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The Road to Our Energy Future: A Candid Assessment

Harvard University
Center for the
Environment



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CAMBRIDGE, Massachusetts, January 31, 2007 -- Good afternoon, ladies and gentlemen. It's a privilege and an honor to participate in the second season of conversations hosted by the prestigious Harvard University Center for the Environment, and to share my thoughts on the subject of the "Future of Energy." Let me begin this afternoon by thanking Harvard University for its kind invitation, and the Center staff for their warm hospitality during my visit to Cambridge.

I always find it interesting and exciting to be in the US, and to witness first-hand some of the changes shaping our world. Frankly, what happens here and what is decided here matters everywhere, given the magnitude of the American economy, the influential nature of this country's politics and foreign policy, and the pervasiveness of American popular culture around the globe. Furthermore, the Boston area holds special significance for me. As an up-and-coming Saudi Aramco manager, I attended Harvard's management development program-which was my very first visit to this country. My initial first-hand experiences of the US were gained right here in Cambridge, and the lessons I learned continue to influence my thinking and approach to business. Even more important to me are the lifelong friendships which began during my stay, and which I have continued to value over the last three decades.

This afternoon, I want to share with you my views on our energy future, to examine some of the most critical factors and trends we need to consider when addressing energy issues, and to outline the steps that we at Saudi Aramco are already taking to ensure that the decades to come are characterized both by energy supply stability and environmental stewardship.

The decisions about energy taken here in the US, back in Saudi Arabia, and indeed across the globe are important, because energy touches every aspect of modern civilization and pervades our daily lives. Access to an economic and reliable supply of energy is essential to achieving greater prosperity and eradicating poverty, to raising living standards in our communities, and to fueling economic and social development at home and abroad. At the same time, we

have a responsibility to both our current and future generations when it comes to the protection and preservation of precious natural ecosystems, meaning that decisions about energy, economic expansion and the environment must go hand-in-hand. That is both our challenge, and our opportunity.

Let me begin with a brief look at today's energy picture, and the factors that those of us in the energy industry grapple with every day, that influence our mental models about energy's future, and provide the basis for our strategies.

The world currently consumes around 210 million barrels per day of oil equivalent, with most of that supplied by a fairly limited number of sources; a reality that applies equally to the United States. Oil meets nearly 40 percent of the world's total energy needs, coal and natural gas each account for just under a quarter of total demand, hydropower and other alternatives for eight percent, and nuclear energy for six percent of total energy supplies. In fact, for all of the attention garnered by renewables and alternative energy sources, fossil fuels like coal, oil and gas still account for a whopping 85 percent of total global energy supplies. In addition, because the number of currently viable energy sources out there is so limited, we have to recognize that the options that are realistically available to policymakers, producers and consumers are also relatively limited. Of course, the flexibility the world may have in terms of choices is also a function of the time horizon under consideration, and in future there may indeed be more options on the table.

We must also remember that each sector of energy use has its own source dynamics. For example, when it comes to power generation, there are a number of sources which contribute substantially. According to the US Department of Energy, the American power generation sector draws upon coal for about half of its energy needs, with gas and nuclear each supplying about 19 percent of demand, and hydro electricity accounting for another seven percent. Oil contributes a modest three percent to this country's power generation pie, and the remaining two percent of demand is met through renewables other than hydro. In contrast to this relative diversity of sources in the power generation sector, oil currently supplies an overwhelming 97 percent of the transportation sector's energy needs, with the rest coming from compressed gas, bio-fuels and other minor sources.

There are distinct reasons why oil is the fuel of choice in the all-important transportation sector: oil technologies have been proven over almost 150 years, and continue to develop; its supplies are abundant; it has an extensive and highly developed infrastructure in every corner of the world encompassing exploration, production, processing, shipping, storage and distribution; it has a very high energy density; and it is readily portable.

These factors are important to remember as we look at-and endeavor to shape-future patterns of energy production and consumption, as well as tackle environmental issues both in this country and around the world.

Turning to the future, we find a variety of scenarios about where energy use is heading. These scenarios are shaped by multiple drivers, ranging from global economic conditions and their impact on energy demand, growth in energy supplies, policy considerations, the state of alternatives and their associated technologies, the comparative economics of different energy sources, and

assumptions about environmental policies. The supply and demand projections which these scenarios produce vary widely—a fact which makes my job considerably more difficult when it comes to business planning and investment decisions! However, the one thing all these estimates agree upon is that the next quarter-century will witness tremendous growth in demand for energy. The Energy Information Administration of the Department of Energy, for example, predicts that over the next 25 years, global energy use will increase an average of two percent annually—meaning that total energy consumption in 2030 will be roughly 70 percent greater than today's level.

Much of that growth in demand will come from developing economies, in particular from India and China, and in five years' time the total energy consumption of non-OECD countries is set to exceed that of the OECD nations for the first time. That is largely a function of an increasing global population and the narrowing of the gap in living standards between the developed and the developing worlds, since energy demand in the industrialized nations will also remain robust. Assuming that none of those trends is likely to reverse itself anytime soon, we have to identify ways to continue to satisfy existing demand while also expanding supplies to meet incremental demand growth. In other words, over the next several decades my industry colleagues and I must substantially increase the amount of energy available to consumers around the world.

Can we do it? Yes, without a doubt, as there is more than enough oil remaining to meet the world's needs for many decades to come. Why am I so confident? Because our industry has devoted tremendous efforts and resources to understand the earth's petroleum resource base, and based on these efforts, we know that the world's remaining petroleum resources are vast. Currently proven conventional oil reserves are approximately 1.2 trillion barrels, while recoverable non-conventional reserves - heavy oils and tar sands - are at least 1.5 trillion barrels. Upstream experts believe that with on-going advances in technology, we will find an additional two trillion barrels from yet-to-be-discovered fields and through increased recovery rates in existing fields. Added together, we are looking at more than four and a half trillion barrels of potentially recoverable oil, and that translates into more than 140 years of supply at today's current rate of consumption. To put it another way, to date the world has only consumed about 18 percent of its conventional and non-conventional producible potential.

While technology holds much promise for enhancing our ability to find, develop and deliver these resources to consumers, I believe it also has an important role to play when it comes to protecting the planet. We all recognize that mitigating the negative impact that energy production and consumption has on the natural environment is becoming increasingly important, and represents another vital imperative for suppliers, consumers, policymakers, regulators and other stakeholders. Whatever our professional role or discipline, or the position we occupy along the energy value chain, each of us has a part to play in lightening energy's environmental footprint, and in making it possible to balance our responsibilities toward the environment with our commitments to the economic prosperity and wellbeing of our communities and their inhabitants. Achieving that balance is among the most significant challenges facing our planet today, and underscores not only the work of the Harvard University Center for the Environment, but also my remarks this afternoon.

So, where do we go from here? Well, when it comes to energy, the immediate future looks a lot like the recent past, with hydrocarbons continuing to account for the lion's share of energy supplies. In fact, fossil fuels will remain the bedrock of energy supplies for both the US and the wider world for many more decades to come, through the use of oil in transportation via significantly improved conventional engines, hybrids or eventually in hydrogen production; and with coal and gas when it comes to electric power generation.

I say that not as a petroleum executive but as a pragmatist, and I would note that the Energy Information Administration of the Department of Energy itself forecasts that fossil fuels as a whole will continue to maintain their relative share of the energy market-meaning that in 2030, oil, gas and coal will still account for roughly six out of every seven units of energy consumed in the world. In fact, because of the growth in overall global demand, the actual consumption of oil, gas and coal is set to increase steadily, with oil demand, for example, rising from about 85 million barrels per day at present to nearly 120 million barrels per day in 2030.

The EIA also projects that renewables, including hydroelectricity, will be generating more energy over the next quarter-century. But even with anticipated technical advancements, that source's share of global energy supplies will only increase by one percent over the next 25 years, from eight percent of total supplies at present to nine percent by 2030. When we look at alternative energy, we find that sources such as ethanol are beginning to play a growing role, while hydrogen and fuel cells still have some way to go before they are viable in the market, and face a number of technical and commercial obstacles that need to be resolved.

But the escalating demand for energy that I outlined earlier means that we will need contributions from *all* sources, whether traditional hydrocarbons or emerging sources like bio-fuels and hydrogen. As an oil man, I not only welcome additional contributions from alternative fuels, but I believe these contributions will be essential if we are to meet the growing needs of global energy consumers.

That will be a considerable challenge, given that the United Nations estimates that the current world population of more than 6.5 billion will grow to anywhere between 7.9 and 10.9 billion by 2050. That translates into something between one-and-a-half and four billion more consumers of energy. If we also consider that there are between 700 and 800 vehicles per 1,000 Americans as compared with 10 or 20 vehicles for the same number of Indians or Chinese, we begin to understand the scope of demand growth in the decades to come. Therefore, I think we must view the relationship between hydrocarbons and alternatives not as "either-or" but as "all-inclusive," and recognize that we will need increased hydrocarbon production supplemented by alternatives to meet the world's growing energy requirements.

This growing need for additional energy supplies is why I think work on alternative energy is so important, and why such efforts should be based on a realistic appraisal of their potential, including the rate at which their contributions to global supplies can be expanded. That means we have to look not only at technical obstacles but also at commercial hurdles, including the costs of developing the infrastructure needed to deliver alternative energy to the

consumer. If we as stakeholders-and when it comes to energy, we are *all* stakeholders-undertake a careful gap analysis and focus our efforts on tackling the issues we identify, then I believe that the promise of alternatives will ultimately be realized, and that they can begin to shoulder a greater share of the burden of supplying energy to the world.

However, this is a process that will take time, and because of the complex, multifaceted nature of the obstacles that alternatives still face, this is not a transformation that can be rushed. We also have to recognize that the speed of adoption will vary considerably around the world, given each nation or region's relative resource base, economic model, level of energy intensity, degree of technological sophistication, and sunk infrastructure costs. Just as different countries have vastly different levels of things like mobile telephone penetration or automobile ownership, in my judgment various markets around the globe will adopt and adapt alternative fuels at markedly different rates, and only slowly begin to converge over time.

Therefore, I also believe prudence dictates that alternatives be introduced gradually as they begin to mature technically and economically, allowing them to gain market acceptance through their proven reliability, availability and affordability. We are all for continued global economic and social development, and we all realize that energy plays so great a part in the daily lives of individuals and institutions in both the developed and developing world. While we gather in Massachusetts to discuss the relative merits of moving from coal to nuclear power or from gasoline to ethanol, we have to remember that in other parts of the globe, energy poverty is the issue, and that some 2.4 billion people worldwide lack access to any kind of modern energy services. In fact, the UN Development Program says that universal access to modern energy services is essential if we are to cut global poverty in half by 2015-a goal that has serious ramifications for the environment as well as for the energy industry. These are real issues that have no simple answers and need to be jointly tackled by the various stakeholders: consumers, energy producers and governments.

Because we face a future in which we will need energy derived from all sources, and since it will take some time for alternative energy to expand its contributions to global supplies, I think we also need to look more closely at the major sources of our energy supplies for years to come. In short, the sources that will make the most important contributions to the energy mix in the near- to medium-term must receive a suitably high priority when it comes to research and the development of technological enhancements. If we ignore the energy supplies that will matter most over the coming decades-and yes, oil is a prime example-we may inadvertently undermine both the environmental and economic goals this nation and the global community have set for themselves.

In order to protect the environment, to eliminate energy poverty in the developing world, and to enable men and women around the globe to realize their aspirations for better lives in the future, I believe we must work simultaneously on both alternatives and on developing cleaner and more efficient hydrocarbon technologies. Even as we press forward on alternatives, let us also direct our efforts toward finding additional reserves of oil and gas, and invest in the production, processing and transportation systems needed to deliver those resources to customers and consumers. In other words, let's recognize that our energy future depends on pursuing a dual track: the gains we make in the

alternatives laboratory or on the test track as well as advances at the drilling rig, in the refinery and along the automobile production line. In time, renewables and alternatives can and will play a more substantial role in meeting the world's energy needs. But for the foreseeable future, our energy prospects hinge largely on the ability of hydrocarbon suppliers to produce more barrels of oil and cubic feet of gas in a reliable and timely manner, on the steps that consumers take to conserve that energy and use it wisely and cleanly, and on the efficiency of the thousands upon thousands of applications and end-uses to which that energy is directed.

At Saudi Aramco, we are already hard at work on building that future. As many of you know, we have embarked on a number of world-scale capacity expansion programs in both the upstream and downstream segments of the business. We are now engaged in aggressive oil and gas exploration programs designed to maintain and expand our massive resource base, and are also bolstering our production capacity from its current level of 11 million barrels per day to 12 million barrels per day by 2009. Despite the current downward pressure on oil prices, we are continuing this expansion program, because we take a long-term view of the market and of our business. Those crude oil increments will also enable us to maintain 1.5 to two million barrels per day of spare capacity, helping ensure market stability in the event of unforeseen circumstances which could disrupt supplies from other producers.

Further downstream, we currently have about four million barrels per day of refining capacity, evenly split between domestic refineries and overseas joint-venture assets. Over the next five years, we will be boosting our total affiliated refining capacity by nearly 50 percent, to a level close to six million barrels per day. Some of those investments are taking place right here in the US, through our Motiva joint venture with Shell, and will help in easing the current tightness in refining capacity in this country. We are also working with international partners to develop a number of world-class refining and petrochemical complexes in the Kingdom, helping to meet growing global demand for refined products, petrochemicals and their derivatives while helping to further strengthen and diversify the Saudi economy.

Nor have we neglected the environmental aspects of our energy future. We have developed a Carbon Management Technology roadmap for the corporation, which is designed to reduce the CO2 emissions associated with the production and use of oil while enhancing the economic value generated from the carbon cycle. In addition, last year Saudi Aramco convened the Middle East's first Carbon Management Symposium, which brought together scientists, researchers and engineers from across the globe to enhance regional awareness about climate change challenges and their potential technological solutions. In fact, we were privileged to have with us at that event Dr. Kelly Gallagher, the Director of Harvard's Energy Technology Innovation Project.

Furthermore, Saudi Aramco has commissioned several studies to evaluate the impact of climate change policies on future energy demand scenarios, and is also working to develop cleaner-burning transportation fuels, both in-house and in conjunction with other companies and institutions. Closer to home, we're implementing energy conservation measures throughout our hydrocarbon production operations, with a goal of cutting the amount of energy required to produce a barrel of our oil by 50 percent over the next 10 years. We're making

good progress on that objective, and with the energy conservation projects currently planned for our facilities, we expect to have cut our energy requirements for hydrocarbon production by 35 percent by 2008.

There is much more to be done, of course, not only in our company or the energy industry as a whole, but also throughout the wider transportation sector, where most oil is used. The current generation of hybrid vehicles is already providing a 30 to 40 percent improvement in mileage over vehicles with conventional engines, and a recent MIT study forecasts a 50 percent improvement by 2020. A four-seater hybrid car that gets roughly 140 miles to the gallon was recently produced in Switzerland, and Amory Lovins of the Rocky Mountain Institute has proposed designs for a 150-300 mile-per-gallon "hypercar" based on lightweight materials and low-drag designs. As mileage efficiency improvements of three to five times appear to be within the realm of the possible, the 14 percent of greenhouse gas emissions now generated by the transportation sector could be reduced to between three and five percent.

In other words, the environmental impact oil used for transportation could be greatly minimized-and this is a goal that could be accomplished in large part through technologies that are either already here or are now on the horizon. Promising developments like these are one reason I am optimistic about future technologies which will make petroleum production and consumption more environmentally friendly, while helping to sustain the global economy. For that reason, I'm a strong proponent of viewing technology as a major strategy in the quest for a cleaner environment in general, and reducing greenhouse gas emissions in particular.

And yet Saudi Aramco's commitment to our stakeholders isn't just a matter of pipes and petroleum projects; it's also about partnership and continuing to fulfill our promises. Nearly 75 years ago, the Kingdom of Saudi Arabia granted a concession to an American company keen to explore for oil in eastern Saudi Arabia. That agreement formed the basis for the creation and development of Saudi Aramco, and over the ensuing seven decades we've never forgotten the immense power that comes through partnership.

Today, we recognize that our continued success as an enterprise is linked to the health of this economy and the strength of this market. As it has for many years, Saudi Aramco remains one of the largest exporters of oil to the United States, helping to sustain standards of living and to fuel economic growth in this country. But because the world oil market is so highly integrated, it is not only the barrels we deliver to these shores that make a difference for American consumers, but in fact all of our exports, given that crude oil is a fungible commodity. As a result, our role in the global oil market, combined with our spare production capacity and the ability to bring it on-stream when needed, helps cushion the US from disruptive bumps and jolts that might otherwise jeopardize the economic wellbeing of this country.

But just as the US looks to Saudi Arabia for energy, so too do we depend on you. First of all, we need the American market and the export earnings it provides every bit as much as you need our petroleum. Secondly, America is the engine that drives the global economy, helping to sustain world demand for our principal product: crude oil. As an energy producer, we rely on a healthy worldwide economy, and that economy in turn relies on you. In addition, many of the other

petroleum companies, first-class providers of goods and services, and research and educational institutions we work with are right here in the US. We continue to look to American firms for business ties, for their world-renowned innovation, for world-class engineering and oilfield services, and for the precision-made, technologically advanced equipment we use in virtually every aspect of our operations.

Just as importantly, we value the educational and career development opportunities available in the US; and the Boston area is of course at the heart of these premier opportunities. In fact, roughly half of our professional employees and an even larger percentage of our senior management members are graduates of American colleges and universities-and I've already mentioned the tremendous impact that my time here at Harvard as a young executive has had on my own career. Beyond their degree programs, I believe that such institutions of higher learning also have an important role to play in knowledge-sharing, and in helping to meet future energy challenges.

Then there are the tremendous contributions that American employees have made, and continue to make, to Saudi Aramco's business success. We now have fourth-generation American Aramcons hard at work in Dhahran and elsewhere in the Kingdom, and we place great value on the skills and talents of our American workforce.

Ultimately, I think that the American-Saudi relationship has been good for both sides because it is so complementary, and because it is based on mutual respect and a set of shared human values. Has that relationship seen hard times over the years? Yes, without a doubt. But it has *always* weathered those difficulties, and emerged stronger and more secure as a result. The interdependence of our two nations-that is, our need for the US export market and American technology and know-how on the one hand, and America's reliance on our oil supplies on the other-has benefited both countries. I firmly believe that our mutual interests are best served by further deepening these already strong ties, and by understanding that energy interdependence is ultimately a source of strength and greater security, rather than a point of weakness or vulnerability.

Ladies and gentlemen, as I said at the outset, when it comes to energy we face both tremendous challenges and a wide range of opportunities. No company or country, no matter how large or capable, can face those challenges or seize those opportunities by working in isolation. Rather, meeting the world's growing demand for energy while protecting the planet requires a pragmatic approach which integrates both the concerns and the contributions of producers, consumers, and all those who impact and influence energy policy.

Let us therefore press ahead with multifaceted and concurrent efforts to bring various alternatives to the market, work to develop cleaner and more efficient applications for existing hydrocarbon sources, and endeavor to reduce the environmental footprint of global energy use. By aligning our efforts and building on a firm foundation of resources, reliability and partnership, I believe we can succeed in achieving the sustainable energy future this great country and the wider world deserves.

Thank you.

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