

2006 Hoyt C. Hottel Lecture

MIT Chemical Engineering Department

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**The Honorable Samuel W. Bodman, U.S. Secretary of Energy,
Speaker**

TRANSCRIPT:

BOB ARMSTRONG: Good afternoon. My name is Bob Armstrong. I've the department head in chemical engineering. And it's my great pleasure to welcome you to the 2006 Hoyt Hottel Lectureship in Chemical Engineering.

This year the lectureship is co-sponsored between chemical engineering and the energy research council as part of the symposium series highlighting energy. Before I formally introduce the speaker, I'd like to say just a few words about Hoyt Hottel after whom we named this lectureship.

Hoyt came to MIT in 1922 at the age of 19 having just received his bachelors degree in chemistry from Indiana University. He got his masters in chemical engineering in 1924 and then went through a series of positions at MIT, associate director of the practice school of chemical engineering, and assistant professor of fuels and gas engineering, professor of fuels engineering, and ultimately the first

Carbon P. Dubbs professor of chemical engineering, a position that he held until his retirement in 1968.

I came to MIT five years after he retired and had the pleasure to know Hoyt really well, and came of the impression that Hoyt did everything extraordinarily well, except perhaps do retirement.

From the dates I've given, you may have noticed that-- I should say Hoyt was an emeritus professor until '98 when he died. So he was an important figure in the department and at MIT for some 75 years. It's a hard record to match these days.

He was professionally known as a leading authority on combustion and radiative transfer, doing pioneering research in large industrial furnaces, doing some of the basic science and engineering on those systems. He published a large number of papers over his 70-year span, published a number of books, graduated some 88 Ph.D. and SCD students as well as 58 MS and 59 BS students.

He's won many awards – the U.S. Medal for Merit, the Kings Medal For Service in the Cause of Freedom from Great Britain. He was a member of the National Academy of Sciences, a member of the National Academy of Engineering, and numerous other awards. Hoyt had a tremendous impact in chemical engineering as well as on engineering broadly.

I'd like now to introduce this year's distinguished Hottel lecturer, the Honorable Samuel Bodman. As a leader of the Department of Energy and a long-time friend and supporter of MIT, I can't think of a more appropriate or distinguished person to give this lecture.

Dr. Bodman became the 11th Secretary of Energy upon a unanimous confirmation by the U.S. Senate on February 1st of 2005. He leads the Department of Energy with a budget in excess of 23 billion dollars and over 100,000 Federal and contract employees.

Previously Secretary Bodman served as Deputy Secretary of Treasury, beginning in February 2004. He also served the Bush Administration as Deputy Secretary of the Department of Commerce beginning in 2001. A financier and executive by trade with three decades of experience in the private sector, Secretary Bodman is well suited to manage the day-to-day operations of both of these Cabinet agencies.

He received the BS in chemical engineering from Cornell University in '61. And in 1965, he completed his SCD at MIT. And then for the next six years, he served as director of MIT's school of chemical engineering practice, and also as an associate professor of chemical engineering at MIT.

He began his work in the financial sector as technical director of the American Research and Development Corporation, a pioneer venture capital firm. He and his colleagues provided financial and minute managerial support to scores of new business enterprises located throughout The United States.

From there, Secretary Bodman went to Fidelity Venture Associates, a division of Fidelity Investments. And in '83, he was named president and chief operating officer of Fidelity Investments and a director of Fidelity group of mutual funds.

In 1987 he joined Cabot Corporation, a Boston-based Fortune 300 company with global activities in specialty chemicals and materials where he served as chairman, CEO and a director.

Over the years, he's been a director of many other publicly owned corporations. Secretary Bodman has also been active in public service. He's former chair of the Chemical Engineering Visiting Committee at MIT and a former member of MIT's commission on education.

He also served as a member of the executive and investment committees of MIT, a member of the American Academy of Arts and Sciences, and is a trustee of the Isabella Stewart Gardner Museum and the New England Aquarium.

This afternoon Dr. Bodman will speak on our energy future, why American science and engineering must lead the way.

[applause]

SAMUEL BODMAN: Bob, thank you for that very lengthy introduction. The audience now knows more about me than they need to. I'm very pleased to be here. We did have a very productive meeting with the energy research council earlier today. I do commend Dr. Armstrong, along with Professor Muniz(?) and my long-standing friend, John Deutsch, as well as the other colleagues on the RC for the important work that they're doing to examine just how MIT can further expand and reorganize and emphasize its already sizeable energy research portfolio.

I also want to congratulate if I may, the Institute for its selection into the Solar Decathlon competition. Now this is something near to my heart. This is the best thing that the Department of Energy does, I believe. We stimulate interest in solar energy and around the college campuses of the country, and encourage them to-- universities that have both architecture and engineering schools to develop the design for a house, to build it on the campus. And then they bring it to Washington and construct it on the Mall.

We're limited to 20 facilities. We've had it twice before. This will be the third one, upcoming. MIT never entered. I was able to encourage my friend Dr. Vest when he was here. So I assume that had something to do this. But I'm very pleased that we'll see MIT participating in this event.

I'm very honored and quite pleased to have so many of you here. I don't get back to Cambridge as often as I would like. I came here as a student 45 years ago and stayed for 40 years. I never left town. Whenever I do get here, I'm always filled with pride and have very warm memories when I do walk these halls.

For me, MIT is not just the place where I received my education and where I started my career. It is also the place where my first wife Betsy and I started our life together and started our family.

As I have continued on in my life, I have always hung on to what this great institution taught me, not just about chemical engineering, not just about problem solving, but also about how to be in the world. And as Energy Secretary, my pride is even more pronounced given the Institute's long and very distinguished record as a leader in energy research.

MIT's pioneering research in nuclear science and engineering, in fuel production, in seismic exploration methods, in superconducting

materials, in climate science, in alternative vehicles, just to name a few, have over many years allowed our nation to turn energy challenges into opportunities.

And to be sure, Hoyt Hottel was the man, who for decades directed a good deal of this research. I had the pleasure of knowing and working alongside if I may say, Professor Hottel during my years here on the faculty. Of course I recall vividly his groundbreaking work in combustion, in industrial furnace design, solar energy research. But his great interest was particularly in his students. He had a reputation as an absolute perfectionist in his work.

What Bob didn't tell you in his introductory remarks about Hoyt was, you'll notice he didn't get a doctoral degree. And the reason was, he did doctoral research ... (inaudible). It was never good enough for him. And so he never turned it in. You think about that.

He moved on and lived his life out. I guess the thing I remember most about him was the wonderful relationship he had with his wife, Nellie. I think it could certainly be described as an opposites attract marriage.

Professor Hottel was always described and always viewed himself as professor Hottel. He was a rather formal man. My wife Betsy and I occasionally had dinner at the Hottel's home. I remember fondly how

by-the-book and serious Professor Hottel was and how casual and easygoing his wife Nellie was.

In fact, when we wrote thank you notes to the Hottels following these dinners, the salutation always read, “Dear Nellie and Professor Hottel.” And when I said that once to Professor Hottel, he didn’t laugh.

Among the great insights and the many great insights in his life, the professor was a man who put into practice the idea that science and engineering can and should be used to advance the public good, to solve complex problems and to help our society and our economy adapt in a complicated global environment. In my view, that is a concept that those of us who make our living in Washington, D.C. should always keep in mind.

These days, there are some in Washington on both ends of the political spectrum who advocate protecting our economy from the global marketplace. They want to put up barriers around economic activity, barriers to trade, barriers to investment, even barriers to immigration.

What they’re really talking about is economic isolation. While that may seem like a recipe for short-term political gain, it is almost certainly a recipe for long-term economic stagnation.

In my view, this is not a time for building walls. It is a time for breaking down the walls that could limit our future of economic growth. And in many cases, the tools that we need to do this will be found through breakthroughs in science and engineering.

In other words, at a time of increasingly aggressive global competition, America must do what it has always done best. We have to take risks. We have to lead. We must invent. We must innovate.

Our President has recognized this and he has acted decisively on this question. Early this year in his State of the Union Address, he announced the American Competitiveness Initiative. In my view, this is a very aggressive initiative that represents a real watershed for American science and engineering.

At its core is a major increase in Federal funding for basic science research particularly in the physical sciences. Some of the impetus for this program came from the President's very personal belief in science and technology. Some of it came from NGOs that liked the Competitiveness Council in Washington.

And a big part of it came from a National Research Council report that has become known as the Augustine Report, a committee chaired by Norm Augustine. President Chuck Vest from MIT was a very

active member of that committee. He played a very strong role in, not just drafting the report, but in working the issue very hard, both in the administration and in Congress in Washington.

While recent advances in biology, genetics, and medicine have been nothing short of astounding, the benefits to all Americans are quite real, it is a risky business in my view to fund one area of scientific study at the possible expense of others. And this is in part because scientific disciplines are increasingly linked.

Today, we're seeing the convergence of disciplines. Molecular biologists are teaming up with physicists, geneticists capitalizing on remarkable advances in computer science, and physicians working with mechanical and even chemical engineers.

President Bush understands this reality. He knows that we must find and fund a national science portfolio that corresponds to the nature and the variety of challenges that we face as a nation. And as importantly, particularly for a place like MIT, we must recognize that these Federal dollars not only will enable future breakthroughs, but that they also fund education of the scientists and engineers who will do the work at our universities, at our government laboratories, as well as in the private sector.

I should add that this initiative also will support new programs in science and math education in our nation's elementary and high schools, vitally important if we are going to continue to prepare the next generation of American students to succeed at great universities like this one.

I'm proud to say that the Department of Energy will play a central role in the American competitiveness initiative. The President has committed to doubling the budget of the Department's office of Science over the next ten years. This includes an increase of a half a billion dollars from 3.6 billion up to 4.1 billion, or an increase of 14% just this next year from '06 to '07.

Among other things, this will allow us to support an additional 2,600 researchers in the year 2007, above that which we're able to do at the current year. Hopefully that will include some of the people in this room.

If Congress approves the President's request for these funds, we hope to use them to advance our work on supercomputers, nanotechnology, high intensity light sources, energy from biomass, and nuclear fusion. We will also increase our support for both high energy and nuclear physics.

In developing priorities, what we have tried to do is to identify those projects that hold the greatest potential for significant advances. Specific projects include the construction and completing of five nano-scale science research centers at DOE laboratories. They will be located at Oak Ridge, at Argon, at Brookhaven, at Berkeley, and at Los Alamos. In most cases-- not every, but in most cases-- they will be located alongside a brand new, very sophisticated measurement source similar to the spallation neutron source that we are currently constructing and will be starting up in Oakridge.

We will continue to support continued construction of the Linac coherent light source at Stanford, which will lead to, we believe, the conversion of the linear accelerator there to a whole new field which we are hopeful that they will become the world leader.

We will increase our investment in microbial research to help us produce cellulosic ethanol and other biofuels cost effectively, and to aid in environment remediation.

To me, this whole initiative is all the more remarkable given our current fiscal environment. Now more than ever, this nation cannot afford to waste taxpayer dollars on programs that are not well conceived or unlikely to be effectively. And so I can assure you that this is not something that the Administration has proposed casually.

The budget of the Department of Energy is essentially flat year to year, so that these very substantial increases that I have alluded to came from elsewhere in the Department. The tradeoffs that we made have been very difficult. And of course, some in Congress whose states have been affected or whose districts have been affected don't like it very much. And that makes me not a very popular person when I deal with them. But we're trying to do what we think is the right thing.

The Administration has proposed these very significant changes because this initiative goes directly to the future economic wellbeing and security for our country. For although intrinsically valuable for its own sake, we expect more from basic science research than new knowledge alone.

I'm sure that many of you are familiar with the work that MIT's own Bob Solo did as a part of his winning the Nobel Prize. And he, at that time, demonstrated some years ago that the technological innovation that had been funded by the government in the preceding decades had been the primary driving force behind the extraordinary economic growth that this country has enjoyed.

We have seen this principle at work in the remarkable achievements of American scientists and engineers over the last century. I expect and I believe that we will continue to see great benefits to society as a

result of the research that we are pursuing today – benefits to our health, to our national defense, to our productivity, as well as our energy security.

For the Energy Department in particular, the President for one has made it clear that he believes that advances in science and technology will help this country break its over-reliance on hydrocarbons as our primary source of energy, whether to fuel our transportation sector or to generate electricity.

The most immediate reminder of this of course is the current high price of gasoline, a topic which seems to be of great interest and concern to practically all Americans. I seem to be running a moving press conference each day that I get up on this topic.

And so in conjunction with the Competitiveness Initiative, a new advanced energy initiative proposes to significantly increase our national investment in alternative fuel and clean energy technologies in order to, over time, fundamentally transform the way we produce and use energy in this country, and reduce our dependence on foreign energy sources.

As a part of the advanced energy initiative, the President has asked Congress to increase funding for clean energy technologies by 22%, up to a level of about 2.1 billion dollars in the upcoming fiscal year. I

would remind you again that this is a Department whose overall budget is flat year to year. So all of this money came from elsewhere within the Department.

With these funds, we will accelerate our research into technologies that we believe hold the greatest promise to transform the way we power our automobiles, our homes, and our businesses. We will focus our efforts on the development of commercially competitive cellulosic ethanol, advanced hybrid vehicle technologies, hydrogen fuel cells, solar energy, wind energy, and the cutting edge technologies to burn coal for electricity production with near zero emissions.

My own favorites from this list are the cellulosic ethanol efforts, photovoltaic research for the distributed generation of electricity, and the clean coal technology, all of which will receive very sizeable increases in funding in the years ahead.

All of these initiatives hold great potential for ultra clean and secure energy options. But let me also say this – if we are to succeed in significantly reducing our dependence on imported energy and further diversifying our energy portfolio, we must expand our use of nuclear power in this country.

And so as a part of the energy initiative, the Administration has also proposed the new global nuclear energy partnership, or as we refer to

it, as GNEP. Everything in Washington has to have a really ugly sounding acronym, and that's ours in this case.

An international effort, GNEP aims to address our growing global energy demand in a way that will foster economic development around the world. It will improve our environment. It will responsibly manage nuclear waste and significantly reduce the threat of nuclear proliferation and terrorism.

In short, we propose to develop and demonstrate an advanced recycling technology that does not separate plutonium like the current reprocessing technology utilized by other countries around the world. Rather it keeps the transuranic elements all together so that they can be made into fuel, that to be consumed in fast neutron reactors, that will also produce electricity.

These advanced burner reactors, or ABRs, would be designed to consume plutonium and other transuranic elements that are in spent fuel, transforming the radiotoxicity of the waste in repeated cycles. The improvements could be remarkable – increased energy extraction, less nuclear waste, decreased heat load of the remaining waste, and reductions in its radiotoxicity by at least three orders of magnitude.

We will compliment these technological breakthroughs with an innovative international fuel services program. Under this

arrangement, nuclear fuel supplier nations would provide fresh fuel for conventional nuclear power plants located in user nations that agree to refrain from enrichment and reprocessing. Then used fuel would be returned to the fuel supplier nations and recycled using a process that does not result in separated plutonium.

In addition to reducing proliferation, this arrangement carries the potential to allow poorer nations to leapfrog over some of the dirtiest, but most rudimentary and prevalent fossil fuel-based technology.

All of this will take years and will take billions of dollars. But we believe that the time to start is now. We have asked for 250 million dollars in fiscal '07 to launch GNEP.

The bottom line of all these initiatives is, we recognize that science and technology will lead us to cleaner and better sources of energy, to new ways to heat our homes, to power our cars, to run our businesses, and to preserve our environment, and therefore to ensure a more secure and safer future.

It's a big challenge for America. But I know that together that we and academia and government and private industry will do it. We will because we must. Much hangs in the balance for our security and for our economic health.

I want to wrap up my remarks if I could on a personal note. I entered MIT at a very pivotal time in the history of our nation as it turns out. It's also a pivotal time in the history of our science establishment. I often describe myself to colleagues and to the young people in our department who are probably getting tired of hearing me say it, but I'm a product of the Sputnik generation.

I have very vivid memories of standing in the backyard where I grew up in Illinois in the late '50s staring up in the sky, trying to make out that Sputnik satellite that was going overhead. These were the days when Nikita Khrushchev had come here and visited New York, visited The United Nations, pounded his shoe on the rostrum at The United Nations and said he was going to bury us.

And when you looked at that satellite, you had to think that maybe he was right. It was a time of fear, to be sure, fears about Russian capabilities and about our country falling behind. But it was also, as it turns out, a time of great opportunity, opportunities to advance our scientific understanding and to put that knowledge to direct and important use for our country.

The launch of Sputnik not only started the space race, but it also led to the creation of NASA, which occurred the following year. It led to a massive increase in funding for the National Science Foundation. The NSF budget was quadrupled in one year. And this really established

the agency as a powerhouse of funding for university fellowships in science and engineering.

It was because of one of those NSF fellowships that I was able to attend this terrific university. Without it, I would never have come here. I would never even have met Professor Hottel, let alone work with him.

At that time, the people in the government of this nation recognized two fundamental truths, first, that in order to maintain this country's economic preeminence in an increasingly competitive world, we simply had to maintain our scientific and technologic superiority. And secondly, that doing so required substantial and a very sustained investment of funds.

The parallels to today are quite striking. Our country faces tremendous challenges to our security, to our health and wellbeing, and to our future economic competitiveness. And in all of these areas, our nation's scientists and engineers will help us turn those challenges into opportunities.

You will develop new and as yet unimagined solutions to meet our future energy needs. You will enable advances that will keep us safer, protect our men and women in uniform, and help us to defeat

terrorism here and around the world. And you will cure diseases, improve our health, and better our environment.

And what will our government do to support you? Well, the way I see it, there has existed for some time in our nation a kind of deal between American scientists and engineers and the Federal government. From our nation's scientists and engineers, whether in government, the private sector or academia, we need now what we have always needed – an unwavering commitment to push us forward into the unknown, to better, more prosperous, safer and more secure days ahead.

From the Federal government, these scientists and engineers need now what they have always needed – a commitment to fund basic research in all fields, from biology to computer science, to the physical sciences.

As an MIT engineer myself, I am very proud to pledge to you that this government is committed to holding up our end of the bargain. And I rest assured that all of you will continue to do the same. It's been a real pleasure for me to be here. Thank you.

[applause]

ARMSTRONG: So we have time for questions?

QUESTION: How much of the energy shortfall do you think will be made up by biofuels? How much from nuclear fission? When will these energies be available in mass quantities?

BODMAN: If I knew the answers to those questions, I could retire. Let me try to answer it in the following way. In terms of ethanol, we now produce about four billion-- We produced last year in '05 about four billion gallons of ethanol. This year, it will be about five and a half, or 5.6 billion gallons. That's the good news.

The bad news is, we use 140 billions of motor fuels in our country, okay? So we're coming up on 5%. In order to produce that much ethanol, we used last year, when we made four billion gallons, 14% of the corn crop. All of it's made from corn.

Pretty soon we're going to start pushing up the value of corn. We will cause ourselves an economic problem. And so the goal here, which the Energy Department is working on out at our renewable energy laboratory in Colorado, in Golden, Colorado, a series of projects involving producing ethanol from cellulose, producing ethanol from, if you will, waste products, whether it's corn stover, which is the stuff left over in the field after you harvest the corn, or switch grass, or wood chips.

That's our job. We're working at it. Four or five years, it's my guess, sort of-- you know, we'll have this going. We're hopeful, by 2011, 2012, that kind of timeframe, that we will be in a position where we will have cracked that code and we will be able to start expanding it. The goal is that we would have five million barrels a day of renewable fuel available in 20 years. That's the goal--

QUESTION: ...(inaudible)

BODMAN: Just a minute. We use-- That's exactly right. We use 20 million barrels a day now. That number will increase to-- About half of that goes into motor fuel, so let's say 15 million barrels a day go into motor fuel. So by that time, you'll be up to 20. So you'll be at 25%.

So that's that. I mean, that's the goal. I think it's a reasonable goal. This is a massive infrastructure. Just getting this done is going to be a massive job. It's going to take that kind of timeframe. That's one thing.

You mentioned nuclear fission. I am convinced that we will see new nuclear plants. We have not had a new nuclear plant in our country in 30 years, following Three Mile Island, following Chernobyl. I am convinced that we will see it. We have been funding for the last three years, four years, a joint, on a cost-shared basis with industry, an

effort called Nuclear Power 2010, which is involved in, dedicated to the licensing of new, generation three technology, from General Electric/Westinghouse or AREVA in France, and citing these new facilities.

I am convinced that that will happen, that we have financial support in the energy bill that was passed last year. That means that we will have support for the first six reactors. I think you will see ground broken in the year 2010. You will see those reactors up and going in the year 2015.

So we will see it. But the problem is, we don't need six new reactors. We need 16 or we need 26 or we need 46. That will only happen if we deal with the question of spent fuel. That will only happen if we deal with the issue of a repository for that spent fuel. That has to go on in parallel with the GNEP program that I mentioned. We are working at that. That's a long answer to a short question.

QUESTION: Do you have any hope for nuclear fusion energy?

BODMAN: Yes. I have been working very hard on the Department to encourage members of our Department to focus on-- Let's get some things done. Let's get some things done so that we can point to it in three years, five years, that we accomplish this and that we're going to go try to solve some problems, that it matters.

Because I frankly found when I got there, these were research programs that seemed to have no end. There wasn't a forcing function to cause, "Let's get these things completed." And so the focus, as I described in my remarks, nuclear fusion works. We are now involved in this international thermonuclear energy research project, ITER we call it, be built in France. We're spending money on it and so forth and so on.

I'm not going to care about that in a sense. I'll be dead by the time that comes on. And so I'm trying to get stuff-- I'm 67 years-old. I'm trying to get things done in my lifetime. You know, we're going to spend the money and we're going to do it. Somebody else will care about it later on. So I'm a believer in it, but it's not going to happen while I'm alive I don't think. I'd like it to, but--

QUESTION: As a result of this successful research program...(inaudible) Department...(inaudible) very successful clean coal technologies. Clean coal is not an oxymoron anymore. The question is, of course, any path ...(inaudible) today won't be operational for the next 40 years. What kind of appropriate incentive could be given to industry to make use of these very good results? Because ...(inaudible) using a conventional message...(inaudible)--

BODMAN: The question is, that we have had some great successes in clean coal technology. The question asked is, are there incentives for industry that would help initiate some of these new plants that would use this.

There are provisions in the energy bill that was passed last year that could be used for such a thing. They are loan guarantees. There's a loan guarantee program that the Department of Energy will be responsible for once we get it up and going. We're working currently with the Agriculture Department, the Treasury Department, because they know what they're doing in this area and we don't. So we're trying to get some knowledge of people who have been through this.

And we will consider that. And so we'll see. We will be making public announcement on that soon. We will see whether we have any takers.

So there are some things that are in the bill that will enable such technology. It's only going to be for the first one or two. I mean, we've got to find ways of getting people to-- Industry has to step up and do this. That may relate to the kind of incentives that we put out there. But that's how I'd go about it.

QUESTION: Going back to the ethanol, the 5.6 billion gallons which will be produced next year--

BODMAN: This year.

QUESTION: --this year will also be associated with about three billion dollars in excise tax credits...(inaudible), which is twenty times higher than the 150 million for the cellulosic ethanol research. Is there any way that that credit can be shifted towards more of a future-looking technology?

BODMAN: The question is that the money for research on cellulosic ethanol is small compared, as you were describing it, compared to--

QUESTION: The excise tax credit for ethanol production now, which is about 50 cents a gallon.

BODMAN: Yes. There is a tax credit for ethanol production, which he is saying. The answer's probably no. But I don't worry about it too much because we have a 50% increase in money for research. There is a tendency in Washington to attribute money with research progress. And that's not always the case.

So I am hopeful. This is a 50% increase that we will have in '07 if we are successful, that over a period a time that we'll be successful in doing that. But I think at least right now, there is a general sense in Congress that we have a lot of incentives there to cause this industry

to get itself up and going. They're working because the industry is expanding rapidly. I think at least for the time being, we're going to see, there will be, I think, a lot of resistance to shifting any of those funds into a research effort. That's my best guess.

QUESTION: I was wondering why there seems to be this emphasis on nuclear power when, if you look at the levelized cost of the electricity that renewables like wind and solar tend to be comparable in terms of the levelized cost. Is it that there's the potential to sell nuclear fuel, so longer term that it seems more profitable? Why does there seem to be a particular focus on nuclear power?

BODMAN: There is a focus on nuclear power because it is the only game in town in terms of scale. It has the capability of delivering electricity at a modest cost. When you have a levelized cost, you mean the cost of the spent fuel, is what your issue-- I take it?

QUESTION: It includes the cost of the spent fuel, also the initial cost for building the plant.

BODMAN: But the costs, to our first approximation in the absence of any money spent on spent fuel, to a first approximation, the cost of nuclear power is the cost for building the plant. The cost of the fuel is modest, so it's just to a first approximation.

And so it simply works. It's scale. And it will produce electricity without greenhouse gases. And so that's the goal. It's not the only thing we're going to do, but it's something that I think we need to do. We haven't had a nuclear plant, as I said, in 30 years. And so we're doing everything we can do to stimulate that, because I think it's the right thing. But we need coal. We need renewable energy. We need ethanol. We need solar energy.

Eventually the market is going to sort all this out. But in the meantime, we're trying to stimulate the things that seem worth stimulating. That's the best answer that I can give you.

QUESTION: What can be done by the Federal government to reduce the consumption of all transportation fuels? Secondly, how could it politically achievable to raise the Federal tax on gasoline and diesel?

BODMAN: Well, the issue comes up. A lot of people talk about raising taxes on gasoline. I guess it's my own position. Right now, if you talk to working families, which I do-- And a lot of them have not budgeted these kinds of gasoline costs. They're already struggling under high prices.

And so to impose higher prices by adding to the tax doesn't seem to me to be productive. It would sure decrease the consumption. But the goal here is to try to accomplish what we are working at, and to do it

in a fashion that does not involve increasing taxes or decreasing taxes, for that matter, on fuel.

The President has asked for the right to-- for authority to mandate new CAFE standards. And if given that, I feel sure he would follow through and do that. So, I mean, I think there are a number of other things that can be done. But the taxation of oil or of gasoline is a highly sensitive matter politically, because it tends to pit urban dwellers versus people in the country. You get all kinds of things – people who are poor versus people who are not poor.

And so there are issues that are there. We're trying to work along the lines that I describe. I don't think it's likely that you're going to see a lot of enthusiasm for increasing gasoline prices even higher. I mean, that's really the bottom line.

I deal with people every day who are upset, Congressmen and others who are upset because their constituents are paying what they consider to be outrageous prices already. If go back to them and say, "By the way, my answer to this is to increase prices more," that's a really hard sell. I'm a pretty good salesman, but that's a hard sell.

QUESTION: Appreciated your remarks. A lot of your comments talked about modes of producing energy. But a lot of what's happened in the last half century is we've seen a change in how energy is used.

Back in the days of Sputnik, for instance, about 16%, 17% of our energy was consumed as electricity. Now it's 40%. Everybody's projecting it might be two-thirds 50 years in the future. That's of a much bigger pie.

So the piece of this puzzle that is becoming increasingly critical is the energy delivery networks. What is the Department doing? What does the Department need to do to make sure that our energy delivery systems are adequate for the future?

BODMAN: Specifically electricity?

QUESTION: Well, electricity is becoming a bigger and bigger piece--

BODMAN: You're right about that. We have every way of regulating electrical distribution. Our electric distribution network in this country grew like topsy(?). Some of it's regulated. Some of it's unregulated. Right now it has gotten sufficiently confusing that investment has stopped pretty much altogether.

There was an energy bill passed last year after four years that the President has been working at this. We finally got the bill through last year. Part of it involves looking at this exact question, and invest in

the Energy Department executive authority if needed to make judgments on citing of new transmission.

So we are working at that. We're going through an understanding of what it is, an analysis of it. This is one of these things that, everybody wants there to be more transmission, but nobody wants to see it. It's like LNG – everybody wants more LNG. We need more natural gas, but nobody wants the terminal near them. So it's an issue where somebody, the only way to deal with these matters is vesting in a centralized authority, the ultimate authority for making the judgment. That's what we're doing. And so we are working our way through that.

QUESTION: ... (inaudible) technology opportunities?

BODMAN: Oh, there are a lot of them of course. Superconductivity for example, we're working with-- 3M is very active in that area, among others, other companies that are making superconductive devices.

QUESTION: ... (inaudible) visit to India, signed this ... (inaudible) nuclear technology pact. What are your personal opinions on how it will be received in the Congress based on situation in South Asia? It's a tough one. And also, its effect on the kind of global partnership you're talking about.

BODMAN: The President is very eager to see us improve our relations with India. He made that clear, has made that clear for some time. So he has made an offer to India, which will need to be approved by Congress. I'm telling you things you already know, but everyone else here may not know.

And so the deal has to be approved by Congress if it is to become law, the law of the land. And if we can then follow through and exchange nuclear technology with the Indians, that's really what they want and what we would like to provide for them.

I guess I would say at this point in time, I am reasonably optimistic that we will get a good reception. But trying to forecast the reaction of Congress today is hard. These are not easy times. So it's a matter of trying to be consistent and explain what the issues are, and to try to get people to act in the best interest of our country. If everybody does that, then I'm convinced that they will approve it. But I haven't yet seen the answer. But we're working the issue.

QUESTION: Just a question. As an MIT alum yourself, do you find that it is a very uphill battle one might think, fighting against, for example, public opinion when it comes to nuclear energy or against Congressional unpredictability when it comes to certain things, that to

MIT students or scientists and engineers in general, seem like perfectly obvious things?

BODMAN: First of all, I went to Washington to serve this country. And I am doing my best to try to serve the country. We have a political system that is-- Maybe the best that you can say about it, it's highly confusing for a newcomer. It's kind of daunting at times. It's concerning at times. It happens to be the best form of government. I keep reminding myself of that. Because what you see is not always particularly pleasant or pleasing. But it is the best form of government; it seems to be, seems to work.

So one of the things you learn as you get older, whether you're a scientist, an engineer, or not is that you have to cope with things that are less than perfect. You have to cope with things that are challenges. And so this is merely one of those. I don't find it any more difficult than trying to convince a legislator that they should authorize us to sell our mutual funds back in the days when I was at Fidelity, 25 years ago, or that calling on a major customer in the tire industry that used to buy carbon black from us when I was in the chemical business.

You kind of learn to deal with some of these things, and you keep going forward. So it's a challenge, but it's something I think can be managed.

QUESTION: Five years ago, President Bush decided not to join in the Kyoto Protocol. Do you see that decision being reversed or something similar happening?

BODMAN: No. I think it was the right thing. I think if you talk to the Canadians today who did sign the Kyoto Protocol, people in the government today are not particularly pleased that they're there. They're not going to be able to make their conditions-- A lot of this that was done at the time, was done-- There had been a lot of political heat over this issue for some time.

The reason we didn't sign it, the President didn't want to sign it was that China didn't sign it. India didn't sign it, or weren't committed to it. They're signed it, but they don't have any commitments. And without them, why participate?

So I think that we do need, you know, as we learn more about climate issues-- and we are learning more. We've been working on that over the last five years that I know of. We're starting to get the results out of the climate science research efforts that have been ongoing for those five years, in fact, longer than that.

I think you'll see something downstream that will deal with it. But I think the key thing on all of this is trying to underscore the importance of economic growth. You have to provide for an economy. The idea

that we would sign, straight up, an agreement with the Germans and the French, let's say, both of who they limit immigration-- They haven't had growing economies in Germany and in France in a number of years that are significantly growing. It's a real issue. And yet we, who have immigrants coming into this country in numbers-- We have a growing economy. I think it's important to rationalize that in some fashion. The Kyoto doesn't do that.

So I think we're not likely to see it change, at least not from this Administration. I think the President was right to do it. I don't agree with everything the President says or does, by the way. But you'll never hear that from me.

QUESTION: Do you think that the amount of gas that it takes to produce a gallon of ethanol... (inaudible)?

BODMAN: No. The issue of energy per unit of ethanol produced-- And there are claims that you use more energy making the ethanol than it's worth, that kind of thing.

A) it's wrong. The people at Argon tore that apart and did a good job on it and so forth. At least I believe that that's not a correct assertion. But even if it were, my view is, that having a locally grown, locally developed source of motor fuel is very important to this country. That's what this is all about. That's what the President believes.

And so we're working at that. And so therefore, having this done locally and doing it in a way that is economic I think is in our best interest. And that's what we're trying to do. I think we're going to be doubly successful. One, it'll be locally grown. And two, once we get this cellulose thing going, it'll be much cheaper. And so we're going to be able to produce ethanol at prices much below what we can do today based on corn, by using cellulose.

But that will take a technological advance and breakthrough which I think we know how to do and that we can do. That's when you'll see the big expansions. But until then, I think we're going to be struggling with corn, at least in the meantime.

Sugar cane is in Brazil. That's been the great example in Brazil. In dealing with that, you've got a lot of Congressional interest in both in corn and in sugarcane, in trying to protect those industries here. That gets into the agriculture bill and gets into a lot of issues that are challenges.

And so the focus that I have right now is trying to deal with that, which I know I can deal with, namely corn, and then trying to put money and research so that we can make it from ethanol. You're quite right – sugar cane inherently is a cheaper way to make ethanol than corn. But I've got tariffs on importing ethanol. The President has

expressed some interest in sort of getting ideas and working with Congress on those tariffs. But I view that as a longer-term thing. Frankly, I will let the President worry about that. I'm worrying about trying to get corn and making ethanol from corn in a fashion that makes sense.

With that, I will turn all of you loose, and with our thanks.

ARMSTRONG: Before we let Dr. Bodman go, I'd like to present him with a small gift as a token of our appreciation.

[applause]

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