram.
23 I'm going to talk a little bit more in a minute
24 about sorted advance lithium-ion options. So I
25 won't do that now, but these are the options

1 that are certainly getting you down to that
2 $300 per kilowatt goal that we have. And then
3 finally, beyond lithium-ion, both EERE and
4 ARPA-E have EV goals into the hundred and
5 hundred and fifty dollars per kilowatt hour
6 range and are working on technologies such as
7 metal air, lithium air, and lithium with
8 high-voltage cathodes, and obviously can get
9 not only low-cost, if we succeed, these are
10 higher-risk options, but also batteries that
11 are much smaller and lighter than what are
12 available today. So lithium-ion, and by the
13 way, I'll warn you, I'm trying to move quickly.
14 We've got about 70 slides to do here in an
15 hour, so forgive me if I'm moving along pretty
16 fast. A lot of questions about, well, how are
17 you going to make lithium-ion better? How are
18 you going to get the cost down? We believe the
19 next generation of lithium-ion can increase the
20 power and energy by a factor of two while
21 simultaneously reducing the cost dramatically.
22 How do you do that? Today's nanotechnologies
23 emphasize graphite, next generation -- and
24 cheap, about 300 million per gram. Next
25 generation of anodes are going to double that

1 capacity of 600 million hours per gram. The
2 electrolyte today, we're at about working level
3 of four volts or less. High voltage
4 electrolyte promise a voltage ceiling of
5 perhaps 5 volts. And then finally, today's
6 cathode materials, layer oxides and spinels
7 have about 150 million of hours per gram. And
8 we feel that the next generation, which include
9 layered oxides and metal phosphates, will
10 double that capacity. Put all those pieces
11 together and you get a battery that is much
12 smaller, lighter, has less active materials in
13 it and basically, that's how you lower the
14 cost. You can also lower the cost a little bit
15 by manufacturing and learning about how you're
16 doing, but you're basically going to lower the
17 cost by improving the battery itself. So how
18 do these pieces fall together for meeting the
19 goal of 1 million EVs by 2015. Our battery
20 cost, as I said, we feel like we're on track to
21 reach the $300 per kilowatt hour goal. If you
22 look at battery production capacity, both
23 through the Recovery Act Projects and through
24 the loan program, they total almost a million
25 battery packs per year with a total capacity of

1 almost 10 million kilowatt hours. And if you
2 look at announced vehicle production capacity,
3 which would total about 1.2 vehicles -- 1.2
4 million vehicles by 2015. That's cumulative.
5 But if you look at the capacity required in
6 2015 to meet those announcements, you'd get to
7 about 8 million kilowatt hours per year. And
8 so these are pretty closely aligned and
9 certainly we think the cost will be in line to
10 accomplish that also. So just to move on, it's
11 not all about batteries. We have a lot of work
12 underway, power electronics and electric
13 machines, so what do we include in that. We
14 include the battery charger, bidirectional
15 converters, inverters, electric motors and then
16 GT and VC converters. And in support of the
17 R&D in this area, we have more targets. We
18 have a complete traction-drive system, which I
19 think the target of most interest to you is
20 once again a cost target of dollars per
21 kilowatt this time. And right now, we're in
22 the area of about $19 per kilowatt. We need to
23 more than half that by 2020 and simultaneously
24 increasing the efficiency of that. Once you
25 start dividing that up into pieces of that

1 traction-drive system, including power
2 electronics and motors, and so we get these
3 sub-targets of how you're going to get there.
4 And we do that, not because the total
5 traction-drive system has to meet these
6 targets. But we also tend to work individual
7 on -- not necessarily on all completed
8 integrated systems, but on individual
9 technologies, so you need those individual
10 targets. Fuel cell, so a prime interest in the
11 fuel cell area is how much cost has come down.
12 And many of you may know, I was involved in the
13 fuel cell program in the '90s and into the
14 early 2000s, and we used to talk about costs
15 that were even in the thousand dollars per
16 kilowatt range. And so this chart shows our
17 trip starting from about 2002 where we were at
18 almost $300 per kilowatt, down to our model
19 cost today at about $50 per kilowatt. So the
20 cost of these technologies have come down
21 tremendously. It's a real testament to the
22 work of that program. This is the model cost
23 at about 500,000 units per year, so it's high
24 volume production. And if you were to look at,
25 you know, what consists of that cost, about

1 half of it is the stack and about half of it is
2 the bXXXce of plan for the fuel cell system.
3 Once again, a model cost. And you might say,
4 wow, 500,000 units per year is very high. What
5 happens to that cost as you vary the production
6 volume, and that's shown on the bottom, that
7 this is a -- here's that $51, same number
8 that's here, plotted here, for 500,000 units.
9 And you can see how that cost slowly climbs as
10 the production volume goes down and there's a
11 good meeting in the curve there, I guess, at
12 about 75,000 units per year. But still, even
13 approaching that, you're still under a hundred
14 dollars per kilowatt, so very important, cost
15 reduction, key milestone. In addition to that,
16 we've demonstrated 155 fuel cell vehicles, 24
17 hydrogen stations over 3 million miles driven
18 and good durabilities and simultaneously
19 validated a vehicle that can achieve over a 400
20 mile range, so good progress in fuel cells.
21 This is another busy chart but, you know, along
22 with the fuel cell, you obviously need
23 hydrogen. And so this chart shows that if you
24 look at hydrogen production cost right here on
25 this top new graph, we've shown dollars per

1 gallon of gasoline equivalent for hydrogen
2 versus the type of hydrogen production
3 technology. And you can see natural gas
4 performing. This is distributed, this is for
5 distributed production, so distributing natural
6 gas performing today is at about $3 per gallon
7 of gasoline equivalent, once again, assumes a
8 certain volume of production. Other
9 technologies a little higher, including ethanol
10 reforming and electrolysis. The longer term,
11 centralized production's important, especially
12 if you want to move to technologies such as
13 hydrogen from renewable resources and so here's
14 biomass gasification which, you know, is around
15 $6 per gallon of gasoline equivalent. And then
16 you can see central production through wind
17 electrolysis is fairly high and that has to do
18 with really the utilization of that
19 electrolysis equipment. And so we have reduced
20 the cost of hydrogen delivery, and I won't go
21 over this, but there's more details about how
22 you would get cost reduction on delivered
23 hydrogen. And then finally, just to cover
24 probably what is most important to hydrogen,
25 and that is how are you going to, you know,

1 it's really about infrastructure. The fuel
2 cells are available at a reasonable cost. What
3 about the infrastructure. You need hydrants at
4 stations everywhere. So just a couple data
5 points if you're not aware. In the U.S. we do
6 make about 9 million metric tons of hydrogen
7 grease annually. Most of that's in the
8 petrochemical industry. There's over a
9 thousand miles of hydrogen pipeline today. And
10 if you were to take advantage of our existing
11 natural gas pipeline network for distributing
12 natural gas reforming and produce hydrogen,
13 that network is pretty extensive. So it is
14 something that could be done, so the near-term
15 strategy is to use that existing natural gas
16 pipeline network and infrastructure. In the
17 long-term, you really need hydrogen from
18 diverse, renewable and low-carbon sources. So
19 just to touch on a few areas of the Recovery
20 Act, you may be familiar with the manufacturing
21 work of 1.5 billion, that's federal funding
22 matched by industry funding, for a total of 3
23 billion to establish battery manufacturing.
24 When we worked on that project, we were looking
25 at establishing a complete integrated supply

1 chain, so we didn't fund just cell producers or
2 battery assemblers. We started at the material
3 supply level so the folks that make cathodes or
4 anodes or electrolytes, 12 awards there, to
5 sell manufacturers and battery assemblers a
6 total of 9 awards. And then in the electric
7 drive component area -- that's this $500
8 million piece, once again, matched by industry
9 for a total of $1 billion, ten awards, and
10 these were awards such as power electronics,
11 electric motors, even capacitors. And what's
12 not shown in here is one more award in the
13 battery area which was for recycling after
14 batteries are used. In addition, has extensive
15 projects awarded under our transportation
16 electrification demonstration projects, include
17 a total of 13,000 electric drive vehicles, over
18 23,000 charging points, including several
19 hundred. And all those charging points, by the
20 way, are level 2, and including several hundred
21 hybrid charging. Sometimes people call it
22 level 3 at the high-voltage centers and the
23 fast chargers. And the purpose of these
24 demonstrations is a largest demonstration of
25 electric drive vehicles ever here in the U.S.

1 Our purpose is the collection of data. We're
2 very interested in how these vehicles are going
3 to be used. How many miles people put on these
4 vehicles before they recharge them. Where do
5 they recharge, do they primarily charge at
6 home, at work, publicly, how many miles do they
7 normally go before recharging, that sort of
8 information. So we are collecting all that
9 data and it will be published publicly. In
10 addition, there are ten grants as part of the
11 program that are really about education, an
12 outreach program educating everyone from first
13 responders to technicians who would work on
14 these vehicles to education curriculum. I
15 mentioned $200 million proposed in the 2012
16 budget to help cities establish the charging
17 infrastructure, so that was announced by Vice
18 President Biden on January 26th, and we will be
19 looking at cities to establish a comprehensive
20 plan to be friendly to the introduction of
21 electric-drive vehicles. So we can encourage
22 working with the public and private sector to
23 collaborate. Let -- not only use these funds,
24 but leverage those resources. Help do things
25 like streamline building permit approval and

1 installation procedures and funding of actual
2 build-out of some of the infrastructure. So in
3 summary, petroleum depends on the environmental
4 drivers, strongly point towards vehicle
5 electrification, battery technology, and our
6 progress is important, critical, and an enabler
7 of it. Fuel cell vehicles are part of the
8 portfolio. I have made great progress,
9 especially from a cost perspective, or perhaps
10 a little longer term. The Recovery Act is
11 helping establish a lot of manufacturing, base
12 required for this, policy emissions, and also
13 be critical, including CAFE, including the
14 Recovery Act, the AGDM loan program and tax
15 incentives. And the infrastructure has
16 build-out, has started with doing plans in
17 place for 2012. We think that meeting the 1
18 million EVs by 2015 goal isn't really
19 constrained by manufacturing capacity. It's
20 more about consumer acceptance. It's more
21 about meeting goals for cost reduction. And so
22 these things are important if we're to meet
23 that goal. I'm going to stop there. Thank you
24 for putting up with my fast pace, and we're
25 going to introduce XXX who's going to talk

1 about vehicle lightweighting.

2 XXX: Good afternoon. I'm XXX.

3 I want to talk a little bit about

4 lightweighting and aerodynamics. As we all

5 realize, vehicle weight influences fuel

6 consumption. A 10 percent reduction in vehicle

7 weight reduces fuel consumption by 6 to 8

8 percent. And in addition, the weight reduction

9 also reduces CO2 emissions, of course. That

10 said, if you look at the vehicle weights in the

11 U.S., these are the fleet average vehicle

12 weights. And ever since 1987 when the last

13 CAFE standards essentially leveled out, the

14 weight of U.S. vehicles have been increasing.

15 Part of this is the result of consumer

16 preference for trucks and for larger vehicles.

17 Part of it is the result of increased

18 standards, particularly in safety, and

19 increased content of these vehicles, more

20 electric seats, electric windows and so forth,

21 that consumers prefer. Just to sort of get a

22 little focus on that, the green line is that

23 same vehicle weight chart and this yellow line

24 is the zero sixty times for the fleets. So you

25 can see not only have the vehicles have been

1 getting heavier, but they've been getting
2 faster. This green line is the average fuel
3 economy for the fleet. You see it's been
4 fairly steady until, and in fact getting
5 poorer, until just recently. But this yellow
6 line is the vehicle efficiency, essentially 10
7 miles per gallon. If the vehicles had not been
8 getting heavier, the fleet today would be about
9 45 percent or more efficient than they are
10 today. So you see the impact that this growing
11 weight, and to some extent the increasing
12 accelerations, have had on the overall fuel
13 consumption in the country. So part of the
14 question behind our lightweighting program, is
15 it really possible to reverse this trend of
16 ever-increasing vehicle weight. Now, I think
17 it's going to be interesting to see the impact
18 that CAFE just had, but nonetheless, it's an
19 issue that I think's very at the core of this
20 program. And the deal we -- program is focused
21 really on lightweighting. How do we make the
22 vehicles have less mass rather than downsizing
23 and making the vehicle smaller. And
24 lightweighting has been occurring. If you look
25 at this chart, you can see that the use of

1 aluminum, high-strength steels, and composites
2 and plastics have been growing steadily in the
3 U.S. automotive fleet. And to a lesser extent
4 we're seeing greater use of magnesium. In
5 fact, without these lightweight materials, the
6 4,000 pound car today would be another 200
7 pounds heavier. And there are multi material,
8 light-weight vehicles that are being designed
9 and being developed and being produced. Here's
10 a couple examples. In the Mercedes, you can
11 see that there are substantial parts of the
12 structure and closures that are aluminum,
13 high-strength steel front and rear assemblies,
14 and even magnesium inner-door castings and
15 plastic closures around, so that there are
16 substantial use of lightweight materials in
17 this vehicle. Another -- a good example is the
18 Chevrolet Corvette. Essentially, an aluminum
19 structure with carbon-fiber floor pans,
20 magnesium engine cradles, and even titanium use
21 in valves and connecting rods for reduced to
22 the (indiscernible) inertia. So it is -- we do
23 see lightweight materials used more heavily in
24 the marketplace although today, tending toward
25 the higher-end products. So what

1 lightweights -- what savings are possible in
2 lightweight? The body structure's about a
3 third of the vehicle weight, the power train's
4 another third, and then the interior, and the
5 trim, and the glazing is the final third.
6 There's been a series of studies over the years
7 looking at what can be achieved with
8 lightweighting and you can see the range here
9 from, say, 20 to 50 percent reduction in total
10 vehicle weight depending on the design choices
11 and the materials and the aggressiveness of the
12 lightweight. And it gives you some kind of
13 range of what may be achievable in this area.
14 The other issue that always comes up is crash
15 safety. The perception is that in a collision
16 with the heavier vehicles, the lighter weight
17 vehicle always loses. And the DOT has been
18 studying this area extensively, and the initial
19 studies were not really promising, where they
20 were talking about as you reduce the vehicle
21 mass, fatalities rise. However, as they've
22 looked deeper into this and tried to separate
23 this relationship between vehicle mass and
24 vehicle size, so as the vehicle gets lighter
25 you still maintain crush base, those analysis

1 show a much smaller effect on safety with
2 lightweight vehicles. And sort of as a data
3 point, some of the cross-over utility vehicles
4 actually have lower mass and the same footprint
5 as large truck-based SUVs and lower fatality
6 risks. So there does appear to be some data
7 that argues that maintaining size while
8 reducing mass is not necessarily a safety
9 issue. Finally, the thing to realize is that
10 statistical analysis of what's happened in the
11 past is not going to be a predictor of what
12 happens in the future with new materials and
13 new designs that are of course not in the
14 statistical database. MISA, EPA and KARR
15 (phonetic), we're doing extensive computer
16 simulations to try to understand the effect
17 that extensive use of lightweight materials
18 will have on safety, but this is an ongoing
19 area of research, and an area that, at least
20 for some materials, we see some real promise.
21 If you look at the energy dissipation during
22 crush and collision, here's steel, so today's
23 vehicles are here. Aluminum and particularly
24 the carbon fiber composites, and even the
25 sheet-woven compounds have greater energy

1 dissipation capabilities in collisions. So it
2 gives us some belief that with some of these
3 new materials, there really are opportunities
4 for significant improvements in crash safety.
5 So there are material options that can
6 substantially reduce vehicle mass. Beyond
7 that, from what's available today, from
8 advanced high-strength steel, aluminum, and the
9 plastics that are coming into the market today.
10 But there are also substantial barriers that
11 need to be overcome to use these materials.
12 Here's sort of our list of materials within the
13 scope. We've got for those materials that
14 provide less than 50 percent mass reduction
15 have aluminum plastic, high-strength steels,
16 carbon-fiber composites including sheet molding
17 compound, and these materials are increasingly
18 being used in vehicles today. And then for
19 materials that provide substantial or greater
20 mass savings, we have magnesium, titanium,
21 carbon-fiber composites, and metal-matrix
22 composites. And the magnesium and carbon fiber
23 are areas we consider for materials, vehicle
24 structures. And titanium and the metal-matrix
25 composites are really more engine-component

1 focused. Some of the barriers of
2 lightweighting. I think we all sort of
3 recognize that if lightweighting was more
4 important for us, it would be easier to put
5 these materials into the marketplace. But
6 there's some other areas that I think are
7 important. One is the design tools that the
8 industry needs to be able to effectively and
9 easily use these materials in the design
10 process. Some of the materials, particularly
11 the carbon-fiber composites, require new
12 manufacturing techniques and new processes that
13 may not fit well within the existing
14 sub-capitals metal-forming structures of the
15 industry. There's existing issues with paint
16 and this issue of spool up. If you had a large
17 industry, it would be a lot easier to work in
18 this area then as we see in batteries and other
19 areas, to sort of drag ourselves up a little
20 bit at a time. I'm not going to go over this
21 but basically, all these materials have some
22 substantial advantages and they all have
23 problems. The problems are different, so you
24 have to focus on each material if we're going
25 to overcome the barriers as needed to get those

1 materials into the future vehicle designs. And
2 cost is really the issue. Current vehicles
3 today sell for about $8 a pound. This is sort
4 of our assessment as on a
5 dollars-per-pound-of-weight savings, where the
6 boundaries are for getting these materials into
7 new vehicles. So you can see that some of
8 these carbon-fiber components, magnesium sheets
9 provides higher costs for the weight savings.
10 And as a result, we're seeing them appear in
11 the more expensive limited-volume production.
12 But as these costs can come down, we fully
13 expect that we'll see greater and greater use
14 of these materials in lightweight vehicles. A
15 little talk about the budget, here's the
16 materials budget. Over the years, you can see
17 that in the early days of the program, the
18 funding was focused on aluminum and composites.
19 And as we moved later on to today, we're
20 focused more on carbon fibers, magnesium,
21 advanced high-strength steels, and that bottom
22 section which is sort of the manufacturing and
23 joining in other enabling technologies to make
24 sure we can build vehicles from these
25 materials. Now with that, I'm going to switch

1 over to aerodynamics briefly. For heavy
2 vehicles, we see significant benefits from
3 aerodynamic improvements. The class A trucks
4 spend most of their operating lifetimes on the
5 highways at high speeds where aerodynamics can
6 have substantial benefits. Plus, these
7 vehicles are not particularly aerodynamically
8 designed, particularly the trailers. In the
9 light-duty vehicles, the industry has worked
10 clearly very hard and for a long time to reduce
11 the aerodynamic drag of these vehicles even
12 though, compared to class A trucks, they spend
13 much less time at high speeds. And so we see
14 sort of low gains in the light-duty vehicle
15 area. So our focus in this area is in the
16 heavy-duty vehicles. There are substantial
17 improvements available up to, say, 16 percent
18 improvement in vehicle fuel economy that's
19 achievable with these classes of vehicles. And
20 so as we look at aerodynamics, we're sort of
21 saying the light-duty vehicle aerodynamic
22 technology is well-developed. The need is in
23 the heavy-duty marketplace. However, in the
24 heavy-duty marketplace we believe there are
25 substantial tools and techniques for

1 aerodynamic improvements that are available.
2 And so many of the barriers in this area are
3 non-technical in that, well, for example, there
4 are far more trailers then there are tractors
5 in this country, so you can't go and match up a
6 tractor and a trailer unless you happen to have
7 a cab defleet operation. So there's business
8 models and issues in the aerodynamics area that
9 also need to be overcome. The aerodynamic
10 activities have been a relatively smaller
11 portion of our budget, and you can see the
12 trends here. And with that, I'll stop, and
13 introduce XXX to talk about the
14 combustion area.
15 XXX: Okay. Good afternoon. As
16 XXX discussed earlier, a lot of our focus in
17 our office is on electrification but engines
18 are still important. So let me go ahead and
19 first start off with our outline. It talks
20 about the current state of the technology.
21 Also look at how much head room there is for
22 further improvement and look at future
23 technology pathways. And then briefly go over
24 some of the projects that we currently have in
25 the program. As I was mentioning, that

1 electrification is very important, but we think
2 that a decrease in the efficiency in the
3 internal combustion engines is still one of the
4 most promising and cost-effective approaches to
5 improving fuel economy, especially in the
6 near-to-midterm. And since engines will still
7 be required, and hybrid vehicles, and plug-in
8 hybrid electric vehicles, we see engines on the
9 marketplace for several decades. And if you
10 looked at medium- and heavy-duty trucks, we
11 really don't see any obvious alternative right
12 now to internal combustion engines, especially
13 for over-the-road type vehicles. And the
14 national trend designs pretty much echoes this
15 finding also.
16 XXX: XXX
17 XXX: Yeah.
18 XXX: Can't hear you in the back.
19 Could you try to speak a little louder?
20 XXX: Okay. Is this better?
21 XXX: Yes.
22 XXX: Okay. Engines also, as
23 you know, can use a variety of fuels, from
24 high-density liquid fuels all the way down to
25 the gaseous fuels. We have run engines and a

1 lot of R&D on hydrogen IC engines. So pretty
2 flexible, very durable, reliable and robust
3 power plant. Contrary to popular belief, maybe
4 not in this room, but on the side of the
5 public, that engine efficiency hasn't improved.
6 I've actually had somebody tell me, you know,
7 we get the same mileage now as the Model T got,
8 and I was really stunned when they said that.
9 And this was a fairly educated person, too.
10 And again, as XXX was showing at his
11 presentation that you could get up to 44
12 percent higher efficiency if you did not have
13 the increase in weight and improvement in
14 performance. And I would say a large part of
15 that is attributed to the improvements in the
16 internal combustion engines. Yes, we've
17 improved transmissions, reduced roll-over
18 resistance, airbags, but I mean largely
19 attributed to the improvement in internal
20 combustion engine efficiency and likewise for
21 the heavy-duty area, you see here, the
22 improvement in thermal efficiency over the
23 years even as the industry reduced emissions by
24 95-plus percent. And along the way,
25 acknowledgment from, in this case, Detroit

1 Diesel, the contribution from the DOE research
2 program, and continually trying to increase the
3 efficiency of those engines. And also, we did
4 an independent assessment of our research
5 during the time frame shown here, '97 to 2005,
6 which showed an over 35-to-1 return on
7 investment, meaning the investment we made
8 improved the efficiency of these engines
9 resulting in production in petroleum use and
10 obviously relates to savings in dollars.
11 Looking at the future, we've had a couple of
12 workshops over the past year. We invited about
13 40 thermodynamists in the engine area from
14 industry, academia, and our national labs and
15 convened for a couple days last March. And a
16 report is available; it's an Oak Ridge report
17 that was put together for us and is available.
18 In a nutshell, the consensus was that the
19 thought is that we can still improve efficiency
20 up to about 16 percent. Of course, cost would
21 be an issue. So that's roughly, you know,
22 twice the efficiency of a current spark-ignited
23 engine. And also the consensus, the
24 possibility of doubling the fuel economy of a
25 light-duty vehicle with just engine

1 improvements alone. Recently we had a workshop
2 looking towards the future, the kind of work we
3 should be doing. Again, we had about 70
4 researchers from industry, academia, and
5 national labs, and even some other agencies.
6 And we're focusing on two efforts here for
7 predictive simulation of internal combustion
8 engines. We call it PRECISE. And this report
9 that's pictured here will be available later
10 this week. It will be on our website as well
11 as the website for the Office of Basic Energy
12 Sciences. This was a joint workshop, so it
13 includes work that will be done by Office of
14 Science as well as Energy Efficiency to look at
15 simulating combustion in particularly these two
16 areas here as to castaic flows and spray
17 modeling. An example of that which was done,
18 say, over the past 10 to 15 years, again being
19 in the work that was done by the Basic Energy
20 Sciences group and the Fundamental Chemistry
21 and Laser Diagnostics, we took advantage of
22 that work in our applied research, applied it
23 to engines, as shown here on the bottom, and
24 came up with very new discoveries that were
25 employed in models that were used by engine

1 manufacturers.

2 In this case, Cummins, it was publicly

3 acknowledged that using these tools and the

4 findings from the other combustion research,

5 they were able to improve the efficiency of

6 their engine by about 10 to 15 percent, at the

7 same time reducing production time as well as

8 cost. And that engine is currently available

9 in the Dodge Ram pick-up truck and it also had

10 met 2010 emissions in 2007 which was another

11 plus. So this is the kind of thing we want to

12 replicate with the PRECISE program now that

13 we're looking towards excellent scale time and

14 computing, architecture available, as well as

15 new diagnostic tools. I think we can take it

16 even a step further and reduce product

17 development time for the manufacturers and get

18 ahead of the curve as far as bringing new

19 products and higher-efficiency engines to the

20 market.

21 Now talking a little bit about our

22 current program, on the bottom I've listed the

23 goals, the targets. We want to improve the

24 fuel economy of light-duty vehicles by 25 to 40

25 percent. This is just by improving the engine

1 efficiency only. And for heavy-duty vehicles,
2 which are already very efficient, as we heard
3 throughout the morning, try to improve their
4 efficiency by another 20 percent in 2015 and 30
5 percent in 2018. And the primary direction
6 here is to try to improve the combustion
7 process, minimize thermal and parasitic losses.
8 We still need to make sure we're compliant with
9 emissions, so we have a big effort on
10 after-treatment. We're bringing in, trying to
11 recover the waste energy from the exhaust,
12 whether it's mechanical or it could be also
13 solid-state technologies like thermal
14 electrics. We also coordinate extensively with
15 our fuels team. We know that changes in fuels
16 can drastically impact these high-efficiency
17 engines. And also I should mention that we
18 coordinate also with the materials team, which
19 provides a lot of the propulsion system
20 materials I think we will need in the future
21 for a higher temperature operation as well as
22 the numerous components that will need to be
23 upgraded. Some of the tools that we have
24 available, ranging from advanced diagnostics,
25 optically testable engines that are shown here

1 up on the right, even x-ray techniques to look
2 inside injectors, combustion simulators here in
3 the middle, this right here, chemical kinetic
4 modeling of the fuel, and then taking all this
5 work, developing simulation models that can
6 eventually be used by industry to help them
7 better design their engines. This work is done
8 in close collaboration with industry through
9 this member understanding we have at Sandia
10 National Lab. You see all the partners listed
11 here. We have ten engine manufacturers, five
12 energy companies that provide a lot of input on
13 the fuels that we should be considering as the
14 fuels research, and then the National Labs are
15 also listed here. And this work, as you can
16 see from the company's cross-cuts, light and
17 heavy duty. We also have a very strong
18 influence, strong program, with numerous
19 universities that provide a lot of input to
20 further develop these technologies. So we've
21 identified many potential pathways for
22 efficiency improvement going back to, one comes
23 to mind where Sandia National Lab, basically
24 John Dec, developed a new picture of diesel
25 combustion, which was different then what

1 anybody else had thought for the previous, you
2 know, decades. And just with that knowledge,
3 the engine companies themselves taking that
4 in-house, were able to redesign their
5 combustion systems, and reduce emissions, and
6 improve efficiency. Another pathway I'll show
7 here, we're doing currently with the University
8 of Wisconsin. Also a low temperature of
9 combustion and using a dual fuel approach with
10 gasoline and diesel, and this has been
11 presented a lot at the SAE meetings, looking at
12 indicative efficiencies that have been
13 demonstrated on simple cylinder engines, 50
14 percent for light duty and 59 percent for heavy
15 duty. And so these kind of numbers, you can
16 see that possibly improve the efficiency of a
17 light-duty vehicle by perhaps over 75 percent
18 if we were able to take this technology into
19 production. And there are heavy-duty and
20 light-duty partners that are already taking
21 this work in-house and trying to learn on
22 multi-cylinder engines as well as we're doing
23 the similar work at Oak Ridge National Lab
24 nearby running this on multi-cylinder engines
25 to try to replicate this kind of data. Also, I

1 should mention, the engine out emissions for
2 this engine are below EPA 2010 levels. So even
3 though we do have low emissions coming out of
4 the engine, we know that we can't really
5 sustain that throughout the entire operating
6 range of a vehicle. So we still have to focus
7 a lot of attention on after-treatment. And we
8 have a working group called CLEERS, Cross-cut
9 Lean Exhaust Emission Reduction Simulation.
10 And again, we have a coordinated program with
11 industry, government labs and academia. Too
12 many partners to list. We have dozens of
13 organizations in the U.S. as well as even
14 international organizations that focus on
15 improving the computational models that you
16 would need to simulate these systems. We've
17 used combinatorial chemistry to identify
18 thousands of catalysts that have the potential
19 of reducing the need for precious metal, things
20 like that. You see on the bottom diesel
21 particulate filter model that was developed by
22 Pacific Northwest National Labs showing the
23 soot accumulation and also a model from Oak
24 Ridge showing the species concentration as you
25 move down the path of (indiscernible). Just a

1 quick example of one of the projects which
2 includes work from Basic Energy Sciences at
3 PNNL using facilities to characterize catalysts
4 all the way to employing this work through the
5 CREATA with Packar (phonetic), a large
6 heavy-duty vehicle manufacturer, looking at
7 ways of trying to combine two different systems
8 into one in an effort to reduce weight and cost
9 and be able to make the whole system more
10 manageable for the vehicle. This one shows the
11 breadth of this project of going from very
12 fundamental work all the way to application on
13 a truck. And speaking of trucks, we have our
14 super truck program and our advanced technology
15 power train program, which was the light-duty
16 portion of that. We made these awards last
17 year to Cummins, Daimler Trucks and Navistar to
18 improve the freight efficiency by 50 percent.
19 Twenty percent of that improvement is from the
20 engine effort to try to get 50 percent break
21 thermal efficiency and also to show a path
22 where you get 55 percent break thermal
23 efficiency as our engine contribution to the
24 super truck. And then on light-duty side these
25 goals are engine only, we we're looking for a

1 25 percent improvement for gasoline engines, 40
2 percent for diesel engines, and this work is
3 being done with a 50 percent cost share with
4 industry and the light-duty award, so we have
5 GM, Chrysler, Ford, Delphi, Bosch and Cummins
6 working on those projects. Really quickly,
7 another part of our program is a solid-state
8 energy conversion. We want to be able to
9 improve the fuel economy of a light-duty
10 vehicle by 5 percent by utilizing the waste
11 heat in the exhaust and converting it directly
12 to electricity. And we have some ongoing
13 projects, again, (indiscernible) industry with
14 General Motors and BSST and subcontracts to
15 Ford and BMW. And also we have taken the same
16 technology and using it in reverse direction to
17 provide vehicle comfort in the vehicle itself,
18 using it for heating and cooling, which will be
19 very important for hybrid electric and electric
20 vehicles in terms of using less energy from the
21 battery for heating and cooling reasons. And
22 that's it. Thank you.
23 XXX: So we will now go to
24 break-out sessions in the next room.
25 (Break-outs are listed.)

1 We will have break-outs really trying
2 to get, you know, let the technical folks key
3 down a little bit and make sure that we're
4 really capturing the presentation you just saw
5 and diving down the next level and we're really
6 capturing where we stand and where we're going
7 in these technologies. So that'll be for about
8 an hour, and we'll take a little break, and
9 meet back in here at 3:15.
10 (Short break taken)
11 XXX: All right. If I could
12 ask you to take your seats please we'll get
13 started. All right, the room got quieter, but
14 nobody moved. Okay. I think the plan for the
15 next hour and a half, we would like to wrap up
16 by five is to hear from the QTR team members or
17 who was sitting at the various technical
18 break-out sessions, the brief reports from each
19 of them, and then some summary discussion of
20 what was heard from the morning break-outs, and
21 then go into group discussion for about
22 45-minutes or so. So I think we'll just let
23 the tech team reports run in sequence, and
24 Laurel's going to start.
25 XXX: All right. So I was in

1 the lightweighting and aerodynamics team --
2 table, and it was really a great discussion,
3 very well organized, well done everyone. So
4 I'll just go through some of the high points,
5 and then afterwards if there's anything that
6 you think I missed or want to re-emphasize,
7 please feel free to contribute. So one of the
8 first questions that -- that everyone posed was
9 whether Lazings (phonetic) was a place where
10 DOE could invest, where value could be found,
11 and some of what we heard was that it's not
12 really a technological challenge, it's more of
13 a regulation challenge, and so it's probably
14 not the best -- sorry -- it's probably not the
15 best place for DOE investment. One of the
16 places where people thought that there were
17 some needs, in terms of understanding, was in
18 safety, and there is a lot of uncertainty in
19 how a light, you know, a light vehicle and
20 heavy vehicle will differentially crush in an
21 accident. So getting more understanding there
22 seemed to be a place where DOE investment could
23 be increased. There were -- some people --
24 what I heard was that manufacturing was going
25 to be a big barrier in the future especially

1 with some of the composites. Molding times was
2 just way to long and so figuring out how to get
3 the manufacturing for composite materials much
4 faster and more reliable was definitely a need,
5 and that there would be domestic supply chain
6 issues with a lot of the composites, so for
7 example, one of the biggest failures people
8 said that DOE had missed opportunity was in
9 carbon fiber. That trying to help the carbon
10 fiber, and domestic supply chain really be
11 established. Another place where there seemed
12 to be some kind of unknown paths forward, or
13 some need for more information was with -- as
14 we've gone to more diverse materials and multi
15 materials, there are additional questions
16 related to corrosion, and so figuring out how
17 those things work together is a place where
18 more information is probably needed, and that
19 there were also opportunities for material
20 recycling as there's -- as we get to these --
21 as we've gone towards multi materials or multi
22 metals and higher value materials, the support
23 for material recycling has also decreased, and
24 that seemed to be some of -- somewhat of a
25 disconnect, and probably the recycling is

1 something that we should look at.

2 Another thing people talked about was

3 the opportunities of the interior of the

4 vehicles and different ways we can make

5 significant advances there, and there were some

6 suggestions to look at what airplanes have done

7 because they've done a lot -- made a lot of

8 advancements in lightweight materials for

9 interiors. One person tech (phonetic)

10 transferred there. The biggest DOE wins, it

11 seemed to be high-strength steel was a DOE win,

12 that we got out of high-strength steel which

13 motivated others to act, and then a bigger DOE

14 win was aluminum, and all the support that was

15 for aluminum in the past that's now being

16 synced for magnesium because there's hope that,

17 you know, we can have a similar win in

18 magnesium. And then -- so that was all on the

19 lightweighting side.

20 On the aerodynamics side, we didn't

21 get to spend a lot of time on it, but it was

22 agreed there was some -- there was no

23 agreement. We did not ask for agreement or

24 advice, but there was some -- I heard from some

25 people that there is still opportunity for

1 aerodynamics and light-duty vehicles and --
2 because as we've made huge efficiency gains in
3 all other areas of the vehicle, aerodynamics is
4 really eating up the most -- is where most of
5 the losses are, and one thing -- one way DOE
6 can contribute to that area is just with better
7 performance computing and CFD sort of models.
8 And that is what I heard, and again, if anybody
9 wants to add anything from my group please feel
10 free, but otherwise, I will have Gurpreet to
11 open combustion, or we can skip to batteries.
12 MR. SINGH: I'm not sure I can get it
13 on here. Okay. Sorry I couldn't get it on
14 here right now. Just to summarize our
15 discussion, we had good representation from all
16 sectors, academia, industry, light- and
17 heavy-duty and national labs in our discussion.
18 We started off by talking about the portfolio
19 for DOE, the engine program. There was talk of
20 all the, you know, different engine
21 architectures that basically our program
22 focuses on, reciprocating engines, conventional
23 four-stroke type engines, and we had some
24 discussion about looking at a two-stroke or
25 closed-piston or rotary or Hudson (phonetic)

1 engines and also the -- RP the representative
2 from RP, they're also considering even other
3 kinds of engines such as sterling and turbine
4 and so forth in their program. So there was
5 some discussion there, and also looking at the
6 aftertreatment system, there was comment that
7 we need to do more work on low temperature
8 catalyst. As the engines get more and more
9 efficient their exhaust temperature goes down
10 and it really inhibits the catalyst slide off
11 for -- typically, for light-duty vehicles in
12 this case. We had a discussion on cost
13 targets. We don't actually have cost targets
14 for the engine, and there were examples brought
15 about having targets and batteries in other
16 areas that you saw in presentations today. And
17 so we'll look at that and see if we can
18 establish cost targets. We did have cost
19 targets particularly in the light-duty area
20 under the FreedomCAR Partnership, and that was
21 like $30 a kilowatt for light-duty engines.
22 The discussion there also led to that
23 we have offered agreements with industry that
24 are cost shared, and industry should decide
25 which technologies they're going to use in the

1 system to make -- to have a competitive edge,
2 and to have proper payback, so perhaps cost
3 targets will be better left to industry in that
4 case, where we're focusing more on developing
5 pre-competitive technologies. Also, by a
6 discussion on the interaction of the fuels with
7 the engine and the aftertreatment, looking at
8 the whole system approach. In the heavy-duty
9 area, we do have a systems approach to a
10 vehicle level that mentioned earlier in the
11 SuperTruck program, but in our light-duty
12 program we have more of a component approach.
13 We don't have a vehicle system -- full vehicle
14 development kind of program, so there may be
15 some more effort in that area. As the engines
16 become more and more finely tuned and very
17 sensitive, fuel specs should also follow suit.
18 Changes in fuel spec can really disrupt the
19 engine operation, which also may require more
20 advanced sensors and control systems that we
21 thought we should look at more. Also, there
22 were comments about the mix of fuel types that
23 DOE has been focusing on in the past. We had
24 focused, and perhaps in the 90s, a lot on
25 gasoline, and then in the earlier part of the

1 last decade we focused a lot more on diesel for
2 light-duty. Heavy-duty was also focused on
3 diesel, and now over the past few years we
4 started increasing our emphasis on gasoline --
5 gasoline engines and that was -- that was a
6 favorable response from the group, and our mix
7 of fuel types that we're looking at. Also,
8 there was a lot of compliments as far as the
9 tools that have been developed in our program,
10 particularly the models that have come out from
11 the various labs, the CFD models, the CHEMKIN
12 type models that really help to advance engine
13 technology. If the group has anything else to
14 add. I can't think of anything else.
15 XXX was in the group, I don't know if
16 you have any comments.
17 XXX: No, that sounded quite
18 good.
19 XXX: Any questions?
20 XXX: There was no consensus
21 achieved.
22 XXX: Nor sought.
23 XXX: Nor sought, right.
24 XXX: So I'll give a quick
25 summary of the energy storage for

1 transportation group. So first we tried to map
2 the space. What are different pathways for
3 energy sources? I was actually surprised.
4 There was a reasonable amount of agreement not
5 consensus, so we talked about -- we kinda said,
6 okay, the space really consists of
7 ultracapacitors and batteries. We didn't get
8 into compressed air storage, flywheels anything
9 else, but we quickly kind of focused not
10 surprisingly on a few areas. We added a few
11 system level pathways, so managing -- it's a
12 thermal management and we added an area I
13 hadn't considered, computer-aided design by
14 various parts of energy storage. Within the
15 pathways I was expecting to be some
16 disagreement over which chemistries are
17 overrepresented, underrepresented as we think
18 about the competition of pathways. Really that
19 didn't come up. Generally, people are
20 comfortable that DOE's focus was in
21 lithium-ion, and that there was some post
22 ion -- post lithium-ion opportunities. Someone
23 said that air cathode is the Holy Grail but far
24 away. That there's some more opportunities
25 around magnesium chemistries. But most of the

1 discussion really focused on cross chemistry
2 approaches. So some things that came up.
3 There is a lot of interest in more modeling
4 ability that the DOE could provide, or in
5 general, modeling is seen as a opportunity to
6 advance this technology, so a particular amount
7 of failure modes, which are hard to know, given
8 the short experience we have for our
9 electrified vehicles, and that within modeling
10 there is a view that electrothermal modeling,
11 there's a lot of imperical data,
12 electrochemical modeling there wasn't a lot of
13 basis for that, and we needed to get better at
14 that.
15 If we break up the battery into the
16 value chain, there is a view about -- that
17 electrolytes have for a lot of opportunity to
18 improve both batteries and ultracapacitors, and
19 there is more we can do there. As an approach
20 to batteries, there's a view that the ideal
21 state, the ideal system is the cell, and we
22 should move towards the battery where there
23 really is an whole need for thermal management
24 or software to manage the cells into a pack,
25 that we could be more descriptive and less

1 prescriptive as a department. There was some
2 disagreement over -- over how descriptive we
3 were, but that was -- that was a suggestion.
4 We could identify parameters to achieve and
5 entrepreneurs and innovators could get there
6 using various innovations.
7 There is a view on manufacturing that
8 we often think of -- we often develop materials
9 and then manufacture them, that we should think
10 of manufacturing earlier in the process and do
11 R&D to manufacture, and then we could bring
12 back feedback loops from the manufacturing
13 process back into R&D. That we should better
14 document our failures, that they're a lot of
15 experiments that end up hitting brick walls,
16 and if we can somehow categorize them,
17 advertise them, that can actually help future
18 researchers not go down the wrong path. And
19 apparently battery R&D group thought there
20 was -- there was quite a bit of that happening.
21 There was a suggestion that the
22 vehicle and grid work broadly in the country,
23 but particularly, DOE integrate more. That
24 $300 a kilowatt hour batteries would be great
25 for the grid, but that wasn't explored enough

1 for enough of a focus on the smart grid side of
2 the world. That the modeling improvements that
3 were recommended for vehicles could apply to
4 grid batteries also. In addition, I'll
5 highlight two disagreements that came up, just
6 as food for thought. There was a disagreement
7 over how important our battery development --
8 how important fast charging is to our battery
9 development and broader electrification goals.
10 One side of the group thought fast charging was
11 critical that we would never have an acid
12 option without five-minute charging. Another
13 group said, it's really price, as long as we
14 can get -- as long as we can get the price
15 down, the charge time, level 2 charger is going
16 to be okay for at least through 2015 and
17 beyond. And then there was some disagreement
18 over the importance of battery reuse. One side
19 of the house thought we actually need to
20 understand what happened -- what the residual
21 value of the battery in order to underwrite
22 quick storage demonstrations, so that's
23 actually a very important piece, and that
24 battery reuse and better understanding of
25 battery degradation are critical to moving

1 forward, and there's another view that
2 technology is moving so quickly, it's just
3 better to focus on improving cost performance
4 and not worry about what happens later because
5 today's batteries won't be reused. So those
6 are the few points of disagreement. So
7 anything else from the group anyone wanted to
8 add from batteries?
9 XXX: I helped facilitate the
10 group that was basically the rest of EVs and
11 hybrids, except for the batteries and all the
12 capacitors and such. And so we didn't get as
13 much into the nitty-gritties of different
14 pathways or different technologies because it
15 was sort of -- it was the everything else
16 category, but mostly on power electronics, and
17 motors, you know, correctly identified in the
18 presentations as our main way of breaking down
19 the space.
20 So I guess a couple of points that
21 came out on, on roadmaps, the importance -- the
22 balance of vehicle is a space where a lot of
23 folks who were at the table played more of a
24 supplier type role rather than OEMs. It was
25 the folks who I heard from the most, and so

1 they felt like roadmaps would be driven more by
2 OEMs and their requirements than necessarily
3 some grand national roadmap.
4 The one thing that came up several
5 times was the potential and importance of
6 standardization for components. The potential
7 return for developing components that could be
8 applied more easily to a number of vehicles for
9 a number of OEMs, but also well-awareness of
10 not necessarily having the standardized
11 components be too big, but the entire -- an
12 entire standardized powertrain wasn't a
13 realistic scale for that kind of
14 standardization, also input that
15 standardization is particularly importance for
16 the medium heavy-duty sector where the numbers
17 are that much smaller and so the potential wins
18 from even a small amount of being able to work
19 at scale are significant.
20 Speaking of scale in terms of
21 barriers, that standardization really plays
22 into the question of benefits of -- the
23 benefits of being able to do things at scale.
24 That really came through in our discussion. In
25 term of particular areas where there had been

1 mentioned in the earlier presentation, but
2 which were brought up at our discussion
3 included on-board chargers, the important of
4 communication protocols, the potential barrier
5 from rare earths and how that plays into
6 electric motors and whether AC induction
7 electric motors or other -- other -- whether to
8 go invest more a in that technology or focus on
9 materials that might replace rare earths, or
10 instead to focus on development of domestic
11 rare earth resources, multiple, different kinds
12 of ways of tackling that barrier and, you know,
13 folks were expressing all the different points
14 of view. Also, folks talk a little bit about
15 transmissions and whether there's potential
16 benefits from integration of motors with the
17 transmission or a potential for a -- maybe a
18 win from a transmission tech team through the
19 USCAR umbrella.
20 Also, we cover a little bit more
21 generally about value adds from DOE.
22 Particularly there was a reasonable amount of
23 enthusiasm for workforce training EcoCAR type
24 programs to really help with workforce, but
25 that doesn't necessarily play directly into --

1 it plays into all the space here, but I figured
2 it was worth mentioning. Anybody in my group
3 want to bring up anything that I left out?
4 XXX: So my group was grid --
5 the grid infrastructure for electric vehicles,
6 and I guess, the really good news is that if I
7 compare my notes to what I heard as the report
8 from the batteries, nobody could ever accuse us
9 of driving towards consensus so. One thing I
10 heard repeatedly was that the grid can handle
11 the proposed EV deployment better than most
12 people think. The grid has accomplished this
13 in the past with other high-powered devices,
14 such as plasma TVs and other things that have
15 gone out in the marketplace of late, and this
16 can be -- EVs can be accommodated with the
17 current system.
18 However, trying to make electric
19 vehicles look like conventional vehicles is a
20 pretty big mistake because the impacts on the
21 grid are directly related to the charging
22 profile, and if we -- if we take the
23 10-megawatt plus gasoline pump and try and
24 provide the equivalent charger for every -- for
25 every point station, that will be problematic

1 for the system. So I think it's -- the
2 perspective that I heard repeatedly is directly
3 in contradiction to that of the battery group
4 in that fast charging, and the rush to do that
5 could be detrimental to the system rather than
6 beneficial. Standardization communications and
7 information protocols is necessary, but it is
8 critical to get these standards right. It was
9 noted by several that unprecise or poor
10 standards can be a barrier, in as much as good
11 standards can be an enabler. Another thing
12 that I heard is that data is absolutely
13 critical, so not only we need information on
14 where the vehicles are going, but we also need
15 information on how they are used, and the
16 behavioral relationship with the grid is far
17 more complex than some might describe. For
18 instance, one member of the group mentioned
19 that their analysis indicates a three to four
20 times impact of fast chargers on a Friday
21 afternoon compared to a Tuesday afternoon. And
22 that is all about behavioral impacts and how
23 these -- how these devices will be used.
24 So there were a few disagreements of
25 course, and there were two stories on the

1 market definition. There were some within the
2 group who advocated for an expansion of -- of
3 the definition of home within home charging.
4 Right now it's often discussed as a
5 single-dwelling units, and some within the
6 group were advocating that multi-dwelling units
7 be addressed seriously. Of course, a
8 representative from LEM in the group also said,
9 well, we're happy to have only 60 percent of
10 the U.S. population as a potential market for
11 early EVs, so the definition of home as single
12 versus multi-dwelling units is, I guess, a
13 point of debate at this time. So workforce
14 capability, there were differing -- differing
15 emphasis placed on workforce in different parts
16 of the country. Some individuals said they
17 don't have enough electricians and enough
18 capability of installing some of these
19 infrastructures, these charging stations, while
20 other -- while people from other different
21 regions in the country said that their region
22 seems to have solved that problem, and so the
23 importance of the criticality of that issue is
24 in genders of a diverse set of opinions and
25 perspectives.

1 And -- so there was also disagreement
2 on the value of in-home versus public charging
3 stations, and I don't know that I need to get
4 into it any more that, other than most people
5 were asking for data about the implications and
6 usage and impacts of the two types of chargers.
7 And finally, it should be noted that I
8 heard that stationary wireless charging
9 represents a long-term consumer value
10 proposition. I don't think anybody was talking
11 about it in terms of an immediate impact, but
12 several people individually mentioned that as
13 kind of the next great app so.
14 XXX: I am doing multiple
15 readouts. I'm still trying to get to the right
16 one. I had, for the technology group, I had
17 the fuel cell infrastructure group. And so
18 just trying to give a quick summary of what was
19 said or where the opinions were clearly on
20 taxonomy question. The group voiced the loud
21 opinion that hydrogen was left out of the
22 framing document, and that that was a
23 significant oversight. When it came to
24 obviously the Department correctly assessing
25 the technical potential for the pathway, we had

1 not done that correctly for hydrogen or for the
2 fuel cells. With respect to the roadmap,
3 where -- are we appropriately setting, you
4 know, the milestones either near term or
5 further out and how are these differing without
6 DOE's support. I think the comment was that
7 the Department in the hydrogen arena has pulled
8 out before we've gotten the job done with --
9 with respective to this pathway, hydrogen and
10 fuel cells and infrastructure for hydrogen.
11 The argument in -- one of the arguments in
12 favor of continued DOE engagement was that the
13 signal that the Department and the government
14 sends by pulling out of something that it has
15 been in is highly detrimental to investments by
16 the private sector, and puts those investments
17 potentially at risk. The barriers to
18 development in this arena, again, inconsistency
19 of effort by the government, the -- there is a
20 observation that we had underinvested in the
21 infrastructure side of the question, and that
22 when -- in earlier initiatives the emphasis was
23 on the onboard component of it, and that we
24 sort of -- we and industry partners had made
25 significant progress, had met multiple

1 milestones, but that given that the
2 infrastructure side of it wasn't tackled
3 concurrently, that that has put the effort to
4 date at risk. In terms of opportunities that
5 we had not looked at in this arena that there
6 are (indiscernible) applications in the
7 transportation sector with respect to auxillary
8 power or small -- small, industrial vehicles,
9 such as yard dogs or forklifts where fuel
10 cells, hydrogen could be significant in helping
11 manage the energy budget of vehicles and making
12 or significantly improving efficiency overall
13 or reducing local pollutants that arise from
14 running standard engines, conventional engines
15 during low power phases at low efficiency.
16 We also seem to be under-valuing
17 technologies that have potential for dual
18 benefits, so we had started the hydrogen fuel
19 initiative and the hydrogen program with the
20 idea of vehicle application, but that the
21 Department isn't doing a particularly good job
22 where hydrogen could be used in the renewable
23 storage application. And so if there was --
24 and did I, for the people in my group, did I
25 leave out anything significant there or not?

1 Okay.

2 Then I am going to plunge right ahead

3 into the report-backs -- a consolidated

4 report-back from the morning breakout sessions.

5 So I'll just do it for everyone and I'll try

6 to -- I'll try to put every -- all the input

7 I've got from everybody else into some -- some

8 orderly readout.

9 XXX: While you're doing that,

10 will you take a question?

11 XXX: Yeah, certainly.

12 XXX: And this is to the authors

13 of the initial draft report and relative to the

14 last topic. The total omission of fuel cell

15 neither supporting neutral or damning, was

16 either implicit, it was assumed an

17 electrification and explicit looking for

18 reaction. There must have been some logic to

19 no mention of it, so I'm just curious what

20 was -- what did the authors have mind for the

21 draft?

22 XXX: I think what the authors

23 have in mind -- had in mind -- we had in mind

24 was to rod community response. I would note

25 that the word "hydrogen" maybe isn't in the

1 report at all, the word "fusion" is not in the
2 report at all
3 XXX: I had noticed that, too.
4 XXX: There are several other
5 words that are missing and, you know, we've
6 been hearing from those communities, and that's
7 great, and that's part of the ongoing
8 refinement generation of this.
9 XXX: Thank you.
10 XXX: Which is actually a good
11 segue into the morning discussion which was
12 sort of focused on what are the broad portfolio
13 principles, how should we think about this, you
14 know, across the spectrum. Some of the various
15 portfolio principles that people did mention,
16 and these are as much for inclusion as they are
17 for how we do the bXXXcing once something is
18 in. There was an articulation of one principle
19 values, is allowing the technologies equal
20 opportunity to succeed. That is, in some
21 sense, an equity, how we should -- we should
22 provide everybody the opportunity.
23 Others -- other principles that we
24 should use, we should look to maximum private
25 sector leverage that for -- something that

1 induces $1 of private sector investment is less
2 attractive than one that induces $4 is less
3 attractive than one that induces $10 of private
4 sector leverage, and one of the reasons that
5 that was stated was that that is a clear signal
6 of technology poll. That is where people can
7 make the most use of the government's
8 investments, and it had -- it's the place where
9 there is the greatest motion and change. DOE,
10 another competing or alternatively frank
11 principle is that DOE should use its R&D
12 portfolio to be an advocate for changing other
13 agencies' behavior. So the agencies that have
14 regulatory authority, that we should seek to be
15 a -- provide independent technology assessments
16 that allow them the maximum flexibility to
17 change a rule or regulation.
18 Conversely, people -- one of the
19 observations was that DOE is perceived as
20 betting on everything, yet the government is
21 not trusted to decide which technologies are
22 worth pursuing because the government isn't
23 trusted to decide which technologies are worth
24 pursuing. There was an observation that there
25 is significant confusion between societal goals

1 that administrations state or promulgate or
2 that are included in the statute. There is
3 great confusion between those and the R&D
4 strategy on the part of the Department to
5 attain those or whether R&D strategy is
6 sufficient to obtain those.
7 There was little, again, little
8 clarity on the discussion on whether -- how we
9 should think our way through this issue of
10 technology diversification in our portfolio,
11 and this attainment of sociable goals. Then
12 there was multiple occurrences of people
13 stating that as a technology got closer to
14 commercialization that DOE's role would
15 naturally get smaller, but there were no clear
16 statements as to how that role got smaller or
17 how DOE should exit or terminate support in
18 terms of performance, evaluating the
19 performance of the ongoing portfolios.
20 We had -- well, there was the
21 observation that DOE didn't have clearer rules
22 as to how it should make any of those
23 measurements either for portfolio interests or
24 portfolio performance. We, not unsurprisingly,
25 got the completely opposite opinions that DOE

1 shouldn't include cost or dates certain in
2 their targets, that we should express our
3 targets purely in terms of performance,
4 technical performance, and then people gave us
5 the exact opposite opinion, and not
6 surprisingly.
7 In terms of where DOE brought value to
8 the table, that it was in terms of driving
9 technologies down the cost curve and taking
10 something from a notional technology to
11 something close to -- close to market and ready
12 for adoption. The other DOE value was in terms
13 of convening power that we have. That we can
14 use our R&D dollars as almost glue funds for --
15 to coordinate the actions of independent
16 actors, to achieve sociable goals, that that is
17 something that people believe we can do, and
18 that may be our biggest benefit. That we can
19 be seen as a trusted source for technology
20 roadmaps, for technology assessments, and that
21 DOE should own the roadmap, but at the same
22 time -- let me -- where did it go the comment
23 go -- that even though we might fancy ourselves
24 honest brokers, we either -- that we don't know
25 enough to do that job, that we can be too

1 influenced by politics in doing that, and so
2 clearly not exactly far from unanimity on that.
3 Other areas where DOE had a
4 positive -- had a potential role is in consumer
5 education. That simple descriptions of what's
6 available in various technology options. How
7 one -- how consumers could think through that
8 would be an area of utility that we can also
9 have a role in policymaker education,
10 consistent messages in terms of technology
11 status capabilities. That if we do a better
12 job with that that can reduce rapid swings in
13 technologies. That we can moderate industry,
14 interim industry discussions as sort of
15 convening power.
16 When it comes to -- there was an
17 observation that DOE doesn't necessarily
18 understand industry business cases particularly
19 well, and that sometimes businesses are not
20 particularly willing to share with us their
21 information for a wide ray of legitimate
22 reasons, but someone did mention that despite
23 that fact, that we are much better now than we
24 were, say in the 1970s or 1980s. So that's
25 encouraging. Let's see, I think that's

1 probably a good place to sum up or stop.

2 XXX: Good. So having had

3 those summary assessments from the tech teams

4 and the principles discussion, I certainly have

5 some things I'd like to say, but I'd like to

6 reserve those until I hear from you-all, so I'm

7 just going to through the floor open for

8 reactions to what you've heard in the

9 summaries, additions and so on. Let's start

10 over here and then we'll go to the back.

11 XXX: Just one correction on the

12 infrastructure group, the limitation was

13 identified as being inspectors, not contractors

14 on the local level. The local cities are hard

15 pressed to come up with additional inspectors

16 to carry out the additional number of EV

17 installations at residences, giving that the

18 economy is coming back and their normal

19 workload is increasing now as well.

20 XXX: Okay. Although, with

21 unemployment remaining, how do you think that

22 we can train up inspectors?

23 XXX: We're presently doing some

24 work, we've done work with General Motors and

25 doing training of inspectors already, so we're

1 doing an outreach program working with the OEMs
2 to approach them. Their challenge is having
3 enough manpower to actually show up in people's
4 garages and do those final inspections.
5 XXX: Okay. Great. Go ahead.
6 XXX: I want to thank you for
7 putting this on today and inviting us to this
8 inaugural QTR process for the DOE. From a
9 process perspective, I wonder how relevant is
10 it as we ask each other how best to work
11 together, how to prioritize our investments,
12 how to down select, how relevant is
13 benchmarking like organizations in other
14 countries? How is this done in China? How is
15 this done in Germany for example? And how
16 might that be relevant to our own process and
17 our own roadmaps? Just an open question for
18 the group.
19 XXX: You know, there are, of
20 course, great cultural boundary conditions,
21 differences across other countries. We do talk
22 with them of course, I mean, we're in energy
23 research partnership with China in various
24 forms, which is revealing interesting
25 differences and approaches. We have had some

1 discussion with the European Union and the U.K.
2 about how they are approaching things. We
3 are -- carry both the advantage and the burden
4 of the way in which we think about the
5 government private sector relationships, and, I
6 think, opposes certain boundary conditions on
7 how we can think about how the DOE does its
8 job, which is different than France for example
9 or China. I -- you know, some discussion about
10 what the potential is for various technologies,
11 that's going on already of course, I mean, that
12 happens at international conferences, different
13 people are betting on different technologies, I
14 mean, you don't see much discussion in the U.S.
15 of molten salt reactors even though it's a
16 technology we invented, but the Chinese are
17 gung ho on that right now. Let's see, what
18 else. Accelerated driven subcritical systems
19 for nuclear fast neutrons, China, India moving
20 full speed ahead because our thulium resources.
21 The U.S. not betting very much on that at the
22 moment.
23 On the other hand, we're placing big
24 bets on other things. We do more cellulosic
25 ethanol research than anybody else in the

1 world. So, you know, it could've been like the
2 private sector, you put your money down where
3 you think the biggest impact is going to be.
4 But we need to be conscious of the fact that it
5 is a international technology world certainly.
6 XXX: So this is a pretty minor
7 point on aerodynamics, there is work going on
8 out there on active aerodynamic aids, things
9 like shutters for the front grille using
10 compressed air to smooth the airflow over the
11 vehicle, and these have fair amount of promise
12 and headache that's something that DOE should
13 at least spend a little money on.
14 XXX: That's interesting. I've
15 not heard those. When you say that, you say,
16 yeah, of course, sounds interesting.
17 Other comments about what you've heard
18 today. So let me give you a couple of
19 reactions and more thoughts, particular in this
20 sector, the vehicles. One of the things that
21 came through loud this morning is a plea for
22 diversity and the bouquet with, you know, not
23 quite the thousand flowers, and, you know, as a
24 technologist, that's great. All right, I
25 understand that. On the other hand, the

1 government does have to invest in something,
2 and to do it with some amount of judgment, and
3 more broadly, you know, we've had the oil
4 problem so to speak for 30 years. I don't know
5 if somebody mentioned today, but yesterday we
6 mentioned Nixon in '74, right? Says, we're not
7 going to rely on any other country for our
8 imported oil within the end of decade, and of
9 course, he was wrong. No foreign energy, he
10 said by the end of -- by 1980. And we've got
11 the greenhouse gas problem along with
12 infrastructure and so on, and so there is a
13 sense, you know, we need to get on with it
14 somehow, and that is in contradistinction or
15 contrast with the bouquet, I think. And I'm
16 just trying to reconcile that tension in my own
17 mind. Even if somebody could give me a good
18 answer and they been here this morning, how do
19 we down select. How do you decide in the
20 notion that we're going to have, let's see,
21 gasoline -- let's just do our LVVs, gasoline,
22 ethanol, natural gas, the grid and hydrogen all
23 coexisting as five separate infrastructures
24 seems to me perhaps a bit optimistic. There's
25 probably going to have to be some down

1 selection. How do we do that. The government
2 is neutral in that. Maybe that's the right
3 posture. But then the government should be
4 entirely neutral and we shouldn't fund any of
5 this. So I, you know, thoughts as to how we
6 reconcile that would be and interesting topic
7 to start the discussion. So either I was
8 incoherent or this is a really hard problem.
9 XXX: I'm not sure that the
10 problem is quite as bad as you present it. For
11 example, I think the future is extremely likely
12 for biofuels. The future is extremely likely
13 to be biofuels that are compatible with the
14 existing fuels, so ethanol, yeah, you can blend
15 it up to a certain level, but if you want to go
16 to higher levels, you're going to have to go
17 through a different process and make it a
18 consistent fuel. And it comes to electricity,
19 hydrogen, natural gas, natural gas is a bit of
20 a wild card.
21 There is some potential to turn
22 natural gas into liquid fuels, perhaps that's a
23 future, you could have it stand alone. I don't
24 think there's -- much likely that you could
25 have hydrogen, natural gas and electricity

1 succeed. If you had -- especially hydrogen, if
2 you have hydrogen succeed, I don't see how
3 natural gas vehicles are going to survive in
4 the marketplace. Hopefully, you're down to
5 just three, and electricity is -- may well
6 serve primarily home refueling, primarily city
7 cars, hydrogen perhaps, long-distance vehicles
8 might be on different timeframes, but the other
9 good news he has is, you don't have to make
10 that down selection now. I really think that
11 it's going to become a lot more obvious over
12 time.
13 XXX: Yes. But because some of
14 these you're getting to the point where
15 significant investment in infrastructure is
16 starting to be asked for and so you'll have to
17 start making choices if funds are limited.
18 XXX: Yeah. Absolutely, but if
19 you can start with clustering where you have
20 small areas, then I don't think that's a major
21 problem yet. The only problem you're going to
22 have is if you've got a situation where you
23 have two different things coming up about the
24 same time and they actually are both taking off
25 of their local clusters. That's when you run

1 into problems.

2 XXX: So I don't do Minneapolis

3 and St. Paul on different system.

4 XXX: XXX, you have to

5 sympathize with this hard decision, but I have

6 to agree with the previous -- with John

7 about -- that we don't necessarily need to make

8 a hard choice now, and especially since each of

9 these fuels will probably find an engine

10 specific market early on, certainly for

11 aviation and shipping. We don't really see an

12 electrified solution being really feasible in

13 those markets, and a lot of the -- and what

14 we're seeing now today is a lot of these

15 companies targeting aviation for renewable

16 fuels. I'm hoping that DOE can help sort out

17 some of the infrastructure on the fuel inside,

18 in terms of the renewable fuels by looking at

19 things -- you know, looking at alternatives

20 like drop-in replacement, you know, with

21 diesels that might get around some of these

22 infrastructure issues and trying to work

23 through sort of a strategic look at fueling

24 infrastructure. I think we have a lot of

25 policies focused at production and we have the

1 RFS, we have the lower-carbon fuel standards in
2 California being developed in northeast states,
3 but we don't necessarily have a great
4 over-arching strategy for fueling
5 infrastructure for alternative fuels. I do
6 think that with environmental constraints,
7 considerations, that that may be one of the
8 factors that helps DOE down select in terms of
9 what it looks at longer term, and at, you know,
10 natural gas potentially a (indiscernible) fuel,
11 perhaps a good longer term solution for
12 heavy-duty, but certainly, in the light-duty
13 vehicle sector we're not necessarily seeing a
14 huge, huge role for natural gas. Although, you
15 could have some types of, you know, landfill
16 natural gas and other clean sources of natural
17 gas. So those are just a couple of thoughts.
18 XXX: You know, as a company that
19 probably has more at risk than the U.S.
20 government in terms of its survival in making
21 this bet, and I think you'll find most of the
22 OEMs, in that condition. I think the question
23 comes how do we collectively down select when
24 we do not have an over-arching policy, or in
25 fact, even the data on the table that says,

1 here is my goal to accomplish. You can -- you
2 mentioned this morning we have the metros,
3 right? But that metric doesn't say in their
4 cost -- it -- you have a necessary but
5 insufficient set of metrics, and no master
6 model to identify which options given potential
7 cost and availability can solve the problem,
8 which is where -- you know, and it's intriguing
9 to me that in the morning breakouts we heard
10 the schizophrenic audience here -- well, I
11 shouldn't say schizophrenic, but polar opposite
12 inputs to whether the Department of Energy is a
13 right or wrong agency to build that model that
14 policymakers could then make an intelligent
15 decision off of. What I would ask the crowd
16 is, for those of you that said the Department
17 of Energy is not the right agency to build the
18 model then who do you suggest is? But until we
19 have that, how do you or any of us make that
20 down select and perhaps be wrong because of
21 absence of the right data and betting on
22 Washington producing a policy consistent with
23 the data. Until that happens, we're in a
24 catch-22.
25 XXX: I would like to hear

1 reactions. I raise one other possibility, and
2 that, are the various down select options, the
3 differences among them are not significant
4 enough or not easy enough to know right now and
5 so you might as well just pick one, and it will
6 be good enough.
7 XXX: And have a policy --
8 XXX: And have a policy to move
9 to that direction, right. You know, France and
10 nuclear power is a good example, and '70s,
11 Brazil ethanol, another example is, the
12 government just said we're going to do that,
13 and yeah, there are downsides to having done
14 those particular choices, but they did it
15 anyway and in the end maybe it's not so bad.
16 XXX: If that was the case, the
17 automotive industry was able to adapt a
18 consistent --
19 XXX: That's right.
20 XXX: -- policy.
21 XXX: So consistency may be
22 important then, the details of what the policy
23 is wanting. So I find those are two
24 provocative sets of comments. Anyone feel
25 provoked?

1 XXX: You wore us out.

2 XXX: Yeah. It's the end of

3 the day.

4 XXX: So I agree with that and I

5 have two kind of additions to this. I think

6 we've heard that before. we really need to move

7 forward with this consistent energy policy

8 somehow, and while I really appreciate what DOE

9 is doing, the intent of the biggest working

10 group meeting was really to have all the

11 government agencies coordinate with this. We

12 are pretty much like to bailout, but if we

13 cannot get them to work together, let's charge

14 DOE to get going with it, and I think sooner

15 rather than later we need to have this agency

16 corroboration, otherwise, we'll miss the boat

17 in respect to some of the other countries, and

18 you know, clearly, different countries think

19 differently because they're in the co-position

20 of political make-up. You know, up in

21 Washington a great deal of politicians are

22 lawyers, in China a great deal of the

23 politicians are engineers, in Israel a great

24 deal of the politicians come from the military,

25 so it's clear that the different companies

1 think differently about it. We need to think
2 what's the best for us, but at the same time we
3 need to be moving.
4 The other thing is about the down
5 selection, I think, if I look at energy needs
6 in the world in the next 30 or more years,
7 we're going to need everything we have, so the
8 different energy sources sometimes get used
9 more efficiently with different types of
10 (indiscernible) and storage systems and so on.
11 So perhaps that that's saying, okay,
12 let's just pick one winner because, you know,
13 we're going to have to deal with all of it, and
14 how do we most effectively as a community, how
15 do we actually deal with who should be focusing
16 on which one of the pathways. So again, just
17 to be provocative, should the University
18 National Lab look at the batteries because it's
19 further out while industry is maybe focusing a
20 bit more on advanced combustion and controls.
21 You know, I'm not saying I have the answer for
22 that, but it seems that everybody in the
23 community is doing everything, and perhaps not
24 most effectively, so that's another issue I
25 see.

1 XXX: In terms of energy
2 sources my remark would be, well, we need all
3 the sources we can get, well, fair enough, but
4 you still have to decide how you use them. And
5 let me take the case of natural gas, 23 quads
6 last year, if I want to use gas in transport,
7 I've got at least three options, right? I can
8 burn it directly in an ICE, I can turn it into
9 electricity, I can reform it into hydrogen --
10 four actually, I can turn it into FT liquids,
11 right -- or something else? And in the end, in
12 some ways that's the real problem and choice,
13 is how do we adapt the infrastructure and the
14 vehicles in the end to deal with one or the
15 other of those choices or all of them.
16 XXX: Sorry to be back up here,
17 but I have to disagree with that one. I
18 actually think that you're just throwing dice
19 if you try make a down select now. I mean,
20 XXX talked earlier about how his own company
21 is working on all these things. They don't
22 know what's going to work in he long run, and
23 if industry doesn't know, I don't see how DOE
24 can possibly know. So what you need is to set
25 up a process by which you know when to make the

1 download. You can't know now, you need set up
2 this process, and even your examples, XXXn,
3 about France with nuclear power, that was a
4 high level government decision. That would be
5 like congress establishing a law saying this is
6 what we're going to do. DOE does not have the
7 power to do that.
8 XXX: Right. Yes, and perhaps
9 thank God for that, but --
10 XXX: And so if DOE makes down
11 select now, your odds are very high, you're
12 going to be wrong.
13 XXX: You know, DOE cannot do
14 that, okay, because in the end, that's a broad
15 societal issue. It's about economics, business
16 and policy and so on. We could recommend, but
17 probably as you say, there are a lot of
18 technology things we don't know right now, so
19 let's back up and see if we can talk about an
20 approach to the problem. What does a down
21 select mechanism look like? What are the
22 milestones, off-ramps, times when you decide
23 we're going to push hard on that one and not on
24 the one, and who gets to do that. All right.
25 DOE can do that for technology funding to a

1 limited extent, and that's what we're doing,
2 but the broader policy decisions that will
3 ultimately drive those choices as they get
4 deployed are not in the hands of DOE. I'm hot
5 sure whose hands they're in, frankly, in the
6 government.
7 XXX: Well, you've defined that
8 challenge of technologies in the energy field,
9 which is they can't be separated from policy,
10 unlike Google for example, which even still has
11 run into policy.
12 XXX: Internet --
13 XXX: The internet, yeah.
14 XXX: Privacy.
15 XXX: The issue of DOE building a
16 model of the future, I think is not a
17 functional direction for the conversation. I
18 think that what we need to do to formulate
19 policy is have the policy describe the outcome
20 that we want, and let the DOE model how the
21 different technologies can achieve that
22 outcome. If for example, the outcome we want
23 to have as a nation is, use less oil, emit less
24 carbon, then we need to define the metrics of
25 the vehicle that achieve that, and say, this

1 vehicles must use X amount of oil per mile and
2 emit X amount of carbon per mile. And once
3 those parameters are put into policy,
4 hopefully, with a foreseeable ratchet going
5 down to zero so everyone's got visibility into
6 the future, then the technologist can go to
7 work, and then the DOE can go to work ranking
8 those technologies, modeling those
9 technologies, and then you've got tools to down
10 select.
11 XXX: So broad policy goals,
12 technology neutral, consistency and do we, the
13 DOE, then fund any of those technologies or
14 with that kind of predictability consistency,
15 the private sector will be able to take care of
16 almost all of it?
17 XXX: That's a good question. I
18 think this country still needs help getting
19 fundamental innovation done, the market still
20 is a little broken.
21 XXX: I think that DOE has on
22 the basic science side a number of
23 capabilities, you know, the big facilities,
24 materials, expertise, simulation and so on.
25 But the private sector by and large has

1 difficulty maintaining, developing, and you
2 know -- so that's a different sort of stance.
3 XXX?
4 XXX: Let's continue the debate if
5 you want to stand. Let me offer why there is
6 some urgency right now. We are on every
7 option, whether it's the infrastructure side or
8 the vehicle side, ready to move out of the lab
9 into first generation deployment. We are now
10 all running the -- we're all capital constrain,
11 and that is the limitation when you move out
12 lab. As a company, we are facing the world of
13 a, not only stranding capital but just having
14 enough capital to launch every vehicle type,
15 and again, the chicken-egg syndrome with
16 launching a vehicle type without an
17 infrastructure is problematic. So the issue
18 becomes -- the point I made this morning, we're
19 in ten years probably before we begin to
20 understand the consumer poll on this, and
21 that's going to be important as much as it's
22 influenced by policy, but the experiment that
23 needs to occur needs coordination between
24 several different industries. And in the lack
25 of over-arching policy and national agenda,

1 nevermind the fact that we have to do
2 experiments around the world, we don't have the
3 capital to do it alone, and remember GEN 1
4 technologies tend to lose money, and so at
5 least we need a coordinated public private
6 partnership to allow this decade of
7 experimentation to occur. Left ad hoc, we will
8 have some options not explored, and what
9 happens if that's the right options.
10 XXX: And that I will agree with.
11 XXX: Okay. So let me raise
12 another dimension that are prompted by what you
13 just said. We are, of course, not the only --
14 we the U.S. are not the only market in the
15 world, and it could be that the technology test
16 will be set by other countries because they've
17 got bigger markets, a willingness to be a
18 little more definitive and make choices whether
19 the best ones or not. And I could imagine that
20 in the end, the U.S. becomes a relatively small
21 prior on a much bigger global market which has
22 been setting the technology standards, and so
23 we've advocated basically by our dollar.
24 XXX: Or drive to a -- Japan will
25 try this one, U.S. will try this one.

1 XXX: Yeah, right.

2 XXX: Divide and conquer.

3 XXX: Anybody else? Okay.

4 This has been good. This is the second one of

5 these that we've done. We did, as I mentioned,

6 alternative fuels in Chicago last week. This

7 has had a very different flavor to it. I think

8 we've fleshed out some new ideas. One of the

9 great disconnects in the energy business, at

10 which there are a number of the fuels,

11 infrastructure, vehicle, tension, and we saw

12 some of that today, and we saw some of it last

13 week also, and we will try somehow to pull all

14 of that together in the process.

15 I thank you for you engagement. I

16 know everybody's busy, but I think this is

17 important, and as we go through it, more and

18 more people seem to think it's important to

19 kind of get these framing questions about what

20 the DOE is about anyway, and what are our

21 national energy goals, and what role does

22 technology and so on. This will be an ongoing

23 conversation. We will forward to your further

24 input as the document gets put together and

25 starts to be circulated, and do I have to say

1 anything else beyond thank you.

2 XXX, XXX?

3 (Whereupon this meeting was concluded.)

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

1 C E R T I F I C A T E

2 STATE OF TENNESSEE:

3 COUNTY OF MEIGS:

4 I, Alisha J. Armour, Licensed Court

5 Reporter for the State of Tennessee, do hereby certify

6 that I reported in machine shorthand the foregoing

7 proceedings; that the foregoing pages, numbered 1 to

8 161, inclusive, were typed by me using computer-aided

9 transcription and constitute a true and accurate record

10 of said proceedings.

11 I further certify that I am not an

12 attorney or counsel of any attorney or counsel

13 connected with the action, nor financially interested

14 in the action.

15

16

17

18

19 _____

20 Alisha J. Armour

21 Tennessee Licensed Court Reporter

22 TLCR # 325

23

24

25