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أرامكو السعودية
Saudi Aramco



**1st Saudi Aramco
Symposium on
Carbon Management
May 22-24 2006**

Research & Development Center
Symposium Organizing
Committee

1st Regional Symposium on Carbon Management

May 22- 24, 2006, Saudi Aramco, Saudi Arabia

EXECUTIVE SUMMARY

Over the three day-period, May 22-24, 2006, an estimated 400 participants representing over 100 institutes and companies from 24 countries gathered in Dammam for the **1st Regional Carbon Management Symposium** with the common goal of finding ways to meet the growing energy demands of the world while reducing emissions. The call for the symposium stemmed from our understanding that as a major source of global energy supplies, the petroleum industry should play a leading role in developing and implementing technological solutions to reduce Greenhouse Gases (GHG) emissions. This is a major challenge which requires the synergetic partnership of all stake holders in the petroleum industry as well as research and international organizations involved in GHG emissions mitigation. This symposium was aimed at raising awareness of carbon management challenges and viable carbon dioxide mitigation options. It was recognized that creative talents from around the world need to partner to address this global challenge.

By hosting this symposium on carbon management, in the heartland of the world's petroleum activity, Saudi Aramco brought together petroleum producers, national and international oil company representatives, and officials from organizations dealing with global warming, and academic organizations playing pioneering roles in developing carbon management technology solutions. Participants discussed:

- The regulatory, environmental and economic aspects of carbon management
- The latest advances in technologies targeting carbon dioxide capture from fixed and mobile sources
- Utilization of carbon or carbon dioxide for advanced applications.
- Carbon dioxide sequestration and its utilization in Enhanced Oil and Gas Recovery (EOR & EGR)

Through these and other special topics, keynote speeches and panel discussions, the symposium focused on leveraging the interactions to formulate a common vision and path forward for the petroleum industry to address carbon management challenges and to convert carbon dioxide emissions concerns into new opportunities. Recommendations following the meeting were discussed under the topic "where do we go from here?"

The conference attracted speakers who believed that that is no need to sacrifice the environment for economic growth and modern development. Technology will address the challenges involved. As concluded by Saudi Aramco CEO, "I believe that technology development will play a pivotal role in finding realistic and credible ways to deal with carbon issues as well as supplying clean hydrocarbon-based energy." In general the feedbacks received regarding the organization of the meeting were outstanding, and all the parties concluded that the outcome of the conference exceeded any expectations.

Feedbacks on the conference, post-conference recommendations by the speakers "where do we go home from here" and speeches by Mr. Jum'ah and Mr. Nadmi are attached.

Feedback and Comments Regarding Organization of the Symposium

1st Regional Symposium on Carbon Management

"Saudi Aramco's Carbon Management Symposium was a wonderful experience. The organizers were generous, creative, and hugely attentive to my individual needs. I particularly appreciated being invited to give comments on what Saudi Aramco should do next. It is a rare privilege to have the opportunity to comment on the on-going decision-making within the management of a major company, and to feel that one's views are being taken seriously.

"I also want to single out the trip to Shaybah as above and beyond the call of duty for any meeting organizers. Seeing first-hand the scale of an operation matched to 500,000 barrels per day of production in the Gulf was worth a thousand hours of reading about it. The ultra-fine red sand between the toes of my bare feet will long remain in my memory."

Prof. Robert Socolow, Princeton University

"The technical and scientific quality of the presentations was high, the organization was absolutely flawless, and the hospitality, service, catering, and social program was unprecedented and beyond imagination." "Now that you (hopefully) recaptured your breath after the symposium, I would like to express wholeheartedly my great appreciation to all of you for organizing and hosting this conference. It was such a great pleasure to be a speaker and to participate in this unique event. The technical and scientific quality of the presentations was high, the organization was absolutely flawless, and the hospitality, service, catering, and social program was unprecedented and beyond imagination! I hope and expect there will be a second symposium on Carbon Management in the future and perhaps more.

Dr. Leo Meyer, Head Technical Support Unit Working Group 3, IPCC

"Just a very brief note to congratulate you again to an excellent symposium. You and your staff did a great job and I would like to thank again for the grate hospitality that you and your team gave us. I look forward to see next steps unfold."

Dr. Christopher W. Frei, Director, Energy Industry & Strategy, World Economic Forum, Geneva/Switzerland, Switzerland

There were many benefits to the symposium. It was one of the most truly international conferences that I have ever attended with representation from almost every region of the world. The expertise from all corners of the world made the conference most stimulating. I was also impressed with the comprehensive approach to carbon management, which seemed both enlightened and forward-looking. The hospitality was wonderful, and I greatly appreciated getting a glimpse into the window of Saudi Aramco and Saudi Arabia in general. Bringing us all together in Dhahran certainly improved the understanding of international visitors like myself about your company and the country.

Kelly Sims Gallagher, Ph.D., Director, Energy Technology Innovation Project Belfer Center for Science & International Affairs, Kennedy School of Government, Harvard University

This is to thank you for the wonderful organization of the symposium last week and for the kindness of everyone I have met in Saudi Aramco. The speakers had been also well chosen and were very interesting.”

Philippe Geiger, French Ministry in charge of Finances, Economy and Industry, General Directorate for Energy and Raw Materials

“I sincerely appreciate being invited to Saudi Arabia to participate in the First Regional Symposium on Carbon Management. I thought that it was a very informative and productive event. Additionally, one could tell that you and your team paid significant attention to detail because everything ran smoothly and appeared to be without problems. I also want to thank you for the hospitality you showed me. You and your staff made my stay in Saudi Arabia very enjoyable. Please thank them for me.”

Ms. Barbara McKee, US Department of Energy

“.... outstanding hospitality and organization. I have been to more than 25 conferences over the years and never have I experienced anything like the Symposium in Dhahran”

Dr. John Carroll, Gas Liquids Engineering Ltd., Calgary, Canada

“ ...you did organize the world best conference on Carbon Management and I would like to congratulate you all for that”

Dr. Paitoon, Dean Faculty of Engineering, University of Regina, Canada

“... wonderfully organized, world-class, and rich symposium. Indeed it is by far the best compared to many that I have attended around the world, ...I am a student in London and I have decidedly paid for my expenses to attend this event and IT IS WORTH EVERY PENNY!”

Ms. Noura Mansouri, Queen Mary, University of London, UK

“I must congratulate the organizers; it was one of the best organized symposiums”
Faisal Ahmed, Manager – Power & Utilities, Bapco, Bahrain.

I would like to thank you again for an excellent and very well organized conference. The hospitality of you and your Aramco colleagues was most endearing. I hope this effort can be continued as it seems of key importance for the region and the world.

Dr. Dolf Gielen, Senior Economist, IEA, Paris, France

“The Symposium was great both in planning/organization and technical content. I truly enjoyed the opportunity to visit the Shaybah Field and to see the facilities and dunes! I learned a lot about Saudi culture and certainly hospitality”

Prof John Kaldi, University of Adelaide, Australia.

“...it was honestly one of the most organized conferences I have ever attended”

Dr. Adrian Stott, CDM Consultant, Mitsubishi UFJ Securities, Japan

“...wonderful organization speakers had been also well chosen”

Philippe Geiger, General Directorate for Energy and Raw Materials, French Ministry in charge of Finances, Economy and Industry

“ ... perfectly organized symposium and most interesting subjects”

Philippe Novak, Christian Fouillac and Yves Michel le Nindre, BGRM, France

“The Symposium was truly a productive and memorable event. Please convey my appreciation and thanks to each of the Saudi Aramco staff that played a role in making this Symposium unique and successful”

V. Kuuskraa, President, Advanced Resources International, Arlington, Virginia USA

“Once again, I would like to express my appreciation for the excellent carbon management symposium organized by you and others at Saudi Aramco. I am very happy that I was able to attend.”

Ms. Laura Atkins, Senior Research Analyst for Technology, OPEC, Austria.

“I should take the opportunity to give some further comments. Once again I think the conference was extremely well organized. Everything went was smooth and your hospitality were great.

Thank you for the splendid conference. My best regards.”

Daniel J.A. Johansson, Chalmers University of Technology, Sweden.

“The message of our symposium was also highlighted from the podium at the Greenhouse Gas Technologies conference (GHGT-8) which I attended in Norway earlier this week. (GHGT8 is the largest international conference on carbon management (1000 delegates representing National and international organizations, energy producers, research centers and equipment providers). During his address Masaki Iijima of Mitsubishi Heavy Industries praised Saudi Aramco for displaying leadership through organization of the Dhahran symposium and the vision of our CEO in calling upon energy producers to join the shared challenge of GHG mitigation. Furthermore, Dr. Ijima called upon developed nations to join with non-annex 1 countries (particularly singling out Saudi Arabia), to fund joint CCS and EOR projects. His rationale was that by November this year (at the COP/MOP2 meeting) CCS and EOR projects are expected to be approved eligible for carbon trading credits under the Clean Development Mechanism (CDM), providing a win-win opportunity for both parties.”

M. D. Wingrove, Aramco Overseas Company, Leiden, Netherlands

“I wish to thank you on behalf of the Royal Commission and all your colleagues for your outstanding efforts in organizing the Carbon Management Symposium .. which in fact turned out to be a major scientific event and gave us the opportunity to broaden our knowledge on this important but often shadowed and overlooked issue that is greatly associated with our Kingdom's oil production and refining

activities . We look forward for future environmental events that promote Aramco's achievements and provide latest information on new technologies”

Khalid AlHajery, Manage, Environmental Monitoring, Royal Commission Yanbu

We appreciate the great efforts and the hospitality of the management teams to organize and conduct this seminar in a highly professional manner. All members of the different committees who made this event successful deserve great appreciation and acknowledgement. Kindly forward my appreciation to all involved in the management of this seminar.

Dr. Mohammad Ashraf Ali, King Fahd University of Petroleum & Minerals, Saudi Arabia

“I wish to take this opportunity to thank you, members of the organizing committee and ARAMCO for a very interesting and very successful Symposium. The program covered a wide range of subjects which made it possible for us to learn about aspects of CO2 management which we would not have an opportunity, as sub-surface engineers, to learn otherwise. I wish to thank the organizing committee for making such a great effort to provide a working system that was practical, efficient and kind. We appreciated all aspects of the symposium.

Mrs. Ghaniya, Senior Reservoir Engineer, ADNOC E&P, UAE

“....my attendance of the 1st Regional Symposium on Carbonate Management was a great event! I was, like all attendees, was totally overwhelmed by the impeccable arrangements of the Symposium by Saudi ARAMCO!! The trip to Shaibah, too, was wonderful!

Waddah T. Al-Hanai, ADNOC, UAE

“Thanks again for the wonderful hospitality by Aramco during the symposium.”

Eric C. Potter, Associate Director, University of Texas at Austin.

“It was a most useful and enjoyable symposium. Thank you for the hospitality.”

Harry Audus, General Manager, IEA Greenhouse Gas R&D Programme

“My hearty congratulations on pulling off a FANTASTIC event last week. I got to talk to a lot of people on the Shaybah trip, and every single one was totally knocked out with the quality of the entire week, in all regards. The Shaybah visit really was a master stroke. It really made for a lot of networking. I know how hard you worked on this, with the Organizational Team. It was worth every ounce of effort, judging by the comments and feedback I received from delegates. I'm looking forward to working even closer with CMT over the coming months, as we follow up on the platform built by the Symposium.”

John Cole, Coordinator, Field Mapping and Modeling, Southern Fields Characterization Division, RCD

"I truly enjoyed the experience of visiting Saudi Arabia and the very stimulating discussions and presentations."

Dr. Joyce Penner, University of Michigan.

"...Forgive me for the delay in expressing my deep appreciation for your hospitality and for organizing a superb conference. The conference format and Q/A sessions plus the lectures made for an informative occasion. I came away from the conference with the immense feeling that ARAMCO's forward thinking on carbon will place Saudi Arabia in better light internationally and will provide better future for the region. Specifically our discussions on the issue of using MOF technology for various applications dealing with carbon dioxide were refreshing. I want you to know that I am prepared to direct my mind and efforts toward building a productive cooperation program with ARAMCO on this topic. I look forward to working with you."

Professor, Omar Yaghi, University of California, Los Angeles.

"The last few words I'd like to say are to the organizers who have done a great job. This is one of the most organized conferences that I have been at and is going to make me very nervous when I have to go back and try to organize a conference because the bar has been set very high right in this group. And not only through organizing of this technical session through this symposium but injecting cultural things from Saudi Arabia into me, at least, and other people that I've talked to. I am going to leave here certainly with new Saudi friends and it makes me really appreciate this side of the world, how great the people are. I'd really take home a bit of Saudi Arabia at my heart and sure many people will also. And so ladies and gentlemen, to the delegates, to the speakers would you join me in thanking the organizers...."

Dr. Michael Monea, PTRC, Canada

"I must raise my عقاب to you for your outstanding organization of the conference and for your fantastic collected and professional start of the symposium sessions and for your handling all aspects really well. I am truly impressed and wish you all the best in all future endeavors."

Mohammad A. Mulla, Manager (A), Public Relations Department, Saudi Aramco.

Feedback and Comments on “Where do we go from here?”

1st Regional Symposium on Carbon Management

Kelly Sims Gallagher, Ph.D., Director, Energy Technology Innovation Project Belfer Center for Science & International Affairs, Kennedy School of Government, Harvard University (via email)

As I suggested in our smaller meeting, I would recommend a five-point plan:

(1) Continue to sponsor a conference on carbon management in the Middle East every two years or so. Work on increasing participation from others in the region. This would provide great benefits in terms of networking, sparking collaborative projects across companies, research institutes, academia, and countries, updating the state of collective knowledge about carbon management, and providing public education in the region through news articles about the conferences.

(2) Launch several industrial-scale carbon storage demonstration sites in Saudi Arabia and connect them to the international effort to understand carbon storage in a transparent way. Make sure they will add to the international body of evidence about the pros and cons of carbon storage. Share data, lessons learned, etc.

(3) Announce a corporate commitment to manage carbon within S. Aramco's own operations. You can achieve some learning through the reduction of greenhouse gas emissions from your own operations, and through this process, you might achieve financial savings and/or marketable products.

(4) Develop a road map for carbon management within Saudi Aramco. Consider how else Saudi Aramco could create value for the company out of the challenge of climate change. What is the technical RD&D strategy? Is it investments in development and deployment of solar PV or solar thermal technologies? Is it carbon capture from industrial operations?

(5) Make all of these initiatives public to show that your company is progressive, responsive to one of the biggest potential challenges the world has ever faced, and to that you provide a good example to other state-owned oil companies.

Prof. Robert Socolow, Princeton University (via email)

This has been an extraordinary meeting. I too am very glad that you have arranged for this time at the end of the meeting for us to reflect on next steps together with you. There's a lot of talent in the room able to think about this question.

I begin with the assumption that there should be, soon, at least one distinctive Saudi Aramco project in CO₂ capture and storage (CCS). Those of us here should be able to help Saudi Arabia think about some of the ways in which the company can make distinctive contributions at the frontier of CCS, given their special advantages and given what is going on elsewhere. Let's suppose a group at Saudi Aramco has been given a year and a half to figure out what project it should undertake. Let's assume it wants to make contributions

complementary to what other people are doing, taking advantage of the local situation, specific oil fields, etc. What criteria would help Saudi Aramco should make this choice? Which open questions in CCS especially need exploring?

I'd love to see Saudi Aramco ask for letters from people who've come here, asking them these questions. The group here knows a lot about the approximately 10 large projects already in operation or well along in planning. What gaps do these projects still leave, from a global perspective? I am pretty sure that the distinctive contributions of Saudi Aramco projects are in the storage area, rather than the capture area. Of the many distinctive features of the Gulf's sedimentary structures, which ones can become advantages Are there opportunities because these structures are carbonates, for example?

I also want to bring forward a question implicit throughout the meeting. How can Saudi Arabia receive an economic benefit from storing CO₂ below ground? The answer is not obvious. Saudi Arabia is not now a participant in a carbon market. Also, the Clean Development Mechanism of the Kyoto Protocol seems poorly suited to projects in Saudi Arabia. Let me expand on these thoughts.

CDM is a secondary mechanism, built upon the Kyoto protocol, limited in total scale by the size of the world's Kyoto-driven activity. Arguably, it is not a large enough mechanism to deal with the immense opportunities for carbon management in the Gulf region. I would like to see Saudi Aramco dreaming about a role in global carbon management that is not subordinate to the Kyoto structure. I would like to see Saudi Arabia expressing an interest in becoming an equal partner with the Annex 1 countries in designing the post-Kyoto regime.

To be sure, CDM has its place. It is important that CCS projects be included in the CDM process. This will accelerate the transfer of experience with CCS around the world, and increase the total level of activity in the next decade, when there will be significant global learning from every project, wherever it occurs. But, if I'm not mistaken, the Gulf is not the part of the world for which CDM was imagined. It was imagined as a mechanism to support projects in very poor countries.

In principle, Saudi Arabia could join the group of Annex 1 countries. It could create a price for its own CO₂ emissions by joining the Emissions Trading System of the European Union and placing its own emissions under an expanded cap. This would remove the mismatch between the intentions of CDM and the wealth of Saudi Arabia. Saudi Arabia would be able to implement CDM projects elsewhere and get credit for doing so.

R K Pachauri, Ph.D, Director-General, TERI, Habitat Place, New Delhi (via email)

My views on 'where do we go from here?' are as follows:

It was refreshing to see the leading hydro-carbon company in the world Saudi Aramco devoting so much time, effort and resources in organizing the First Regional Carbon Management Symposium. Most heartening was the commitment displayed by the leadership of the organization throughout the proceedings and the conduct of the summit. The legendary hospitality of the Arab world was of course so much in evidence throughout the symposium, but even more significant was the effort to mobilize the best minds and the

highest level of expertise from across the world for dealing with the theme of the symposium.

I believe it is particularly important to move forward by carrying out an assessment of how Saudi Aramco could transform itself to a more responsive role in respect of carbon management in its future operations. To my mind this would require investment in technologies to capture carbon in a diverse range of operations and to develop technological solutions based on renewable energy of which Saudi Arabia has an abundance. It is essential for a company extracting an exhaustible resource to invest adequately in creating inexhaustible resources through technological innovation. I think this could be achieved effectively by Saudi Aramco by setting up a small group of advisors, drawn from an international pool to help the company with an exercise that develops scenarios and trajectories of how such an objective could be met, say in the next 25 years.

I wish the organizers of this Symposium all success in carrying this mission further.

Prof. Daniel J.A. Johansson, Chalmers University of Technology (via email)

My impression from the first letter was that the conference would be somewhat wider in scope, more about greenhouse gas abatement in general and not so focused on carbon capture and storage technologies. Now afterwards I guess it is a good idea to focus on the specific topic you did. There are a lot of conferences on abatement technologies, economics and policy related to it going on in various parts of the world.

So where should you go from here? I guess it is a good idea to organize a new conference in a couple of years from now. The organization was splendid, so you do not need to do much about that. Perhaps you should make the schedule a bit less tight, the conference days included the very nice dinners where a bit too long. I know that there is so much research going on about carbon capture and storage (CCS) both really technical research and more policy orientated. I think it would be central to conference to wider the discussion on about how important CCS are going to be, both from the perspective of enhanced oil production, but more importantly from the point of view of climate management. How important is CCS in relation to energy efficiency measures, renewables, carbon sequestration, abatement of non-CO2 GHGs etc?

Comments at the closing sessions

Michael Monea, PTRC

Langhorne Smith very rightly thanked Saudi Aramco for putting on this great conference. I'm absolutely overwhelmed with the vision and foresight that Saudi Aramco had and as a person who's traveled a long way as many of you, I really appreciate having a chance to talk about some of the technologies we're working on. Like I heard at lunch time, one person said, my head is full of CO₂. And we have so much that we've talked about. Each time that I attend a conference, I come out with a different perspective because somebody has boiled down some research and it made it really look like we can make a difference. And I think we can because we are coming at it from an oil and gas point of view. And I feel sorry for government officials that don't have the background that we have collectively.

Because it must make them feel frustrated or really wonder if we can do something about this CO₂ that we are putting into our atmosphere. But what you've seen here is that we have technologies that we exploit and we learn from drilling and how to inject CO₂ in the aquifers. We have tools, and we have that to help us find our oil, that can actually help us bury the CO₂ so I think we're going to be the mechanics, I guess, for different governments and companies much like Saudi Aramco is doing right now, trying to be a leader, which they are, in getting rid of CO₂. So, I think the work that Saudi Aramco is doing is just absolutely commendable.

Leo Meyer, IPCC

First of all thank you for this fantastic experience. I think we made a lot of new friends here. I have a few suggestions for the 2nd regional, or 3rd or 4th conference, maybe taking up some momentum that was created here.

1. Add a platform for exchanging practical experiences on CCS projects as they will become more overtime and will be quite valuable to have a free place for it for people who really know how to do it from a practical side of view to exchange those experiences. Take part on the discussion that we started this week in Bohn at the climate convention where they were discussing CCS and CDM on all the difficulties they encounter. One of which the CDM Executive board is insecure about things like sight selection criteria. And a lot of knowledge apparently is right into this room and would be quite helpful to the discussion and to come to a positive conclusion, to feed that discussion with insights how to properly select sights for CCS and also from monitoring techniques. Another question that would be very important for politicians. I heard two estimates on world potential on EOR, storage of CO₂. One was about 1.6% of all oil produced so far and the other one is 100%. Maybe the truth is somewhere in between but that really would deserve more attention and perhaps more studies that could be brought to this table because I think that is a very strategic number not especially for governments but also for oil companies to focus on.

Some really new innovative ideas were brought here to the table. They normally are not that popular at large conferences but they would certainly applaud for giving the opportunity for, even if they are long-term to keep the momentum also for that and encourage researchers from both academia and industry to come up with innovative ideas. And I hope these suggestions can be taken aboard.

Via email.

At the end of the symposium, there was a request from your side to give some feedback to you with regard to possible future symposium subjects. Let me offer you a few personal thoughts, building on the Aramco symposium, and based on the question: how could the oil producing industry develop long term strategies to cope with climate change (leading to both opportunities and threats):

(1) In general, on with regard to all downstream carbon management technology options: specific attention could be paid to:
- energy and CO₂ balances: if a certain technique is introduced leading to lower CO₂ emissions, there could be an 'energy penalty'. What would be the net effect on CO₂ emissions? How could this balance be improved?

- economic balances: what would be the costs (including transaction costs) and benefits (including co-benefits) of introducing a new technology at what CO₂ price might this technology become competitive; what would be an acceptable rate of return.

(2) more specific on CCS:

- global evaluation of storage capacities (with/ without EOR, different geological formations)
- criteria for site characterization and selection; how to ensure long-term monitoring of CO₂ retention/ release

(3) create more background knowledge within the oil engineer community on the broader issue of climate change (issues like: are the observed changes in climate natural or human induced; what to expect in the future; are the potential consequences really important),

Again, my sincere thanks and gratitude for this great event.

B. Iain Wright

First of all I'd like to applaud Aramco for asking us all for our feedback... We usually go to these large conferences and you give your presentation and you go home and there's never any integration or feedback. So thank you again for asking us....

1. At BP, we've learned a lot by putting together integrated projects. At this conference and others, we see maps of sources and maps of sinks. However, when you try to connect them together to focus on an industrial-scale project you learn how limited this might be. So, I would encourage Aramco and also your other colleagues in the Gulf States to put together some options for large scale demonstration projects that you can put out there in the public arena and help this discussion because regulators are not interested in regulating something that only appears in the lab. It's only when you get serious and you talk about large scale projects that you get the interest of regulators and the policy makers and also the public.

C. John Kaldi

I'd like to echo everyone's compliments and absolute satisfaction in everything we have had in the little bit of Saudi Arabia that we will all be taking back in our hearts and suitcases after our shopping trip

1. One of the things that I found is that I make a lot of mistakes. I learn hopefully from other people's mistakes and hopefully people learn from my mistakes. I'd like to be able to consider ourselves as a small community, a small family that we can share those mistakes made and lessons learned as part of the agenda because if we can admit our mistakes, someone else won't make them and to think that would be helpful.

D. Ed Writer, Dow Chemical

Just a follow up on John's comment. It said that a smart person learns from their mistakes and why this person learns from the mistakes of others. So, I think

1. It's really good to think for the second conference or whenever that might be, what is it as a group we've learned, and not only what is it we've learned and we thought about doing and also
2. Some measurement on what we've been able to do as a collective body.

There are a lot of things that can be talked about. That in the end what really matters is what we've been able to accomplish.

E. Robert Socolow, Princeton University (see email above)

F. Neeraj Kumar, Oil and Natural Gas Corporation - India

It was really wonderful to be over here, I would like to congratulate Saudi Aramco for the wonderful symposium that they have. It was definitely a lot of knowledge getting from all the speakers that we have in the three days. We also will be taking a lot of culture back to our country about Saudi Arabia, learning the last 5 days.

1. The most gained part for me was we had a personal implementation of CCS project, and it was almost after every session that we have, running after speakers, how you do that, what's the challenge and everything...and almost know each of the speakers, that's the biggest gain for me.
2. The only solution that I have is we should have another symposium like it, maybe in another year or so, so that we can go back and see what you learned and how we have implemented it in the next one year or one and a half years.

G. Emil Elewaut, TNO-Netherlands

One of the things I've seen, time and again, is how science works. You start with an idea but that idea only bears fruits when the technology is implemented by the industry and afterwards come to government with the regulations and etc...And that may give you an idea or maybe I should wait until there's more known because we all make mistakes, we've learned from the beginning as an engineer and geologist...it is simple, just like producing oil, well it is not....there are some other hiccups and pitfalls in there. And you can stand on the side. But I made the analogy this morning with PCs, the early times of personal computers. Everybody said, I'll buy my computer next year because it will be cheaper and more powerful and in the end they waited such a long time that they missed the boat and never learned about computers.

1. This is a time when a new technology is emerging, those that will jump on it, will give us all the opportunity here in the room to learn and better plan for the future.

H. Ed Writer, Dow Chemical

I would just add one comment to that, relative to talks perhaps for the next session and that is in the talks that

1. You give consideration to not only telling what it is that you know or you think you know but what it is that you don't know, the constraints that you have tried to examine and have fallen back because you were not able to determine something and present it as a challenge to the collective body to help you fill in the space of knowledge.

I. Leo Meyer, IPCC

Apologies for taking the floor again but I would like to elaborate a bit of what Professor Socolow just said and another remark that was made by British Petroleum by Mr. Ian Wright. This is all fine guys but we need to make money out of it, that was the bottom line of these presentations and unless there is some sort of a price for CO2 generated by some sort of constraint either by Carbon Trade or Taxes or whatever then that money is not going to flow in. And to that end, for the environment it would be the best if all countries will join in some sort of Carbon Trade system but that's still a far cry at this moment. At this moment, this CDM may not be ideal mechanism but it is the only one that is available right now for those countries that are not part of the Kyoto protocol and outside at one country. Being the majority of the oil-producing countries, to use this mechanism and to generate that kind of income. That could help as a start as a catalyst for a longer process.

J. Iain Wright, BP

Just picking up on these two excellent comments from Professor Socolow and Leo Meyer on the CDM process,

1. I don't think the CDM process is going to deliver any material value to us any time soon for CCS projects because it will take such a long time to put in place that the Kyoto protocol will be finished by the time we get there. So I'm interested in the post Kyoto framework.

2. However, there is one thing that the CDM is addressing right now, and Adrian's projects have been key to this. The key issues for geological storage are:

1. project boundaries,
2. leakage, and
3. permanence.

So, I think that you may or may not believe in the CDM process but you have to believe that if we write some rules at a global level to address those three issues that those rules will still be in place in any post-Kyoto framework that comes along, such that CCS may actually be able to benefit commercially from it eventually. So, for that reason, you need to stay engaged in the CDM process, not because we think there is any money that can be made out it anytime soon, but because it can create guidelines for global standards that will need to be met if the geological storage of CO2 is to receive any form of monetary credit other than the value of the additional oil recovered from EOR.

K. Waddah Alhanai, ADNOC

On behalf of my colleagues from Abu Dhabi, I would like first to thank Aramco for this wonderful opportunity of bringing us together here with such a heterogeneous background. You put us, in terms of organizing the conference, at the summit and from now on we can only go downhill from here, I'm afraid. So that you really put a tremendous responsibility on the next country to hold this symposium if it's not going to be here again. So again, thank you very, very much.

1. I'm sure I gained a lot. I personally gained a lot, at least the courage to talk about the future of CO₂ injection as miscible gas for EOR, and carbonates... We had one experience and I personally was afraid to talk to our management about the results and now I think I learned at least to have the courage to talk about it.

Thank you again, very, very much for this successful opportunity.

L. Vello Kuuskraa

This is quite a unique event. And following that, I was thinking,

What is it that you, Saudi Aramco and Saudi Arabia could do that would be a unique contribution to the next step and I looked at the title to your conference, Carbon Management, it isn't just carbon sequestration, carbon capture, it's carbon management. And there are couple of sessions here, one this morning that was just outstanding which began to deal with industrial use of carbon, whether it's carbon fiber or in methanol, or other applications in strengthened materials. That is unique, I have not seen that often in a conference.

Second would be, you also have a unique geological opportunity which is to apply CO₂ early in the life of oilfields and ask a question is that a more efficient way to recover oil than waiting, like what we have in the US, to the very dead end.

M. Ashok Chakraborty, Oil and Natural Gas Corporation - India

Thank you, first of all, to Saudi Aramco for an excellent arrangement and organizing this symposium. This was our first visit to KSA and we are deeply impressed. Thank you once again.

Now, coming back to CDM, I am referring to Iain's comments.

1. Firstly, when this CO₂ sequestration methodology is likely to be approved as we have learned the last three days, sometime in the CobMob meeting which is due in November.

2. As for this protocol, when we are developing the CDM project, we have the choice of two periods: That's called Accounting Accrual Periods. We can have for ten years the certified emission reductions for what is called in short CER's or carbon credits.

- a. So if we choose for the ten year period then we'll continue to get the credit for the continuous next 10 years.

Now the benefit of ten years is that we have to get the validation done only once and it will be done yearly monitoring and verification.

- b. Or there is another option. We can go for 21 years, that is 7 into three. And if we have to go for this, at the close of seven years, we have to go again for another validation.

So it's not ending with the first commitment we heard, that is 2012.

N. Adrian Exon Stott

As a CDM consultant, I'm always asked by my customers, what's going to happen with this 2nd commitment period? I'm quite upbeat on the negotiations at CobMob. I actually think that there could well be a 2nd commitment period. Even if there isn't a 2nd commitment period, you can look at selling verified emission reductions and arguably they could demand a higher price and see us, depending on demand, depending on the systems which are up and running. There could be systems in the States, there could be systems which are linking all over the world. So, it will depend on demand.

1. And I encourage Saudi Aramco to go forward by a-learning-by-doing process. So I agree with Iain, CCS is still a long way away within regards to CCM. But they should look at other projects which are easier to go forward with, for example, renewable energy, energy efficiency; these are the projects that can go forward now because there are accepted methodologies.

2. In regards to the CDM methodology for CCS, that is still under debate within regards to the eligibility issue. How that pans out, I don't know yet but this would be decided this year. Hopefully....

O. Christian Fouillac, BRGM

First, I want to thank Saudi Aramco for having organized very nicely and efficiently this symposium, where during three days, we have been able to listen to CO2 capture, storage, industrial use, financial instrument...

But I also want to point out that, a very, very important point is, in some of the points of that carbon chain, we need additional scientific knowledge. For example, for CO2 EOR, we need to understand very precisely what is exactly the kinetics of calcite dissolution and precipitation; maybe we should take advantage of knowing what are the bacteria living in the reservoir? Can we use it? And if I may suggest something, is not to forget beside all these technological point of view, not to forget the necessary knowledge that we need to use for the long-term improvement which may of course get us, very important reduction cost in long-term strategies.

Thank you very much again.

P. Ed Writer, Dow Chemical

If I could just add one more comment, one of the Speakers this morning summarized well the focus of the meeting so far. And that he mentioned that we talked about how we capture the CO₂ and then 2nd what we do with the CO₂ after it's captured. However there are other options that were also mentioned.

And by far, the best economics is if you don't emit the CO₂ to begin with. And a few comments were made that we can all actually participate in that by conserving the energy, by turning the thermostat down - I remember one of the comments in that direction. Between now and the next conference, I guess, what we all can do in that regard.

Q. Isao Mochida, Kyushu University

First of all, thank you very much with Saudi Arabia, Aramco and the organizing committee...Our material group would rather minor this conference but I enjoyed very much the technique and science of CO₂ sequestration and we try to find our contribution to this rather long term issues of... all to be solved.

In addition that Saudi Arabia, Aramco is the largest oil supplier to all over the world, in short term, we try to get better use of petroleum all over the world. And I'm sure that we have enough amounts of resources, maybe within 100 years. But still the people want to use the petroleum... growing and growing every year. So, in the short term, we try to work how to use the petroleum in the better way and we need/lean to the better material and better engines and other elements. So, this is a very good conference and very balanced in the short term and long term problems in the energy in the world.

R. Emil Elewaut, TNO-Netherlands

It happens so that I am a member of the EU-GCC Experts Advisory Group. There is a Memorandum of Understanding between the EU and the GCC members related to energy, in the development of energy, and related problems such as carbon management. There have been a few questions here in the audience about creating a platform, maybe

1. This memorandum of understanding between the EU and the GCC might be a good vehicle to start off such a platform. I will take that suggestion with me to Brussels; perhaps it can get some support here too.

S. Salman Al-Khayyat, BAPCO

On behalf of myself and my colleague, I would like to thank Aramco for their great hospitality and for a well-organized conference. I would never; in fact when I came here, I'd never imagined that the conference would be a great success. Congratulations and well done.

1. Secondly, I think I heard a comment from one of my colleagues here saying that everybody is looking at the economics. I think there is another issue which we have to look at and that's we have an ethical responsibility towards our grandchildren. We have to

create a safe and clean environment. That's the second issue that we have to cater for in addition to economics.

T. Michael Monea, PTRC

Anybody that's starting up Phase II of any research project or collaboration, I think you could, as I did,

1. Learn a lot from that sword dance last night. I'm probably going to use that technique when I get all my lawyers together next week and they stall my contract negotiations. I think I'll be doing that sword dance to see if I can get that contract moving.

**Presentation at 1st Regional Symposium on Carbon Management
Dhahran, 22-24 May, 2006**

**Nadhmi Al-Nasr
Symposium Chairman
Saudi Aramco**

Welcoming Address

Distinguished guests, ladies and gentlemen, let me begin by welcoming you to Saudi Arabia, and to the 1st Regional Symposium on Carbon Management. I greatly appreciate your commitment to supporting the petroleum industry's role and activity in responsible carbon management.

I am delighted to see so many new faces, and I look forward to meeting many of you in person as the proceedings unfold. I express my thanks to the organizing team who have worked extremely hard to make this event possible and I appreciate their dedication.

Ladies and gentlemen, we are at a crossroads in the debate on climate change - at a point where management of carbon emissions can no longer be ignored. In fact, the current level of manmade carbon emitted worldwide is around seven giga tonnes per year—over three times that of 1955. If society does not introduce new and responsible carbon management practices, that level is set to double again by 2055.

The convening of this symposium is an important milestone and a positive step to engage the region's response to the carbon management challenge. The program will engage participants from both the supply and demand sides of hydrocarbon industries. The region as a whole plays a vital role in supplying oil and gas to domestic and international markets. Therefore this symposium is designed to enhance carbon management awareness and has special relevance to petroleum.

Over the next three days, this forum will not dwell on the science of climate change; rather, the program aims to generate insights into the important role that the petroleum industry can play in future endeavors.

We will start with keynote presentations and discussions that highlight the necessity for practical and pragmatic carbon management solutions. Furthermore, the program focuses on relevance to global markets, governmental policies and regulations, and the economic development of nations.

Supply and demand challenges and technology are other key themes that will likely surface in presentations and panel discussions on our agenda over the next 3 days. During the conference, we will listen to updates on industrial carbon capture and disposition options. Speakers will reveal the progress of ongoing demonstration projects and promising new technologies.

We will also hear from industry partnerships established to manage carbon emissions from the electricity, heat and power generation industry. Following sessions address the role that carbon dioxide-motivated enhanced oil recovery can play in meeting petroleum supply challenges.

Presenters will highlight the petroleum industry's need to address carbon management of the transportation sector. Later in the program, speakers will highlight the possibilities for manufacturing carbon-based products that add economic value to the carbon extracted from hydrocarbons.

I recognize that the petroleum industry must play a more prominent role in carbon management if it is to continue to supply clean-energy products to the world. Introducing timely carbon management solutions that are acceptable to markets, governments and society will require new industry partnerships to evolve, and the launching of new technology development initiatives.

Bringing together so many leading authorities and wide ranging perspectives over the next three days provides a valuable opportunity to network. We should strive to make necessary commitments to resolve petroleum-related carbon management challenges in innovative ways - furthering dialogue - sowing seeds - harvesting solutions in the future.

Ladies and gentlemen, let me close my remarks by wishing you all a successful symposium and an enjoyable time in Saudi Arabia, and to thank you for joining us for this historic event. Thank you.

Distinguished Guest, ladies & gentlemen,

It is now my great pleasure to introduce the President and CEO of Saudi Aramco, Mr. Abdallah Jum'ah, who will present the opening address.

**Presentation at 1st Regional Symposium on Carbon Management
Dhahran, 22-24 May, 2006**

**Abdallah S. Jum'ah,
Saudi Aramco President & CEO**

Opening Address

Distinguished guests, ladies and gentlemen, it is a pleasure to be here for the opening of the 1st Regional Symposium on Carbon Management, a topic that has attracted a great deal of attention globally, as well as here in the Gulf. On behalf of Saudi Aramco, I welcome all of our guests and thank our speakers and panelists for their participation in the symposium. I would also like to thank the organizers for developing such a wide-ranging program of addresses by distinguished speakers and technical presentations, and for their leadership in making this landmark event a reality.

I am delighted to see so many participants representing international organizations, national bodies and commercial entities - coming together to discuss and debate carbon management with special application to the petroleum industry. I understand that there are some 400 attendees representing over a hundred different institutions and companies, joining us from 24 countries. That's fitting, because just as our participants come from many nations and many different backgrounds, the carbon management challenge ahead is global and multifaceted in nature too.

Ladies and gentlemen, at Saudi Aramco we believe our position in the petroleum industry brings with it a number of important responsibilities:

- to provide a reliable, stable supply of energy to the world, while minimizing the environmental footprint of developing and consuming this essential energy source;
- to contribute to the Kingdom of Saudi Arabia's continued prosperity;

- and to play our part in the realization of the nation's economic, human, and social potential.

That is why we continue to work so aggressively to meet the growing energy demand of a hydrocarbon-hungry world, to capture additional value from the Kingdom's precious oil and natural gas resources, and provide greater opportunities for the Kingdom's citizens.

Naturally, our role as a leading energy supplier requires us to address environmental issues that are of concern to society—because we as a company and as individuals are an integral part of that society. Stewardship is one of our corporate values, and in keeping with that principle, the protection and preservation of the natural environment is one of our highest priorities. Our commitment takes many different forms, from environmental impact studies and research on energy conservation, waste management, and the protection of land, water and air resources; to community outreach and educational programs that encourage environmental awareness among young people in the Kingdom and abroad.

That role is certainly not unique to Saudi Aramco; indeed, corporate responsibility and positive engagement in local communities is a hallmark of this region's petroleum sector.

Now, in keeping with our enduring commitment to the environment, and in recognition of the concerns involving climate change, Saudi Aramco and other oil companies are also increasingly engaged in the ongoing discussions surrounding carbon management. As a major provider of global energy supplies, I believe the petroleum industry should actively engage in policy debate on climate change as well as play an active role in developing and implementing carbon management technologies to meet future challenges, and that national oil companies—like Saudi Aramco—can make meaningful contributions to those efforts.

Ladies and gentlemen, while scientific debate over the nature and causes of climate change continues, the world's population is set to grow by about 50 percent during

this century. For the foreseeable future, countries will continue to rely upon hydrocarbon-based energy to elevate and sustain living standards of their people, and to foster economic growth and social development. If that is the reality, how can we meet growing energy demand in a manner that is both economically sensible and environmentally responsible, providing petroleum products in a way that lays a firm foundation for today as well as a sustainable tomorrow? That to me is both the crux of the issue and the challenge to be addressed by forums such as this.

In fact, ambitious targets to reduce carbon dioxide emissions have been set by many countries, and are to be achieved over the next decade. Meeting these objectives will have significant implications for energy product choices; the rate of economic growth in different parts of the world; and the competitive situation of nations, both developed and developing. These dynamic changes will in turn create complex new market realities with which we all must grapple.

However, I believe that carbon management is not just a regulatory issue, a governmental imperative, or someone else's concern. From my perspective, the petroleum industry can and should be an integral part of the solution - not the source of conjecture. The carbon management challenge is too large and too complex for any single set of actors to tackle alone, and companies, governments, regulatory agencies and research institutions must work together if we are to be successful in our carbon management as well as climate change policy endeavors.

That said, our industry boasts some of the most talented people and most creative minds of any economic sector on this planet. Those of us in the oil business can look back with pride at a century of achievement, of technological innovation, and retell major success stories that have overcome mighty challenges. Ladies and gentlemen, I see no reason why the century ahead should be any different.

Without a doubt, new solutions need to emerge that allow both responsible management of carbon and the healthy growth of the global economy. Importantly,

real solutions will not only minimize the amount of carbon released to the atmosphere, but can potentially also capture value from the carbon recovered. Personally, I believe that *technology development* will play a pivotal role in finding realistic and credible ways to deal with the carbon issue as well as supplying clean hydrocarbon-based energy. Efforts such as the sub-surface sequestration of carbon, next-generation engines and propulsion systems, more environmentally friendly fuel formulations, and the manufacture and industrial utilization of carbon fibers are all exciting areas for further research and development. Here again, the history of innovation in our industry makes me optimistic.

But no company and no industry can go it alone, and I strongly believe that the carbon management challenge is best tackled by bringing together creative talents from around the world, and by encouraging the active participation of all stakeholders.

Collaboration requires partnerships between upstream hydrocarbon suppliers, downstream product manufacturers, transportation industries, international research organizations, government agencies, and end-users themselves. That's why I consider this symposium to be so important. It represents a gathering of all of these parties to understand the policy debate, focus on carbon management and creates an opportunity for us all to exchange ideas, share information and benefit from one another's perspectives.

This symposium also recognizes the responsible role that companies and institutions in the Gulf region can play by working in partnership. This includes not only better understanding climate change, but also promoting greater regional carbon management awareness, and identifying with, developing and deploying new initiatives that make sense from both the economic and ecological perspectives.

I look forward to hearing of new insights and recommendations emerging from the valuable exchanges which will take place over the next several days. I hope that

together we leave this symposium with a renewed sense of purpose, a better understanding of our responsibilities to the planet and its people, and a greater determination to both tackle the carbon management challenges in a balanced way, and benefit from the exciting opportunities which thoughtful solutions can offer.

Ladies and gentlemen, thank you for your attention, and let me wish you all a very productive symposium and an enjoyable stay in the Kingdom of Saudi Arabia.