ASPO

The Association for the Study of Peak Oil

Second International Workshop on Oil&Gas Depletion, IWOOD2003

26-27 May 2003

Institut Français du Pétrole
Rueil-Malmaison, Paris, France

Contents

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WELCOME

The Association for the Study of Peak Oil (ASPO) is pleased to welcome you to its Second International Workshop on Oil and Gas Depletion. We hope it will match the success of our first workshop last year at Uppsala University in Sweden.

ASPO is a network of scientists in universities and government departments, now represented in almost all European countries. Its mission is to:

- evaluate the world's endowment of oil and gas;
- model depletion, taking due account of economics, technology and politics; and
- raise awareness of the serious consequences for Mankind.

The world runs on oil and gas. They were formed in the geological past, which means that they are inevitably subject to depletion. We started running out when we produced the first barrel, but running out is not really the main issue. Much more important is the discontinuity that will arise when the past growth of production gives way to decline. Given the central position of oil and gas in the modern economy, it is no exaggeration to say that this discontinuity is one of the most serious issues facing the world today.

This workshop will explore some of the key issues. When will peak arrive? Will it be a peak or a plateau? What are the political reactions? What are the economic implications? What will be the geopolitical consequences? Does it necessarily spell resource wars? What solutions are there? How soon can renewable energies be brought in? To what extent can they substitute? What does it mean for individual countries, each facing its own conditions? Why are public data and information on this critical subject so grossly unreliable? How do we define what we have to measure? Where do governments now stand on energy policy?

These are the questions that the speakers will address and we will debate. Our aim is to stimulate new thinking, understandings, proposals and reactions. Do resource constraints challenge the very foundations of classical economics? Do we need a new mindset with which to face a different world from the one that we have become accustomed over the past century, when the population of the planet expanded six-fold exactly in parallel with the growth of oil supply?

This event results from the indefatigable efforts of the organising committee in Paris, comprising Pierre-Réné Bauquis, Jacques Moulin, Benedicte Reverdy and Isabelle Gueret. It has been made possible by generous support from our sponsors and from the Institut Français du Pétrole (IFP). Thanks are due to The Oil Depletion Analysis Centre (ODAC) and IFP press officer Anne-Laure de Marignan for assisting with publicity and media relations, and to Multi-Science Publishing Company, which will publish the papers and proceedings.

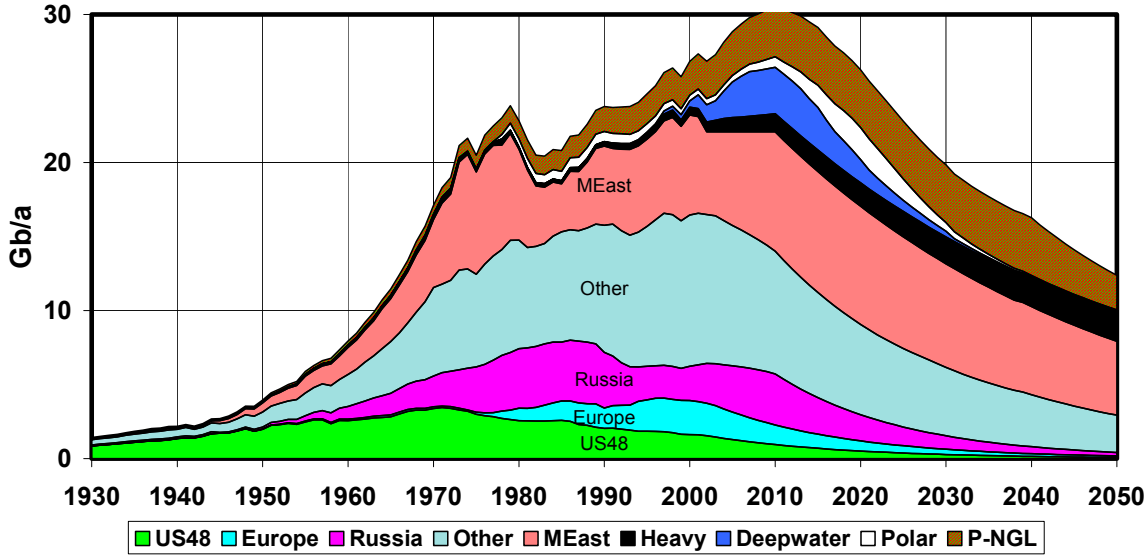
It would, however, be nothing but for the participants – some 150 from more than 20 countries – many having travelled great distances to attend and contribute to this important debate.

Finally, we welcome the representatives of the media and commend them for their efforts to help inform the wider world of the important subjects being addressed here.

We look forward to an informative and thought-provoking exchange of views over the next two days.

GENERAL DEPLETION PICTURE
Uppsala Hydrocarbon Depletion Group
www.isv.uu.se/uhdg

Regular Oil & Natural Gas Liquids
2003 Base Case Scenario



This plot shows the estimated depletion of the world's oil and natural gas liquids, which are derived from gas, showing the effects on the principal regions. The model assumes that:

- the demand and supply for regular oil will be, on average, flat until 2010, reflecting alternating price shocks as capacity limits are breached and consequential economic recessions curb demand;
- the swing role of the Middle East will end in 2010 when in practice it will no longer be able to produce enough to offset the natural decline elsewhere;
- the production of heavy oil, partly from tar sands, will grow slowly, and deepwater oil will come in as fast as technically possible to peak also around 2010;
- the entry of more polar oil, mainly from Russia; and

- an important addition from gas liquids related to gas supply, with probably some increase in extraction.

The model is clearly subject to the impact of unpredictable short-term effects, including war in the Middle East, which could advance or delay the peak, but long-term production is constrained by the endowment in Nature. That is based on established trends of falling discovery since the global peak in the 1960s.

PROGRAMME

Monday 26th May

08:00 – 09:00	Registration
SESSION 1	**Chair: Mr Pierre-René Bauquis**
09:00 – 09:30	*Opening Address* **Olivier Appert** Chairman, Institut Français du Pétrole, France
09:35 – 10:05	*Resource Wars* **Michael Klare** Professor of Peace & World Security Studies Hampshire College, USA
10:10 – 10:40	*The War for Oil* **BBC Film**
10:40 – 11:00	Coffee Break
SESSION 2	**Chair: Mr Jean Laherrère**
11:05 – 11:35	*A Realistic View of Long-Term Middle East Production Capacity* **Ali Samsam Bakhtiari** Corporate Planning Directorate, National Iranian Oil Company, Iran
11:40 – 12:10	*Russian Oil Reserves, Future Exploration Potential & Production Capacity* **Ray Leonard** Vice President, Exploration & New Ventures YUKOS Oil Company, Russia
12:15 – 12:45	*The World's Endowment with Natural Gas:* *The Perspective from BGR's New Energy Study* **J. Peter Gerling** Head of the Energy Resources Section Federal Institute for Geosciences and Natural Resources (BGR), Germany
12:45 – 14:00	Lunch
SESSION 3	**Chair: Dr Roger Bentley**
14:00 – 14:30	*Modelling Oil Production, Energy Consumption, Population & Economy* **Jean Laherrère** Former Deputy Exploration Manager, Total Oil Company, France
14:35 – 15:05	*The Physical Modelling of Future World Energy Demand* **Malcolm Slesser** Chairman, Resource Use Institute, UK
15:10 – 15:40	*Energy Supply Conditions and Oil Price Regime* **Jean-Marie Bourdaire** Director of Studies, World Energy Council, UK
15:40 – 16:00	Coffee Break

SESSION 4 **Chair: Dr Peter Gerling**

16:05 – 16:35 *The North Sea – A Victim of Depletion*
Chris Skrebowski Editor, Petroleum Review, Institute of Petroleum, UK

16:40 – 17:10 *Modelling of Remaining Reserves In a Mature Basin*
Vincent Lepez Assistant Professor, IFP-School, France

17:15 – 17:45 *Oil Prophets: Looking at World Oil Studies Over Time*
Steve Andrews Energy Consultant, USA

19:00 Reception
20:00 Conference Dinner

Tuesday 27th May

SESSION 5 **Chair: Dr Werner Zittel**

09:00 – 09:30 *How to Make the World Aware that the Party is Over*
Kjell Aleklett Professor, Uppsala University, Sweden

09:35 – 10:05 *Will 2000 Turn Out to be the Peak,*
Followed by Wildly Oscillating Oil Prices?
Kenneth Deffeyes Professor Emeritus, Geosciences
Princeton University, USA

10:10 – 10:40 *The 2003 Update of the ASPO Oil & Gas Depletion Model*
Colin Campbell & Anders Sivertsson
ASPO & Uppsala University, Sweden

10:40 – 11:10 Coffee Break

SESSION 6 **Chair: Prof Kjell Aleklett**

11:10 – 11:40 *Options for Future Transport Fuels*
Jörg Wind Senior Manager, DaimlerChrysler Research & Technology, Germany

11:45 – 12:15 *Non-OPEC Oil Supply: Economics and Energy Policy Options*
Maarten van Mourik & Richard Shepherd
Economist & Journalist, France

12:20 – 12:50 *What Energy Sources for Transportation in the 21st Century?*
Pierre-René Bauquis Associate Professor, IFP–School, France

12:55 – 14:00 Lunch

SESSION 7 **Chair: Prof Rui Rosa**

14:00 – 14:30 *The Contribution of Technology: "Creating" Reserves*
Gérard Friès Executive Vice President, Institut Français du Pétrole, France

14:35 – 15:05 *Extra Heavy Oil and Bitumen:*
The Challenges of Enhanced Recovery
François Cupcic Total Oil Company, France

15:10 – 15:40 *Status of Renewable Energy in Europe*
and Its Role in a Renewable Transport Fuel Strategy
Werner Zittel L-B-Systemtechnik GmbH, Germany

15:45 – 16:15 *Property Rights for the Global Commons – Feudal or Democratic?*
Paul Metz Managing Consultant, INTEGeR... consult, The Netherlands

16:15 – 16:30 Coffee Break

SESSION 8 **Chair: Dr Colin Campbell**

16:30 – 17:00	*The U.S. Reaction to World Oil and Gas Depletion* **Matthew Simmons** Chairman & Chief Executive Officer Simmons & Company International, USA [via video link]
17:05 – 17:35	*Risks and Solutions to Ireland's Energy Supply* **David Callaghan** Sea Energy Ltd, Ireland
17:40 – 18:10	Short Presentations and Discussion
18:15 – 18:30	*Closing Remarks* **C. J. Campbell** ASPO

THE SPEAKERS

KJELL ALEKLETT is Professor of Physics in the Department of Radiation Sciences at Uppsala University, Sweden. He holds a doctorate degree from the University of Gothenburg, Sweden. His doctoral thesis was titled, 'Total beta-decay properties and masses of nuclei far away from beta stability.' He worked as a post-doctoral staff scientist at the Natural Science Laboratory at Studsvik. In 1978-79 and again in 1983, he was invited to work with Nobel Prize winner Glenn T. Seaborg at the Lawrence Berkley Laboratory. In 1986 he was appointed Associate Professor at Uppsala University. His main research interest has been nuclear physics. His interest in the global energy situation started in 1995 and has grown dramatically since then. He organised the First International Workshop on Oil Depletion in May 2002 at Uppsala University. Subsequently, he obtained research grants from the Swedish government and from private industry, which made it possible to start the Uppsala Hydrocarbon Depletion Group in January 2003.

STEVE ANDREWS has worked as a Denver-based energy consultant and free-lance writer since 1980. He toils on the demand-side of the energy field, primarily in the homebuilding sector, yet his work ranges broadly. During the 1980s he worked at the National Renewable Energy Laboratory, taught solar and energy design classes at universities and colleges, plus helped produce the PBS TV series "A House For All Seasons" and the "Running on Empty" PBS documentary series. He co-chaired a Denver-based World Oil Forum in 1998, co-authored the draft report on electric industry restructuring to Colorado Legislature 1999, and consulted with a municipal electric utility during 2000. In early 2001, he testified (on the winning side) before the Colorado Public Utilities Commission about long-term natural gas prices and the merits of diversification by rate-basing wind power. His interest in the broader energy story increased after a lengthy interview of M. King Hubbert in 1988; since that date, he has maintained communications with a number of world oil experts. His multiple public presentations on energy topics include several conference keynote talks on the long-term energy picture.

OLIVIER APPERT was appointed Chairman and CEO of the French Institute of Petroleum (IFP) in April 2003. He previously worked as Director of the International Energy Agency's Long-Term Cooperation and Policy Analysis Directorate, starting in October 1999. From 1998 to 1999, he was the Senior

Executive Vice-President of ISIS, a technology holding company publicly listed subsidiary of the Institut Français du Pétrole (IFP). From 1994 to 1998 he worked as Executive Vice-President of the IFP in charge of research and development activities. From 1989 to 1994, he headed the oil and gas department of the French Industry Ministry. He worked in the private sector from 1986 to 1989 as Vice-President of the Phillips group for mobile radio activity and strategy. He was Executive Director of the French Industry Minister's cabinet from 1984 to 1986, and was a member of Prime Minister Pierre Mauroy's cabinet from 1981 to 1984. He is a graduate of the Ecole Polytechnique and Ecole des Mines.

ALI SAMSAM BAKHTIARI holds a PhD in chemical engineering and is currently Senior Expert attached to the Director's office in the Corporate Planning Directorate of the National Iranian Oil Company (NIOC). He began his employment with NIOC in 1971 as Project Engineer at its Research Centre. In 1974, he joined the National Petrochemical Company as Project Engineer in its Projects Evaluation Department, and in 1977 he moved to its Corporate Planning Division. He returned to the NIOC Research Centre in 1985, where he headed several departments, and then moved up to Deputy-Director in charge of Special Projects. Between 1990 and 1995, he was Senior Expert in Technology and Development at the NIOC Corporate Planning Directorate, Senior Project Assayer, coordinator of NIOC's international seminars in Iran, and secretary of several internal technical committees. From 1996 to 1998, he was Senior Expert in Technology and Environmental Affairs in the NIOC Corporate Planning Directorate. For one year, in 1999, he was managing editor of *The Journal of the Iranian Petroleum Institute*. He has also been a part-time lecturer in the Chemical Engineering Department at Tehran University, has published numerous articles, and is the author of *Peaks and Troughs* (London: Minerva Press 1996) on the history of modern Iran.

PIERRE-RENÉ BAUQUIS has been a special adviser to the chairman of TotalFinaElf SA since 1995. He also is an associate professor at the Institut Français du Pétrole (IFP) School and is a vice-president of the French Energy Institute. He served as president of the French Association of Petroleum Professionals during 1999-2000. He is a member of Environmentalists for Nuclear Energy.

JEAN-MARIE BOURDAIRE graduated from the Paris School of Mines in 1965 and began a teaching career as an associate professor of Maths & Physics at Bergson Insitute (1967-69). After military service in the Cavalry (1969-70), he joined Total in 1970 and held successively the following posts: research engineer in geophysics, Paris (1970-71); geophysicist in Total Indonesia, Jakarta (1972-76); senior operational researcher, Paris (1976-81); R&D coordinator for worldwide Exploration, Paris (1981-84); deputy director of the Operational Research department, Paris (1984-87); and Director of Economic Studies (corporate), Paris (1987-95). He then entered the

International Energy Agency as Director, Long-Term Cooperation and Policy Analysis in Paris (1995-99). In that position, he was responsible for: studies of energy policies of member countries; energy diversification (coal, gas, electricity) and deregulation of energy networks; energy and environment (climate change impacts on the energy sector); and long-term energy analysis (World Energy Outlook). Since 1999, he has been an international consultant covering three domains: short- and long-term analysis of energy markets; gas and electricity liberalized markets, lessons and constraints; and implications for the energy sector of climate change threat. He was directly involved in the writing of the WEC Statement for 2000, *Energy for Tomorrow's World: Acting Now*, has prepared studies on the world energy and oil situation, and has analysed the positions of the French and European Industry on the issue of climate change. Since 2001, he also has been the director of studies of the World Energy Council. He is the author of *Economic Decision Making*, a book published in French (PUF-QUE SAIS-JE, 1985), as well as the author of many papers published in, or presented to, international forums. He is a member of the French Energy Observatory Council (Ministry of Economics, Finance and Industry), a member of the editorial board of the "REVUE DE L'ENERGIE" and a member of a number of different scientific organisations. He is married to Josy and has four children, and five English and Japanese grandchildren.

DAVID CALLAGHAN is a Chartered Engineer (Mechanical and Electrical) and has an MBA from University College Dublin in Ireland. He has had experience in a copper mine and manufacturing plants (Turner and Newell). He spent some years in the Middle East with Caltex in the Bahrain Refinery, and worked for Caltex Engineering Services in London. He has been construction project director on large construction sites and more recently has established Sea Energy Ltd and the Sea Energy Foundation to develop and build DVT systems for harnessing the massive kinetic energy resource in sea currents.

COLIN CAMPBELL spent his career in the oil business, starting it as a field geologist in Latin America and ending it as an Executive Vice-President in Norway. In a form of subsequent retirement, he has written four books on oil depletion, and has published, lectured and broadcast widely on the subject.

FRANÇOIS CUPCIC holds an engineering degree from Ecole des Mines de Paris and studied reservoir engineering at Ecole Nationale du Pétrole et des Moteurs in Rueil, France. From 1980 to 1982 he worked at the Mineral Exploration Research Institute in Montreal, Canada, developing geostatistical technologies. He joined TotalFinaElf in 1982. He spent 12 years as a reservoir engineer in France, Congo and Netherlands, four years as production manager of a sector of the sour gas treatment plant of Lacq in France, and then general manager of all technical studies for Angola. Since 2001, he has been leader of TotalFinaElf's research program on Heavy Oil (based in Pau, France).

KENNETH DEFFEYES was born in the middle of the Oklahoma City oilfield, the son of a pioneering petroleum engineer. He was an undergraduate at the Colorado School of Mines and a graduate student at Princeton. After graduate school, he was a colleague of M. King Hubbert at the Shell research lab in Houston. After teaching briefly at the University of Minnesota and at Oregon State, he joined the Princeton faculty. Soon after he retired, he wrote *Hubbert's Peak: The Impending World Oil Shortage*.

GÉRARD FRIÈS is a graduate of Ecole Polytechnique (Paris), "Ingénieur en Chef" in the Corps des Mines and a doctor of science. He joined Elf Aquitaine Production (Pau) in 1987 as a geophysical engineer and became a sector manager with Elf Gabon in 1989. In 1992 he took charge of the Operational Interpreting Group for Russia and Kazakhstan with Elf Neftegaz. In 1994, he was named Director of Exploration of Elf Aquitaine Exploration Production France (Boussens), then Delegate for Gabon of Elf Exploration Production (Paris) and a director of Elf Gabon in 1997. In 1999, he joined TotalFinaElf Exploration UK PLC in London as Director of the Geoscience Research Centre, and in 2001 the Institut Français du Pétrole as Executive Vice President.

J. PETER GERLING is head of the Energy Resources section of the Federal Institute for Geosciences and Natural Resources (BGR), which acts as an advisory body to the German government and conducts aid projects in developing countries. He received his Diplom (equivalent to an MSc) in geology and paleontology and his Dr.rer.nat. in geochemistry from the Westfälische Wilhelms-University of Münster. After three years working as an exploration geologist for a German oil company, he joined BGR as an oil and gas geochemist in 1984, working on a variety of national and international oil and gas basin studies. He was BGR's liaison officer in the German Ministry of Economics in 1996.

MICHAEL T. KLARE is the Five College Professor of Peace and World Security Studies (a joint appointment at Amherst, Hampshire, Mount Holyoke, and Smith Colleges and the University of Massachusetts at Amherst) and Director of the Five College Program in Peace and World Security Studies (PAWSS), a position he has held since 1985. He has written widely on U.S. defense policy, the arms trade, and world security affairs. He is the author of: *Resource Wars: The New Landscape of Global Conflict* (Metropolitan Books/Henry Holt, 2001); *Rogue States and Nuclear Outlaws* (Hill and Wang, 1995); *American Arms Supermarket* (University of Texas Press, 1984); and *War Without End: American Planning for the Next Vietnams* (Knopf, 1974). He is also the defense correspondent of *The Nation* magazine, a Contributing Editor of *Current History*, and a member of the Editorial Board of the *Bulletin of the Atomic Scientists*. He serves on the Board of Directors of the Arms Control Association and the Advisory Board of the Arms Division of Human Rights Watch, and is a member of the Committee on International Security Studies of the American Academy of Arts and Sciences.

JEAN LAHERRÈRE graduated from Ecole Polytechnique and Ecole Nationale du Pétrole in Paris. He then joined Compagnie Française des Pétroles (now TOTAL) in exploring the Sahara and was involved with the discoveries of two supergiant fields: Hassi Messaoud and Hassi R'Mel. He went on to explore Central, Southern and Western Australia. He was in charge of exploration in Canada for TOTAL in Calgary, where he started exploring the Labrador Sea and Michigan. After 15 years overseas, he moved to TOTAL headquarters in Paris where he was in charge successively of the new ventures negotiation, technical services and research, and basin exploration departments, and finally deputy exploration manager. He was member of the Safety Panel of the Ocean Drilling Program (JOIDES). He was President of the Exploration Commission of the Comité des Techniciens of the Union Française de l,Industrie Pétrolière where he directed the publication of a dozen of manuals. He was director of Compagnie Génerale de Geophysique, Petrosystems and various TOTAL subsidiaries. After 37 years of worldwide exploration with TOTAL, he retired in 1991. He is now writing articles and giving lectures. He has written several reports for Petroconsultants and Petroleum Economist on the world's oil and gas potential and future production. He was a member of the Society of Petroleum Engineers/World Petroleum Congress ad hoc committee on joint definitions of petroleum reserves, and also a member of the task force on "Perspectives Energie 2010-2020" for the Commissariat Général du Plan. His graphs are used in the International Energy Agency 1998 report "World Energy Outlook", and in the World Energy Council 2000 report "Energy for Tomorrow's World: Acting Now". He chaired the 2002 World Petroleum Congress (Rio de Janeiro) panel on hydrates (RFP9: "Economic Use of Hydrates: Dream or Reality?").

RAY LEONARD was born in New York, of a family of Ukrainian ancestry. He received a Bachelor of Science in Geology from the University of Arizona and a Master of Arts in Geology from the University of Texas at Austin. His 19-year career with Amoco was entirely associated with international projects. In 1989, he was appointed the Director of New Ventures for the Soviet Union, Eastern Europe and China. He was in a unique position to view the political and economic changes taking place. In 1995, he was appointed Vice President for Resource Acquisitions, Amoco Eurasia. In June 1998, he accepted a position as Exploration Vice President for First International Oil Company (FIOC), a newly formed company in Almaty, Kazakhstan. He accepted a position as Vice President - Exploration and New Ventures for YUKOS, the second largest Russian oil company in January 2001. He is responsible for diversifying the YUKOS upstream portfolio out of the core areas of West Siberia and Samara, specifically East Siberia, the Russian Shelf and Central Asia, and concluding partnership agreements with non-Russian companies.

VINCENT LEPEZ was born in 1974. He is assistant professor of quantitative economics and mathematics at the IFP-School. He holds the Agrégation in Mathematics and received his PhD in Mathematics from the Université Paris XI - Orsay in 2002. His research, granted by TotalFinaElf, IFP and the CNRS,

was focused on estimating the reserves' potential of a petroleum system from a statistical point of view.

PAUL E. METZ is Managing Consultant of INTEGeR...consult, The Netherlands, and Board Speaker of e5 - European Business Council for a Sustainable Energy Future, Brussels.

MAARTEN VAN MOURIK is an economist. 1990-1995 Rotterdam: Netherlands Economic Institute, shipping research division. 1996-2000 Stavanger: Petrodata Research analysis and forecasting. 2000-2003 Stavanger/Vienna: OPEC Secretariat oil supply non-OPEC supply model, market analysis and forecasting shipping and offshore sectors. 2003-present Paris: energy market economics and policy research.

RICHARD SHEPHERD is a journalist and publisher. 1965-1969 Brussels: European energy policy, McGraw-Hill. 1970-1972 Paris: oil and nuclear power, McGraw Hill. 1973-1975 Paris: nuclear power and technology, McGraw Hill. 1975-1977 Stavanger: offshore business publications, Noroil. 1977-1979 London: European nuclear power, Nucleonics Week. 1979-1981 London: international gas trade journal, World Gas Report. 1981-2000 Aberdeen/Houston: Petrodata upstream markets, Tomorrow's Oil. 2000-present Perpignan: Cabrach energy policy research.

MATTHEW SIMMONS is Chairman and Chief Executive Officer of Simmons & Company International, a specialized energy investment-banking firm with offices in Houston, Texas, Aberdeen, Scotland, Boston, Massachusetts and London, England. The firm has guided its broad client base to complete over 450 investment-banking projects at a combined dollar value of approximately $56 billion. He was raised in Kaysville, Utah. He graduated cum laude from the University of Utah and received an MBA with Distinction from Harvard Business School. He served on the faculty of Harvard Business School as a Research Associate for two years and was a doctoral candidate. He founded Simmons & Company International in 1974. Over the past 29 years, the firm has played a leading role in assisting its energy client companies in executing a wide range of financial transactions from mergers and acquisitions to private and public funding. Today the firm has approximately 150 employees and enjoys a leading role as one of the largest energy investment banking groups in the world. He is a Trustee of The Museum of Fine Arts, Houston and The Farnsworth Art Museum in Rockland, Maine. He serves on the Board of Directors of Kerr-McGee Corporation (Oklahoma City), The Atlantic Council of the United States (Washington D.C.), The Research Partnership to Secure Energy for America (RPSEA), The Petroleum Industry Research Foundation, The Initiative for a Competitive Inner City (Boston), Houston Technology Center, and the Center for Houston's Future. He is also on The University of Texas M.D. Anderson Cancer Center Foundation Board of Visitors (Houston) and is a charter member of the University of Houston National Advisory Council. In addition, he is past Chairman of the National Ocean Industry Association. He serves on the Board of Directors of the Associates of Harvard Business School, and is a past President of the Harvard Business School Alumni Association and a former member of the Visiting Committee of Harvard Business

School. He is a member of The Council on Foreign Relations and The Advisory Council of the National Trust for Historic Preservation. His papers and presentations are regularly published in a variety of journals and publications including *World Oil*, *Oil and Gas Journal*, *Petroleum Engineers*, *Offshore* and *Oil & Gas Investor*.

ANDERS SIVERTSSON is a research student at Uppsala University, who has rebuilt, refined and updated the ASPO depletion model.

CHRIS SKREBOWSKI has spent his entire working career in the oil industry split roughly two-thirds as an oil journalist and one-third as a planner/market analyst within the industry. He became editor of *Petroleum Review* in June 1997, having edited *Petroleum Economist* for the previous three years. Prior to that, he spent eight years working for the Saudis as a market analyst in London. He started his working career in 1970 as a long-term planner for BP, and then joined *Petroleum Times* as a journalist just before the first oil crisis of 1973/74. In the late 1970s he edited *Offshore Services*, an offshore magazine that was subsequently merged into *Offshore Engineer*. He rejoined *Petroleum Times* as technical editor in time for the second oil crisis of 1979. As well as writing extensively for a range of oil industry related publications, he has also broadcast on radio and TV on oil and gas subjects.

MALCOLM SLESSER graduated in chemical engineering and worked in the oil, synthetic fibres and nuclear industries before taking up a post at Strathclyde University, where he eventually became Professor of Energy Studies. He has taught in the USA and Brazil, and was for three years head of systems analysis with the European Commission in Italy. He retired to an honorary position at Edinburgh University in 1981 and for 17 years led a research team in natural capital accounting, a bio-physical modelling procedure, fulfilling many contracts with the aid of post-graduate students and assistants from all over the world. He is currently chairman of the Resource Use Institute. He has published 10 books, over 30 refereed papers and many articles. He is a well-known mountaineer and arctic explorer.

JÖRG WIND studied physics at the Technical University of Munich. His diploma thesis dealt with the absorption of light in semiconductors for photovoltaic energy conversion and sensors. He received his PhD in 1992 in the field of optical sensors and microsystem technology. Since 1992 he has been working with DaimlerChrysler Research and Technology on fuel cell technologies for stationary (MCFC) and transport applications (PEMFC), as well as exhaust gas after treatment. He is now responsible for energy and fuel supply for future cars, working on fuel production and infrastructure, especially synthetic fuels based on biomass and hydrogen.

WERNER ZITTEL studied physics in Munich and received his doctorate degree from the Technical University Darmstadt in 1986. Since 1989 he has

worked at the L-B-Systemtechnik GmbH in Ottobrunn, Germany, a small consulting company to industry and government. His main areas of expertise are environmental aspects of energy use and studies on hydrogen infrastructure scenarios.

ABSTRACTS

Opening Address
Olivier Appert

The issue of peak oil production is an open-ended debate. IFP's experience in technologies is leading us to be optimistic about development of oil and gas supply in the long term. Technology is offering new opportunities, the playing field for exploration and production is growing, and demand is lower than anticipated.

However, we need to avoid any complacency. Oil supply is relying heavily on giant fields discovered 30 to 40 years ago and huge investments would be required to compensate for increasing depletion of existing field. So it is timely to reopen the debate.

Resource Wars
Michael T. Klare

The 'National Energy Policy' (NEP) released by the Bush Administration on May 17, 2001 was supposedly intended to meet growing U.S. energy requirements in the first two decades of the 21st Century while also diminishing U.S. dependence on imported oil. This was to be accomplished, the White House suggested, by increasing production at existing oil fields in the United States and by commencing drilling on the Artic National Wildlife Refuge (ANWR) in Alaska. So great was the furor over drilling on ANWR that most people never bothered to examine the NEP closely. This is unfortunate, as a close reading of the NEP report reveals a very different picture than that suggested by White House pronouncements: far from promoting energy "independence," the NEP assumes that the United States will become MORE, not less dependent on imported petroleum in the years ahead and therefore calls on the Federal Government to take whatever steps are necessary to promote enhanced U.S. access to foreign oil. In particular, the NEP calls on the U.S. Government to seek additional petroleum from the Persian Gulf area, Russia, the Caspian Sea basin, Mexico, Venezuela, Angola, and Nigeria. As is implied by the report, the United States must acquire more oil from these countries in order to permit increased oil consumption in the United States at a time of declining domestic production. Even leaving aside the question of whether these countries will be able to boost their production sufficiently to satisfy steadily rising demand in the United States, this strategy poses enormous challenges for the United States because most of these areas are highly unstable and house anti-American governments and forces. It is likely,

then, that U.S. efforts to acquire more oil from these countries will entail the increased presence of U.S. military forces in the area and periodic U.S. military intervention. Indeed, the requirement for increased military action in support of U.S. foreign energy policy is one of the driving factors behind the Bush Administration's military buildup. And while the war in Iraq had several causes, the protection of U.S. oil imports from the Persian Gulf is one of the most important.

A Realistic View of Long-Term Middle East Production Capacity
A. M. Samsam Bakhtiari

The Middle East is a unique landmass bridging the continents of Europe, Africa and Asia. It now consists of fifteen major countries and one neutral zone. Four of these countries (Afghanistan, Israel, Jordan and Lebanon) are practically devoid of commercial oil resources. And the other eleven jointly control oil reserves estimated by Dr. Colin Campbell at 805 bnb (42% of world total) -- made up of 758 bnb discovered and 47 bnb yet-to-find. These eleven countries, which produced on average 20.8 mb/d and 19.3 mb/d in 2001 and 2002 respectively, can be subdivided into three categories: (i) the low producers (4 countries); (ii) the mid-size producers (4 countries); and (iii) the three large producers (Iran, Iraq and Saudi Arabia).

In order to investigate the Middle East's long-term production capacity, the forecasts and scenarios developed by the following experts or institutions were reviewed: (a) Dr. Campbell; (b) the major international institutions (IEA, EIA, OPEC); (c) the major oil companies; (d) the major international banks; (e) the specialised press; (f) prominent economists and consultants; (g) the simulations of the 'World Oil Production Capacity' (WOCAP) model.

The most significant results were derived from Dr. Campbell's predictions and the WOCAP model. Both of these show Middle Eastern producers going through a long "bumpy plateau" between 2003 and 2020 with a gradual ramping down during the second decade. WOCAP's simulations for each of the large three producers are presented and analysed.

All in all, the Middle Eastern countries, which produce nearly a third of global crude oil, will continue to play a major role on the global oil stage, a role that, with time, can only tend to become more predominant. And although the region's oil represents over 40% of global reserves and roughly two-thirds of proved reserves, there are limits to its output. For those believing that for Middle East oil "the sky's the limit," some shattering surprises might result over the next two decades.

Russian Oil Reserves, Future Exploration Potential and Production Capacity
Ray Leonard

An evaluation of Russian proven oil reserves has been conducted taking into account public information, such as published reserve audits of Russian oil companies, supplemented by economic evaluation. The results indicate proven recoverable reserves of 97-119 billion barrels depending upon a low ($16-22/Bbl Brent) to high ($22-28/bbl Brent) price scenario. Approximately two-thirds of the proven reserves lie in West Siberia. An analysis was also conducted to predict future exploration potential taking into account the high price scenario. Separate studies were completed for each of Russia's major petroleum provinces. An estimate of 43 billion barrels of additional reserves through exploration encompasses a risk factor of probable reserves, possible reserves and potential resources at 50%, 25% and 10% respectively. While West Siberia accounts for approximately 50% of probable and possible reserves, it accounts for less than 5% of potential resources, while 90% of potential resources will be located in East Siberia and the Russian Shelf. Russian production capability has been enhanced by utilization of modern technology and economic efficiency, although to date this has only been fully utilized by YUKOS and Sibneft. In lifting costs, (CAPEX + OPEX) these two companies rival costs in the Middle East of less than $4/bbl. With a reserve base in excess of 100 billion barrels and increasing efficiency, Russian production will continue to increase to more than 10 MMBO/D within five years and can sustain that level through 2020. After 2010, however, production will increasingly come from Timan Pechora, East Siberia and the Russian Shelf, and by 2020, these higher cost areas will contribute up to 50% of Russian production. The ability to export the increased production will be facilitated by three major pipeline projects: expansion of Primorsk to serve the European market, the Murmansk pipeline for the U.S. market, and the Angarsk-Daqing pipeline for the China market.

The World's Endowment with Natural Gas: The Perspective from BGR's New Energy Study

J. Peter Gerling & Hilmar Rempel

Natural gas accounts for about 24% of the worldwide primary energy consumption, after crude oil and hard coal. Its share has increased in the last several years, and this trend can be expected to continue in the future.

The global estimated ultimate recovery (EUR) determined in this study for conventional natural gas is about 447 T.m³ corresponding to about 353 Gtoe, which is about the same as the EUR for conventional oil. This value is nearly 8 T.m³ (about 2%) more than the previous estimate in 1997. It may be considered as a conservative estimate. The remaining potential is about 2 T.m³ less than before.

The CIS countries, particularly Russia, have the largest EUR. The value for the Middle East is also considerable. Although North America has a substantial EUR, the remaining potential is less significant, since nearly half of its EUR has already been produced (particularly in the USA). The EUR of about 5% for Europe (not including the CIS countries) is of little importance. The European gas market, however, has access to about 38% of the global EUR for natural gas, due to the accessibility to Russian fields. If the Middle East is considered a potential supplier, this figure rises to about 70%. The European gas market, therefore, is in a comfortable position compared to other gas markets.

Despite increasing production, global reserves of conventional natural gas have further increased to nearly 161 T.m³ at the end of 2001. Their energy content corresponds to about 84% of the global reserves of conventional crude oil. Global

resources of natural gas are estimated to be about 217 T.m³. The global remaining conventional natural gas potential is about 337 T.m³, with an energy content about 26% above that of the remaining conventional oil potential.

Global production of natural gas has continually increased in the last several years, reaching a high of about 2.5 T.m³ in 2001. The regions with the highest production are the CIS countries and North America, each with about a third of global production, followed by Europe with an eighth. Cross-border trade (not including transit across third countries) amounted to about 650 G.m³ (about 25% of production worldwide) in 2001. About 23 % of this amount was liquified natural gas (LNG).

Cumulative natural gas production by the end of 2001 reached nearly 70 T.m³, or 30% of the total reserves discovered up to that time. Half of this amount was produced within the last 16 years. When flared gas is taken into consideration, more than one-third of the original reserves have been removed.

Half of the total reserves discovered up to this time will have been consumed by 2019, assuming annual production remains the same and reserves are not increased by new discoveries and enhanced production methods. Static lifetime of the present natural gas reserves is about 64 years.

There are four main regional natural gas markets in which producers and distributors have long-term contracts: the European market, with the main exporters Russia, Algeria, Norway, and the Netherlands; the North American market (NAFTA); the Asian market characterized by large distance between the main consumers (mainly Japan, South Korea, and Taiwan) and the producing countries (mainly Indonesia, Malaysia, Australia, and Brunei as well as Qatar and the UAE in the Middle East); and the South American market, which has recently developed.

There are considerable uncertainties in the estimates of the amounts of non-conventional natural gas that can be recovered. Global reserves of non-conventional natural gas are estimated to amount to only 2 T.m³, because recovery technology is available only for coal-seam gas and tight reservoirs. Moreover, the conditions necessary for economic production are present only in relatively small regions. We estimate non-conventional natural gas resources (not including gas hydrates and aquifer gas) to amount to about 220 T.m³, which is about half of the estimated ultimate recovery of conventional natural gas. The 1:100 ratio of reserves to resources reflects the low degree of exploration. For comparison: This ratio is about 1:1 for conventional natural gas and about 3.3:1 for conventional oil.

Estimates of the quantity of natural gas in gas hydrates and aquifers differ considerably and have a high degree of uncertainty. A few production facilities for this kind of gas do exist, but they are mostly on a pilot scale. A critical analysis of the results of recent research leads to a distinct reduction of the resources that can be expected. Significant commercial production is not probable in the foreseeable future, despite the immense amounts that can possibly be recovered – 800 T.m³ for gas hydrates and 500 T.m³ in aquifers, which is more than the EUR of conventional natural gas.

Demonstrated global reserves of natural gas will last until mid-century, assuming production remains at the same level as at present. It can be expected that the technologies for production of coal-seam gas and tight gas will continue to be improved, and increasing demand will be met into the latter part of the century.

Modelling Oil Production, Energy Consumption, Population and Economy
Jean Laherrère

Most published data on energy, population and the economy are unreliable. In many cases, authors have political motives, selectively choosing data from a wide range of uncertainty to give a desired image. In addition to the uncertainty of the measurements themselves, as in the case of population or the confidentiality of the oil reserves, they often indulge in manipulation. A so-called hedonistic factor distorts the calculation of GDP in the United States; and the definition of the Proved Reserves by the Securities and Exchange Commission gives rise to “reserve growth”. OPEC misreports its oil reserves because its quotas depend upon the reported reserves, and the reserves were overestimated in the Soviet Union because economic and technical constraints were ignored.

Our present culture of eternal growth makes the word "decline" politically incorrect, but constant growth is unsustainable in a finite world. Growth is the Santa Claus of the modern age who is supposed to provide welfare and retirement for us and our children.

All natural events, when measured over their full life, can be modelled under one or more cycles, as in the Fourier analysis. This cyclical nature corresponds with the finite nature of the Universe; everything that is born will die, whether we speak of the solar system, the Earth, or human species. What goes up must come down.

The Russian population is already declining and Europe’s will soon do so too. This basic understanding was recognised by the celebrated King Hubbert when he made his famous prediction in 1956 that US oil production would peak in 1970. But, in fact, he oversimplified by showing a single peak. In reality, US oil production had a secondary peak (93% of the first one) in 1985, reflecting the entry of Alaskan production, which itself peaked in 1988. A symmetrical oil cycle reflects a large number of independent producers, acting randomly, but in many cases economic and political factors disturb the pattern, giving one or more new cycles.

To model an event made up of several cycles extending into the future calls for an estimate of the ultimate value, which corresponds with the area under the curve up to the end of the event. For oil, the best tool to determine an ultimate value is the creaming curve that plots cumulative discovery versus the cumulative number of new field wildcats, the result being modelled by one or more hyperbolas. Another method is to plot the ratio of annual to cumulative production versus cumulative production, and extrapolate the trend to zero. When the trend is linear, it represents the derivative of the logistic curve. The fractal distribution of sizes (field reserves, incomes, urban agglomerations plotted against decreasing rank) can also be extrapolated to an ultimate value.

Population can be well modelled with two cycles, distinguishing countries with high and low fertility rates. Previous UN forecasts were too high for different reasons. Economic parameters, such as unemployment or inflation, can be correlated with oil price after a certain time-shift. Income distribution is well described by a fractal plot of population versus income. The income fractal distribution in France is in fact the same as that in the United States, although the total of the latter is higher because of a larger population.

Many graphs are shown for each domain using the same tools. The goal is that the reader may be able to draw his own conclusions, and make his own forecast. Ironically, it appears that the modelling is more reliable than the input data. Accordingly, the main challenge is to secure better data, but that will be achieved only if and when political influences can be removed. A neutral agency is needed, but neither the UN nor national agencies are neutral. It is hard to see how to force the actors to tell the truth, or know who would run and finance such an organisation. A step in the right direction would be to make official organisations liable to prosecution for releasing false data, as is already supposed to apply in the United States under Public Law 106-554.

The Physical Modelling of Future World Energy Demand
Malcolm Slesser

Though human greed may be the driving force for economic expansion, the unique factor that makes it possible is thermodynamic work. This is the only non-substitutable physical input to the economic process. The current source of such work is largely obtained from fossil fuels, of which oil and gas are the most convenient forms. By recognising that energy must be invested in order to extract and refine further energy supplies, it is possible to construct a world-scale model to determine the maximum rate at which the world economy can expand, and thus the future demand for fuels, provided there is information on the energy dissipated per unit energy delivered as a function of depletion. This procedure is known as Natural Capital Accounting, and is articulated in the ECCO model, an example of which is posted on the Internet.

Such a world model (GlobEcco) was developed in 1992, on the data as then known. The forward evolution of this model from 1992 to 2050 reveals a future demand for oil and gas close to that posted in the ASPO newsletters, with economic growth virtually ceasing after 2025. Updating such a model is merely a matter of investing research time. It should then be possible to develop a reasonably rigorous profile of future oil and gas depletion, and a picture of world economic prospects.

Energy Supply Conditions and Oil Price Regime
Jean-Marie Bourdaire

The energy world is shaped by four drivers:

- the needs and behaviours of the consumers;

- the technological progress and new ways of "doing";
- the perception of risks and their implications;
- the evolution of regulations and of decision-making powers.

These drivers change, either because of Man, through his creativity or his folly, or because of Mother Nature, through the scarcity or abundance of natural resources. Yet, all these changes end up in a unique kind of change, that of the price of energy, either higher or lower than what it was before.

Gathering the prices of all primary energies and energy-related final services into the single concept of "energy price" may look like an over-simplification because primary energies and final energy services are very different in terms of "quality": wind is different from oil just as running a PC has little to do with running a car or heating a building. Nevertheless, the history of energy shows that the primary energy that is used "at the margin" plays the most important role because it sets the price for all primary energies. History also shows that final prices only partially reflect the price of primary energies but that the fixed cost component varies little and with great difficulty.

The paper will proceed along four parts:

- Analyse the first oil shock as the greatest event so far because the marginal energy and price-setter that had been coal since the early days of the industrial revolution then became oil.
- Show that oil prices always follow a pattern starting with a price rise because of a scarcity and followed by a 3%/y regular decline thanks to improvements and economies of scale.
- Explain how this pattern that had little impact up to 1948 (oil was a small component of the energy portfolio) has become and will remain the fundamental driver of the energy scene.
- Propose a new vision of the future energy scene based on the recent or still to appear energy imbalances with their implications in terms of energy demand and GHG emissions.

This paper draws heavily on an important study of the 2001-2004 programme of the World Energy Council. This study, titled "Drivers of the Energy Scene", is chaired by Dr. Majid Al-Moneef, Economic Advisor to the Minister, Ministry of Petroleum and Mineral Resources, Saudi Arabia. The author is indebted to WEC for using some of the materials gathered in this study. However, the presentation itself and conclusions are those of the author and do not engage WEC.

The North Sea – A Victim of Depletion
Chris Skrebowski

- Introduction of speaker and his background in the industry.
- The role of journalists as observers who are free of corporate or political pressures.
- The documentation of the North Sea. The best public data of any province?

- ASPO as the only real alternative data source to the companies or the 'political' reports of the IEA, EIA, USGC etc.
- Getting the North Sea in proportion. The size of its reserves and production flows and the pattern of change. The relative size of the North Sea's largest fields in comparison to other fields and provinces around the world.
- The Geopolitical importance of North Sea production, particularly as a counterweight to OPEC over the last 25 years.
- The importance and outlook for North Sea gas production with the UK set to be a net importer by 2005/6 while Norway is set to become a major exporter. And Denmark and the Netherlands struggle to maintain production flows.
- The importance and outlook for North Sea oil production now that the UK is entering its 4th year of decline, while Norway and Denmark are now starting their production declines and the tiny Dutch production swings around on a single new field's production.
- The flight of the oil majors to richer and more productive provinces as the 'bottom feeders' come in to squeeze the rocks for the remaining North Sea reserves.
- What we can learn from the rise and fall of North Sea production in terms of future global production.
- The geopolitical implications of declining North Sea production and the likely consequences of Europe's increasing import dependence for both oil and gas.

Modelling of Remaining Reserves in a Mature Basin

Dr. Vincent Lepez

The speech will present results and possible extensions of a PhD research. The aim of this work is to build a statistical model of oil and gas fields' sizes distribution in a given petroleum system, for both the fields that exist in the subsoil and those which have already been discovered. The estimation of the parameters of the model *via* some innovative statistical tools helps to provide estimates of the total number of fields which are yet to be discovered, by class of size.

Following some previous work by Laherrère, we assume that the set of underground fields' sizes is a sample of unknown population with Lévy-Pareto law, which parameter is unknown. We also assume that the area is mature enough to ensure that the biggest field has been discovered for sure. The set of already discovered fields is a sub-sample without replacement of the latter which is "size-biased", due to the effectiveness of geologists' work! Indeed, the bigger a field, the larger its probability of having been discovered. But how large? This is the question we shall try answer.
An arbitrary partition of the observed sizes' interval being set (called a model), we are able to estimate the inclusion probability of a given class, defined as the ratio between the number of fields discovered in the class and their total number in the subsoil. This information allows one to derive within-class and total estimates of the number of fields and reserves that are yet to discovered.

We then allow our partitions to vary inside several families of models and prove a model selection theorem, which aims at selecting the best possible partition in terms of a statistical quality criterion.

We conclude with various applications to real data and propose a discussion of the underlying hypotheses of this work and possible extensions regarding, for instance, the influence of technological progress, better geoscience knowledge or economical impacts through time. Another crucial matter that will be discussed is the associated possible forecast of the aggregated production profile of these new reserves.

Oil Prophets: Looking at World Oil Studies Over Time
Steve Andrews

All great truths begin as blasphemies. (George Bernard Shaw)

Early reports of world oil assessments date back to the 1940s. In the intervening 60 years, the number of studies projecting Estimated Ultimately Recoverable (EUR) oil reached well over 50. A detailed search would undoubtedly lengthen the list that will be provided with this paper. How have their estimates fared? Given general agreement that we haven't yet reached the halfway point in eventual production, it's too early to offer definitive assessments. However, several factors stand out:

- The learning curve. It took over a decade of effort for projections to emerge that are in line with lower-end projections of more recent studies. The learning curve has flattened.
- For those individuals and groups who conducted multiple studies, their subsequent EUR numbers generally trend higher.
- The analyses lack a common definitional framework. Beyond crude oil, what liquids are included? Heavy oil and tar sands? Some or all gas liquids? Polar and deepwater oil?
- While the ability to locate, evaluate and extract oil in the field has drastically improved over time, analysts continue to be hampered by a lack of access to definitive data plus disagreements about assessment methodologies.

Striving to determine how many petroleum liquids we have left is a useful exercise, but primarily as a means to help determine when daily worldwide production is likely to peak. To that end, a key point is that "not all liquids resources are created equal;" many of the larger new fields are located in harsh and remote regions, in politically unstable environments, or require large energy inputs during extraction. Production rates and costs will vary dramatically. Since demand is somewhat fickle, identifying a year or range of years when liquids production will peak qualifies as part art, part science. That said, the paper will list estimates by "oil prophets" as to when they project that petroleum liquids production will peak. The estimates range from 1995 to 2025.

How have their estimates fared? Projections for an early peaking of production, during the mid-1990s through today have not proven out. This

provides critics with ammunition. Yet we're steadily approaching the time — 2010, plus or minus a few years — when the largest grouping of analysts projects that daily petroleum liquids production will peak. Peaking is a matter of "when," not "if."

The "grandfather of oil prophets" was M. King Hubbert, a former employee of Shell and the U.S. Geological Survey. First in 1948 and later in 1956, Hubbert projected an EUR figure for the U.S. that led him to project a peaking of U.S. oil production by 1970, plus or minus a year. By 1961, the USGS countered with an EUR figure nearly three times as large as Hubbert's, implying that his near-term peaking projection would not be a problem. History proved Hubbert right and the USGS to be wishful thinkers. This paper draws a warning parallel between the Hubbert-USGS debate of the 1960s and the current disagreement: between those who project a world oil peaking around the year 2010 and those who accept the less worrisome EUR figures in the USGS's year 2000 World Energy Study. (The USGS does not project a peaking date for world liquids production.)

How to Make the World Aware that the Party is Over
Kjell Aleklett

The depletion of oil, which furnishes 40% of traded energy and 90% of transport fuel, should by all means be a sensitive subject for all governments as well as for you as an individual. It heralds for Mankind a discontinuity of historic proportions. It is easy for the economists who advise most governments to map short-term economic cycles but it is very difficult for them to deal with major discontinuities, especially those that undermine the very foundations of their subject. This must be changed.

Speakers at this workshop are presenting the evidence for a Natural Science Approach to the depletion of oil, addressing the geological constraints, the technical basis of reserve estimation, the distribution of field sizes, and the obvious correlation between discovery and production after a time lag. Those of us who realize that all this evidence points in one direction must act as soon as possible to alert governments and others of what the true situation is.

Last year the first International Workshop on Oil Depletion was organized in Uppsala, Sweden. During the past year we have tried to make Sweden aware of the problems, as well as drawing attention to ASPO and the work it stands for. The subject has attracted much media interest, with more then 30 interviews with TV, radio, magazines and newspapers. This sets an example of what can be achieved on a wider scale. The lessons that have been learnt are discussed and reviewed in the presentation.

Will 2000 Turn Out to be the Peak, Followed by Wildly Oscillating Oil Prices?
Kenneth Deffeyes

There is an uncanny parallel between the 1970s peak in U.S. oil production

and the present peak in world oil production. Hubbert's original prediction, in 1956, required as an input an educated guess of the eventual total production. By 1962, U.S. oil history was far enough along for Hubbert to dispense with the educated guess. The actual year of greatest U.S. production was 1970, but it was not immediately recognized as the peak. The Texas Railroad Commission removed production rationing in 1972. That news was the first overt signal that the U.S. had no remaining unused production capacity. However, there was little or no publicity until the decline became pronounced.

Estimates of world oil production made after 1980 do not require independent guesses about the total world oil endowment. Many of these scenarios placed the world peak between 2000 and 2010. It now looks as if the world peak production year is 2000. The 2001 and 2002 production levels were lower than 2000, and 2003 is not off to a great start. On March 6, 2003, the Dow Jones Newswire stated that the government of Saudi Arabia announced that "the kingdom's crude oil output has reached its limit at around 9.2 million barrels a day and won't rise further." The announcement received little or no publicity. Those of us who worked on the estimates are no longer prophets; we are now historians.

Most economists expect that declining production will cause oil prices to rise to a new equilibrium level. However, for most of this decade we will be traversing the broad curved top of the Hubbert curve; oil production will be roughly the same as demand. A well-known result from queuing theory says that systems operating close to their capacity are subject to wild swings in behavior. As an example, North American natural gas prices were quite steady until 1985, followed by increasingly large price oscillations. Over one weekend this past winter, the price of natural gas doubled.

OPEC has been attempting to hold world crude oil prices in the range of $27 per barrel. Most of the unused oil production capacity has been in Saudi Arabia, but that surplus capacity has now disappeared. The good news is that OPEC is no longer in charge of the price of oil. The bad news is that nobody is in charge. Welcome to the post-Hubbert world.

The 2003 Update of the ASPO Oil & Gas Depletion Model
Colin Campbell & Anders Sivertsson

What we can term the ASPO Oil and Gas Depletion Model has developed over many years, based on an evolving knowledge of the resource base, culled from many sources, and evolving ideas about how to model depletion. It is sure that the estimates and forecasts are incorrect. The question is: *By how much?*

The model recognises so-called *Regular Oil*, which excludes the following categories:

- Oil from coal and shale
- Bitumen and synthetics derived therefrom
- Extra Heavy Oil (<10^{o} API)

- Heavy Oil (10-17^{o} API)
- Deepwater Oil (>500 m)
- Polar Oil
- Liquids from gas fields and gas plants

It has provided most oil to-date and will dominate all supply far into the future. Its depletion therefore determines the date of peak. The evidence suggests that about 896 Gb (billion barrels) had been produced to end 2002; about 871 Gb remain to produce from known fields and about 133 Gb is expected to be produced from new fields. It is convenient to set a cut-off of, say 2075, for such production, to avoid having to worry about the tail end that can drag on for a long time.

A simple depletion model assumes that production declines at the current Depletion Rate (annual production as a percentage of future production) or at the Midpoint Rate in countries that have not yet reached Midpoint (namely half the total). The five main Middle East producers, which hold about half of what remains, are assumed to exercise a swing role, making up the difference between world demand and what the other countries can supply. The base case scenario assumes that consumption will be on average flat until 2010 because of recession; and that the Middle East swing role will end then, as in practice those countries will no longer have the capacity to discharge it. Whether the Iraq war results in extending or shortening the swing role remains to be seen. Adding the contributions of the other categories of oil and gas liquids gives an overall peak in 2010.

Gas depletes differently, being more influenced by infrastructure. Production tends to follow a plateau rather than a peak. The United States is now close to the cliff that marks the end of the plateau and Europe not far behind. World supply is tentatively assumed to reach a maximum of about 130 Tc/a, lasting from 2015 to 2040 before declining abruptly. The production of coal bed methane and gas from “tight” reservoirs is expected to increase slowly, but methane hydrates are dismissed as an unrealistic source of energy.

Options for Future Transport Fuels
Jörg Wind

Modern civilisation is based on an economy which widely depends on communication technologies, sufficient energy supply and unrestricted individual mobility. Up to now, the energy supply for industrial and household use as well as for transport largely relies on resources of fossil fuels, such as coal, natural gas and crude oil. These resources are limited and there is some discussion about the timeframe when these fossil resources will be reduced significantly. To assure fuel supply for sustainable mobility of all citizens and reduce CO_2 and pollutant emissions, use of alternative fuels has to be increased.

In the last years a variety of fuel options for transport of the future have been discussed and produced. Today, cars are fuelled with diesel, gasoline (up to three different qualities), natural gas (NG), gas to liquid fuels (GTL), fatty acid methyl ester (FAME), ethanol and some drivers even use plant oils. Additionally, there are a small

number of cars powered by electricity. Methanol and hydrogen are also tested as fuels for cars with an internal combustion engine (ICE). In the last ten years the development of fuel cells for transport application made a big step towards commercialisation of fuel cell cars with very high efficiencies, which are fuelled with hydrogen, methanol or even gasoline or diesel.

The European Commission has announced numbers for alternative fuels, in a communication paper on alternative fuels for road transport, as a proposal for a Council directive. For 2020, 8% biofuels, 10% natural gas and 5% hydrogen are suggested. The best alternative fuel would be one which is environmentally benign to produce, not emitting any greenhouse gases during growth of the biomass and subsequent fuel production, and at low cost. Additionally, this fuel should have favourable properties in ICEs and fuel cells, even improve performance and regulated emissions.

Hydrogen has a very high potential to fulfil all requested requirements. Especially in combination with fuel cells, which provide for a very high efficiency, this fuel option would be preferable. Hydrogen production by steam reforming or electrolysis is a well known industrial process, but storage in cars still does not yet allow for sufficient travel distances. Building of a hydrogen infrastructure is very costly and will not take place until a significant number of cars will need to be fuelled by hydrogen. The open issues for implementation by the end of the next decade are: vehicle production costs and onboard H_2 storage, efficient H_2 production and installation of a fueling infrastructure, as well as the need for attractive subsidies or tax incentives. These can be resolved by a joint effort of governments and the auto and oil/energy industries. If successful, it is likely that by 2020 2-3% of the overall European vehicle fleet will be fueled by hydrogen, and that in the subsequent decade the use of H_2 fuel will sharply increase.

In the next 20 years the ICE will dominate the market for new cars, and it will remain an important technology beyond that period. A significant reduction of greenhouse gas emissions could be achieved by the introduction of fuels based on biomass in the next two decades. From all options for biofuels, synthetic fuels from biomass (BTL) seem to have the best potential to fulfil all requirements. Such fuels have similar properties as the gas-to-liquid fuels that are currently produced by a number of oil companies. The first process step is the production of synthesis gas (CO and H_2). The second step is synthesis of hydrocarbons, like methanol or diesel fuels, by Fischer-Tropsch synthesis. Currently, a number of research groups and small companies are working mainly on the gasification step. In 2001 DaimlerChrysler started a joint project with the Choren Company to investigate in a pilot plant the feasibility of producing synthetic renewable Methanol and BTL Diesel from wood and using it in road vehicles. Since June 2002, DaimlerChrysler and Volkswagen have been pursuing this pathway jointly.

In conclusion, it seems likely that synthetic biofuels will play an important role in fuel supply for transport applications in the future. Hydrogen, which is the most favourable fuel with respect to reduction of CO_2 emissions and diversity of primary energy sources, remains the most promising candidate for future fuels, especially in combination with fuel cell powered vehicles.

Non-OPEC Oil Supply: Economics and Energy Policy Options
Maarten van Mourik & Richard K. Shepherd

Apart from the enigmatic FSU, there is little prospect of long term growth for non-OPEC oil supply and a strong likelihood that over the next few years the trend will flatten and then decline irrevocably. Decline will come faster if the spectacular discoveries in the deep water offshore plays of the southern Atlantic and the Gulf of Mexico attract sufficient investment to match the loss of production in the North Sea. Deep water oil supply might be expected to reach a peak of as much as 6-7 million barrels a day by the time the North Sea has lost more than half its current output in the period beyond 2010. But economics play as strong a role as geology in real world oil business. Current indicators suggest that the prolific deep water wells are delivering less oil than expected and for a shorter period. That means less revenue. This paper outlines the disappointing performance of recent offshore fields, in both deep water and conventional water depths, and suggests consequences for global supply in the next decade.

The 30 year success story of non-OPEC oil supply stems directly from the oil price revolution of the 1970s, without which the North Sea and most other offshore oil plays would not have been economic. The non-OPEC oil boom was also necessary because access to the cheap oil of the Persian Gulf and a few other plays were simply not available to the international private sector oil industry, as they had been before. That era is now over. It is ending not because oil is too cheap, but because there are powerful reasons for change. Firstly there is not enough oil left to make a difference beyond the next few years. Secondly, the economics of deep water and other offshore oil may not be attractive enough. Thirdly the doors to the Middle East are now being opened again to companies that can write those assets on their balance sheets and generate profits, allowing better return on investment and their higher share prices. There is no more compelling reason for a shift in investment strategy than the lure of better profits.

However strong the evidence of an imminent peaking of offshore and perhaps total non-OPEC oil supply, the reality is that governments will not readily recognise a “bad news” scenario that will inevitably tarnish their own political image. It follows that a global and permanent threat to their economies and energy security from a shortfall in oil supply outside the Persian Gulf and central Asia will only become a policy assumption if viable and attractive energy policy options are available. If there is single focus to any energy supply threat, then it is the market for transportation fuels, the strongest growing segment of the energy market and the only segment of the energy market where there are no significant alternatives already on offer.

The second half of this paper suggests that there are industrial or financial obstacles to the large-scale introduction of fuels other than current specification gasoline and diesel. Almost all the current initiatives to explore and encourage alternative fuels address a long-term future in which fuel cells or hydrogen or “California-clean” liquids replace the current fuels at the pump. Further, most research concentrates on the environmental aspects of the

alternatives rather than their large-scale industrial availability. Yet the hard reality is that any solution to the global oil supply dilemma must be large scale (at least 10% of the total market for transportation fuels) and soon, which means within a decade.

The technical facts are that fuels such as ethanol and methanol can be produced in very large volumes and delivered to the consumer without any significant change to the huge infrastructure constituted by the global internal combustion engine manufacturing industry and by the existing fuel distribution networks. This large, immediate and obvious opportunity has not been grasped so far for the excellent reason that the status quo is profitable and convenient for those who now control the fuel business. It is after all, the duty of integrated oil companies to deliver best value for their shareholders, not to find secure, competitive, long-term energy solutions to the needs of consumers and their governments.

In short, there is no need for a massive metamorphosis in fuels, or engines, or cars or delivery systems which fuel cells and other alternatives necessitate. Instead, it is entirely feasible that any growth in transportation fuel demand in the critical period a decade from now can be met by simple changes in the specification of current fuels through blending of biodiesels, methanol from natural gas, ethanol and other products. This process will deliver a transportation fuel continuum that does not form a significant part of any national energy policy outside Brazil, a country that has plainly demonstrated what is possible for many years. For politicians, these policy options are profitable in terms of balance of payments savings, employment and energy security. For investors, non-crude oil transportation fuels are likely to enjoy long-term demand growth, controllable political risk, large volumes and an opportunity to break into a market until now the exclusive domain of large integrated oil companies.

What Energy Sources for Transportation in the 21st Century?
Pierre-René Bauquis

During the whole of the 20th century transportation has been dominated by road transport. Both cars and trucks have been powered during all that period by the internal combustion engine utilizing either gasoline or diesel fuels. As during the 21st century we will see the decline of world oil production, this raises the question of what energy sources will be used for road transport and also for air and marine transportation.

The author has developed a view on the world oil production profile for this century, ranging from 3.5 GToe today (75Mb/d) up to a peak of 5 GToe (100 Mb/d) around 2020 and slowly declining thereafter (back to 3 GToe in 2050 and down to 1 GToe in 2100). From this total natural liquid hydrocarbon production, the author foresees that only 50 to 60% will be available for

transportation. As transportation will require some 4 GToe by the end of the century (based on the author's assumption of world GDP growth, population, technological improvement effects and so on), we will have to provide 75% of the required energy from sources other than natural hydrocarbon liquids.

Facing this question, two kinds of responses exist today. A dominant school of thought pretends that a new magic couple, consisting of hydrogen as a fuel coupled with fuel cells as energy converters, will replace the old magic couple, consisting of liquid hydrocarbons coupled with internal combustion engines, for ground transport or jet engines for aviation. Another school of thought visualizes a breakthrough in the possible storage of electricity in road vehicles, allowing for a massive development of electric vehicles. Pierre-Réné Bauquis proposes a different vision in which synthetic fuels will play a major role, while electricity could provide a rather large share (say 25%) of the world transportation requirements.

In this vision, the author will develop two original points of view. First, the synthetics would include not only those already known today (i.e. Fischer Tropsch liquids and biofuels) but also new synthetics (carbonised hydrogen produced by the nuclear industry). Second, electricity would penetrate the automobile industry not thanks to new electric cars, but thanks to the development of new types of hybrid cars, which would be "rechargeable" with some limited autonomy (20 to 40 km) provided by their batteries.

According to these views the future of the automobile industry would therefore avoid technological and logistical discontinuities and would be consistent with new oil pricing systems, which will emerge when the world oil production peak is reached.

The Contribution of Technology: "Creating" Reserves?
Gérard Friès

The issue of the ultimate recoverable reserves is subject to ongoing debate. For several years, pessimists have warned that discoveries no longer cover the volumes of oil withdrawn. At regular intervals, they have predicted that world petroleum production will peak by about 2015 – in other words, imminently – before entering a decline.

The purpose of this presentation is to review the current reserve/resource situation, as well as the research and development options that the industry may explore to maintain and renew current reserves at an acceptable cost. The purpose of the presentation is also to try to quantify the contribution of these different technological alternatives.

New petroleum resources may be mobilized in different ways.

First, new accumulations may be discovered. Estimates concerning conventional petroleum remaining to be discovered in new fields vary widely, but they all indicate that the average undiscovered field will be smaller than in the past and that, to find new accumulations, it will be necessary to explore more complex areas (foothill

zones, exploration at greater depths, exploration of infrasaliferous zones, etc.). In the field of exploration, improved petroleum system assessment and characterization requires high-performance tools for data acquisition, analysis and modeling. Furthermore, a number of possibilities have been opened up thanks to basin modeling and the steady progress made in seismic data acquisition, processing and interpretation.

New resources may also be mobilized by recovering more of the volumes in place at the field. It is important to recall that, on average, only one-third of the oil in place is recovered. A quick calculation shows that improving the average rate of recovery by only one point for all known oil fields worldwide would make it possible to cover oil consumption for two additional years. A number of solutions may be combined to boost the recovery rate for resources in place, as well as productivity, at an acceptable cost. These solutions are based on progress in reservoir characterization (improved knowledge and modeling of fracture networks, etc.), reservoir management (notably via 4D seismic), the optimization of well architectures, and the pursuit of research on the modeling of fluid flows during production.

Other possible oil resources, non-conventional petroleum -- extra-heavy crude oil and tar sands -- represent volumes in place amounting to an estimated 2,900 Gbbl. The possibility of developing and producing these resources should not be disregarded. To optimize the latter operations, work would be necessary at every point of the supply chain: knowledge of reservoirs and fluids, production, transport, upgrading, etcetera.

Due consideration should also be given to the technologies used to produce petroleum products from other fossil resources. Gas-to-liquid technologies offer new possibilities for the exploitation of natural gas involving the production of high-grade petroleum products. Coal-to-liquid processes, which are technically feasible but more costly, may also be envisaged.

Finally, the focus will be on a way of “creating reserves” that is often forgotten: the technological progress contributing to maximize the energy efficiency from each barrel produced.

Extra Heavy Oil and Bitumen – The Challenges of Enhanced Recovery
François Cupcic

Extra heavy oil from the Orinoco belt in Venezuela and bitumen from the Athabasca oil sands in Alberta (Canada) represent the largest remaining resources of non-conventional oil in the world. If they could be produced economically with recovery factors comparable to those currently obtained with conventional oil, they would represent as much reserves as those commonly acknowledged for conventional oil.

So far, only limited production of these extra heavy oil and bitumen resources has occurred, based on conventional recovery methods, such as cold production and huff & puff, with reasonably low costs but limited recovery efficiency.

Nevertheless, the oil industry has been studying for years some new recovery methods that could result in much higher recovery factors. Among those, one

is emerging in Canada for specific application to bitumen based on an innovative steam injection process called SAGD (Steam Assisted Gravity Drainage).

Despite the higher recovery expected from this emerging process, the huge amount of energy required results in major drawbacks, such as much higher greenhouse gas emissions and much higher production costs, when compared to conventional recovery methods. The development and implementation of such new technologies is therefore a major challenge for the oil industry and can only result from an accurate evaluation and a balanced choice between various advantages and drawbacks.

Status of Renewable Energy in Europe and Its Role in a Renewable Transport Fuel Strategy
Werner Zittel

Recent statistics of installed Renewable Energy capacities are presented with special focus on the development of wind and solar energy.

In addition to these statistics, the role of hydrogen as possible transport fuel is briefly sketched. Company activities are summarized and the state of the art of hydrogen infrastructure build-up is given.

Property Rights for the Global Commons - Feudal or Democratic?
Dr Paul E. Metz

In Sustainable Development policies our governments try to compensate for the well known – and little understood – deficiencies in economic science called "externalities", of both economic, social and environmental natures. Many governments are experimenting and the OECD annually reports on the results of these trials, mainly the success stories.

Little attention is given to the role property rights could play, despite some established practices, which are considered successful. And despite the dominant place of property rights in mainstream economics itself. Most fossil fuel reserves are under control of states, but for the management and sustainable exploitation of things that cannot easily be captured or privatised, like the atmosphere, the oceans, the electromagnetic spectrum and biodiversity, lessons can be learned from the Alaska Permanent Fund.

Putting the Alaska model of 'fossil equity' into global practice for the Global Commons can solve many of the fairness and financing problems in international policies for Sustainable Development and Globalisation, including the range of transitions currently considered. An Earth Dividend model will be presented, which ends "environmental colonialism", stops further growth of the "ecological debt" of the North to the South and generates purchasing power in a 'bottom up' way which is beneficial for clean, local businesses worldwide.

The U. S. Reaction to World Oil and Gas Depletion
Matthew Simmons

The reason the topic of Depletion is so controversial and so misunderstood is that too many skeptics think depletion (or the phenomenon that oil and gas production from any field, or any basin, ultimately peaks and after some time staying flat, then begins to decline) is wrong is that most assume depletion means "oil has run dry."

The reality of the topic is that depletion (i.e. "when daily production of energy flattens and begins to decline) is a topic wrapped in secrets. No oil or gas company ever published a table or chart showing how much their production base at the start of any period ended up declining, had no new production come on stream.

Oilfield technology then compounded naïve skeptics to the thesis that oil and gas were non-renewable energy sources. For a decade, myths like "we have eliminated the dry hole," or "oil and gas prices are now following Moore's Law and will steadily fall," became conventional wisdom but like always, conventional wisdom was wrong.

"Peaking" of any oil or gas basin, so far, has been an event that only gets acknowledged about a decade after the fact. All serious basin-wide declines have always caught the principals of the same basins by the most surprise.

Do we even have the right terminology to frame this critical issue? If the world is close to peaking in oil supply, could the same event also be happening to Natural Gas? If Natural Gas ever became supply constrained, would that end any vision for hydrogen?

What is the role of energy price in this complex arena? If oil prices were extremely high, would this suddenly bring on many new supplies? Or has price now become a literal "one-way street" where high prices seem to have little impact on extra drilling or surge of new supply, while low prices quickly bring any drilling to a halt?

Risks and Solutions to Ireland's Energy Supply
David Callaghan

At the present time, 85% of Ireland's energy requirement is imported. As gas and oil reserves continue to decline the Irish Economy becomes vulnerable and dangerously exposed to rising fuel prices. Also, there is an increasing demand for additional generating capacity. While wind turbines and peat-burning stations are commissioned, there is a renewable energy resource available in Ireland, which has not so far been tapped. This resource is the predictable kinetic energy in the strong sea currents around parts of the Irish Coast. A system incorporating Deflecting Vane Technology (DVT) has been developed in Ireland to harness this energy and the system could be applied to many parts of the EU. Breakthroughs occurred during DVT evolution and some are listed below:

- A threefold increase in energy density at turbine entry (not possible with propeller systems).
- Breakthrough in bearing protection with overall cost savings and reduced shutdown time.
- Problem of marine growth on vanes has been resolved.
- Onsite topography requirement recognised. Some sites have significant advantages.
- The 24-hour cycle incorporates an energy storage sequence to capture best market price.
- The structure is semi-submersible and maintains best position relative to the surface.
- Main buoyancy is well below the surface, safe and away from storm waves.
- The main elements of each platform and facility are in multiples and are dispersed.
- The dispersed underwater nature of the system facilitates protection against attack.

THE WAR FOR OIL

Script of the BBC Money Programme broadcast 26th March 2003
Producer/Director: David Strahan

COMMENTARY
The advocates of war insist it's not about oil. But when the fighting's over, it will have to be. Because everybody needs Iraq's massive reserves. For oil companies it's a fight for survival.

David Horgan: For the super majors, it's essential to be in Iraq. They will not remain super majors if they're not part of Iraq's oil future.

COMMENTARY
But its not just companies who are desperate for Iraqi oil. The West will soon begin to run short of supplies, and Iraq could be a lifeline.

Matt Simmons: Physical shortages are a real, real serious concern.

COMMENTARY
In fact global oil production is on the brink of terminal decline. Some predict as soon as 2010. The consequences could be catastrophic.

Richard Hardman: We could look back in 20 years time and see the present crisis as the first of the oil wars.

COMMENTARY
This is the story of the hidden agenda behind the invasion of Iraq. How much has this war really been about control over a dwindling resource?

TITLE: The War for Oil

COMMENTARY
The lure of Iraqi oil stretches a long way. All the way to Dublin.

David Horgan runs a tiny Irish oil company. They already produce oil in Texas and South America. But in 1997 he turned his sights on Iraq.

David Horgan, MD, Petrel Resources: Why Iraq? Because that's where the oil is. There is no mineral or oil exploration play anywhere in the world that comes close to Iraq. You could drop the North Sea, the entire North Sea from beginning to end, into three or four Iraqui fields. So this really is a bonanza.

COMMENTARY
Four years ago David Horgan set off for Baghdad, to try to cut a deal. UN sanctions were still in force, but he was determined to be first in – the moment they were lifted.

What Horgan found was that sanctions had crippled the Iraqi industry. The Ministry of Oil was keen to develop. So Horgan began to negotiate for exploration rights covering a patch of desert a third the size of Ireland. Eventually he persuaded the Iraqis to give him some crucial seismic surveys of the area.

David Horgan: So where are these seismic lines?

Munim: These seismic lines are located in the area round here and they do trend from northeast to southwest.

Horgan: Right.

COMMENTARY
Horgan then hired in specialist consultants. One is an Iraqi professor of geology. They started to analyse the seismic surveys to see if there were any geological structures which might contain oil. Their early impressions were encouraging.

Munim: So we reckon this structure should be as good as the other discoveries.

Horgan: And if it's oil prone we're laughing?

Munim: Absolutely.

COMMENTARY
The company's chairman knew it was hugely risky dealing with Iraq, but even he was beginning to think it was worth it.

John Teeling, Chairman, Petrel Resources: One, you're going to find amongst the biggest discoveries in the world. Secondly the quality is going to be very good. And thirdly, your costs of production are the cheapest in the world. It's a very easy choice as to where you go to explore.

COMMENTARY
The company had no qualms dealing with the Iraqi regime. And by the end of last year, it looked as if they were on the point of clinching a final deal.

David Horgan: We have come to the conclusion that there are very large structures in the western desert – billion barrel type structures – and that really is a prize that any oil man would travel anywhere to get.

COMMENTARY
And many already have. The Russian giant LUKoil originally won a contract to develop a massive oilfield. But because of sanctions they couldn't do the work, so the contract is now in dispute. Total of France also held years of negotiations for two big fields, but their deal remains unsigned.

Then, as Saddam's days began to look increasingly numbered, big oil shifted its attention to Iraq's many opposition groups. They met in London, last

December, to prepare for power. And they've been inundated by oil companies lobbying for access post Saddam.

Dr Salah Al-Shaikhly, Iraqi National Accord: The enquiry always have been the same, whether or not they have a chance to bid for future Iraqi oil.

Q: Has BP been in touch?

Dr Salah Al-Shaikhly: Er, I'm afraid I cannot, er, confirm any of these companies.

Q: Exxon Mobil?

Dr Salah Al-Shaikhly: Er, the same.

Q: Total?

Dr Salah Al-Shaikhly: Er, well as I said, er, large European companies have been in touch, yes.

Q: And large American ones?

Dr Salah Al-Shaikhly: Er, indeed, yes.

COMMENTARY
It's not surprising the big oil companies are desperate to return to Iraq – they carved it up once before. After the First World War, BP, Shell, Exxon and Total owned the Iraq Petroleum Company. They paid the Iraqis pennies for each barrel of oil, and built a pipeline to take it away.

Newsreel: And to mark a great engineering achievement, King Feisal arrived to open the pipeline. He was escorted to the dais by Admiral of the Fleet Sir John Cunningham, the chairman of the company.

COMMENTARY
In 1972 the Iraqis nationalised the industry and threw the foreigners out. From then on Western oil companies could only dream of Iraq's oil reserves – the second largest in the world.

With Saddam came decades of war and sanctions. So those massive reserves lay largely untouched. But as regime change began to look more likely, at last there was a chance to get back in.

But it's not greed that's driving big oil companies – its survival. Because they're discovering less and less oil with every year that passes.

It's something senior oil explorers have worried about for decades.

Richard Hardman, Vice President Exploration, Amerada Hess (1998-2001): The rate of oil discoveries has been falling ever since the '60s. The

‘60s were the most that was ever found and that was 47 billion barrels per year, mainly from the Middle East. In the ‘70s the rate dropped. The industry of course was exploring everywhere, but concentrated on the North Sea, and the rate dropped to about 35 billion barrels. And in the ‘80s it was Russia's turn, and the discovery rate then dropped to 24 billion. And then the rate dropped even further in the ‘90s. The industry concentrated on West Africa but only some 14 billion barrels were found, and 14 billion barrels is not enough to replace production, because the world consumes about double that amount.

COMMENTARY
No wonder the multinationals are desperate to get back into Iraq. And it’s all the more urgent because not only are they discovering less and less around the world, but production from their existing fields is falling too.

In America – always the greediest consumer of oil – production has been falling for thirty years. Americans guzzle 20 million barrels of oil every day, but now they have to import over 60 percent of it.

COMMENTARY
In the high plains of West Texas, falling production is a fact of life.

Jim Henry: Production peaked in Texas in the early 1970s, and that's when I went into business. Throughout my career, I've watched the production rate in the United States and in Texas decline.

COMMENTARY
Jim Henry is an independent oilman. He owns about a thousand wells.

All around, the nodding donkeys are a symbol of decline. The pumps are only needed because of falling pressure in the oilfields below. There's still lots of oil there – it’s just that as the pressure drops it comes out ever more slowly.

It’s an iron law of nature.

Jim Henry, Henry Petroleum: What we have here is a stripper well that's producing from about five thousand feet down, about a mile down. It’s only producing seven barrels per day, which is not very much. Most of the wells in this area produce about seven barrels per day. This well once produced one hundred barrels per day, about thirty years ago. Since then, it’s declined because it’s only so much oil down in the ground, so we're producing it all, and it’s running out of oil.

COMMENTARY
It’s not just falling pressure that causes production to decline. Oilmen always try to find and exploit the biggest oilfields first. But later on, when they have to rely on small oilfields, there’s a cost to pay.

Jim Henry: The production goes down because the large fields are declining, the smaller fields come on but they don't produce nearly as much as a larger field. In the overall aggregate, the production declines.

COMMENTARY
In America, the trend was so pronounced that production started to fall when HALF the oil was still in the ground. Now the same forces are taking effect around the world.

Dr Colin Campbell is an exploration geologist with a long career in big oil. Now Dr Campbell leads an international group of scientists which predicts when oil production will start to fall in other areas of the world. He has long forecast the peak and decline of the British North Sea. And now it's started.

Dr Colin Campbell, Association for the Study of Peak Oil: In 1999 Britain went over the top and is declining quite rapidly.

And it's now 17 percent down in just three years, and this pattern is set to continue. That means that Britain will soon be a net importer, imports have to rise, the costs of the imports have to rise, and even the security of supply is becoming a little bit uncertain.

COMMENTARY
Soon Britain will be in the same boat as America. Today we're self sufficient in oil. But by 2020 we will have to import three-quarters of our supplies. It wouldn't matter so much if there were other sources to make up the difference. But increasingly, there aren't.
Richard Hardman: It's not only the United States and Britain where production is falling. It's falling all over the world in many places. For instance, in the Norwegian North Sea the government forecasts that in the next ten years production will halve. In Argentina oil production has been down for several years. And in Columbia, which was a big producer in the '90s, production is now past peak. Alaska, which was the saviour of the United States for many years, is now in decline. Australian oil production is down, and Indonesia passed its peak some five years ago. Because production is falling all over the world we're going to become increasingly reliant and vulnerable to the Middle East, and in particular the five largest producers. Of those, the two most important, from our point of view in the West, are Saudi Arabia and Iraq.

COMMENTARY
When George Bush took power two years ago, his administration was already worried about the vulnerability of America's oil supplies – the buzzword was 'energy security'. Like Bush himself, the men and women behind the President had close links to big oil. Donald Rumsfeld owned oil company shares worth millions of dollars. Condoleeza Rice was a director of Chevron for a decade. And Vice President Dick Cheney used to run the oil services company Halliburton. So he got the job of heading an Energy Task Force on how to safeguard America's oil supplies.

COMMENTARY
Matt Simmons is banker to the Houston oil industry. Like Colin Campbell, he's worried by falling oil production around the world. He was also a key advisor to the Cheney Energy Task Force.

Matt Simmons, Simmons & Co: What I basically told them is that we had some looming energy problems because we'd run out of productive capacity. We'd basically, in the '90s, used up all of the cushions, and yellow lights were going off all over that we were barrelling into a really nasty energy crisis.

COMMENTARY
The Administration was receptive to Simmons' message. The Cheney Report concluded that energy security should be a priority of America's foreign policy.

Matt Simmons: Is there a paranoia about energy? That's probably not a bad description. We've been a heavy importer of oil for two decades, but I think that it's just the fact that so many of the areas that we used to rely on are showing signs of no longer growing, and probably shrinking, that gives rise to just an uncomfortable sense that we have a lot more serious energy problems to address than we've really thought about for the last twenty years.

Q: And the U.S. Administration is worried about that?

Matt Simmons: Yeah, absolutely.

COMMENTARY
Most worried of all was Defence Secretary Donald Rumsfeld. Since 1998 he and other leading hawks had openly advocated invading Iraq to protect U.S. oil supplies. In two open letters he wrote:

"… if Saddam does acquire the capability to deliver weapons of mass destruction … a significant portion of the world's supply of oil will … be put at hazard.

"We should establish and maintain a strong U.S. military presence in the region, and be prepared to use that force to protect our vital interests in the Gulf."

COMMENTARY
9/11 was the most shocking terrorist atrocity America has ever known. But according to Washington Post journalist Bob Woodward, Donald Rumsfeld saw it as an opportunity. The very next day, at a National Security Council meeting, Rumsfeld urged President Bush to attack Iraq immediately. Even though there was absolutely no evidence of any connection between Saddam and 9/11.

Colin Campbell: I think it's quite possible that the United States realises the key importance of the Middle East generally to world supply in fact, and especially its own, and that it sees Saddam Hussein as a ready-made villain so to speak, and it finds this a convenient way in which to establish a military

presence in the Middle East, aimed partially at Iraq by all means, but with a wider significance to control the production elsewhere there.

Clip of George W Bush with fireman at 9/11 site

Bush: And the people who knocked these buildings down will hear all of us soon.

COMMENTARY
It soon became clear that most of those people were Saudis. This raised the spectre of an Islamic fundamentalist revolution in the world's biggest oil producer. Saudi exports could be cut off. But that was unthinkable.

John Teeling: It would be apocalyptic. No American cars would move. It would cause a depression certainly the size of the 1930s, if not worse. But they're not going to allow that to happen. This is just not going to be able to happen. They would fix it in six months. The world would demand it. And rightly so.

COMMENTARY
The Administration's 'energy paranoia' began to look increasingly justified. Worries about the stability of Saudi Arabia meant there was even more reason to secure Iraq as a reliable alternative.

America pushed its allies hard to support military action against Iraq. With resolution 1441 last November they seemed to be making progress. But then last December, America's energy security took yet another turn for the worse.

In Venezuela, a national strike by oil company workers and managers broke out – cutting world oil supplies by up to 2 million barrels per day. Yet another big worry for America's Commerce Secretary, Donald Evans.

Matt Simmons: I got a call from Secretary Evans just saying is Venezuela as intractable and serious as it sounds? And I said yeah, I'm sorry to tell you I think it is.

COMMENTARY
Venezuela used to be the one OPEC supplier that America didn't have to worry about. Reliable and close.

Matt Simmons: They are an unbelievably important supplier, and the longer we're without Venezuela, the more we have to bring it in from someplace else. Raises the second problem. Where is someplace else? Well, it's the Middle East.

COMMENTARY
Oil prices started to soar, soon hitting 35 dollars a barrel. America's vulnerability – and Iraq's importance – were more obvious than ever. But with Saddam and sanctions in place, Iraqi oil could never be fully exploited. For that, regime change was necessary.

David Horgan: They want to install a compliant regime so that they can develop Iraqi oil exports in a way that is secure for Western oil consumers without putting money in the hands of an unpredictable radical Arab regime.

COMMENTARY:
Last month, as preparations for war gathered pace, there were massive demonstrations around the world. Millions believed it was all about oil.

But Donald Rumsfeld had changed his tune. Now he claimed the oil had nothing to do with it. So did everybody else who supported the invasion.

Tony Blair: (*speaking on Newsnight, 6th February 2003*) If the oil that Iraq has were our concern, I mean we could probably cut a deal with Saddam tomorrow in relation to the oil. It's not the oil that is the issue, it is the weapons.

David Horgan: What would you say if you were them. You can hardly come out and say we want to sacrifice the infantrymen, or the Iraqi children and other civilians because of our selfish oil interests

COMMENTARY
That widely held view so worried the U.S. and Britain, they came up with a plan. At the Azores summit, on the eve of war, they promised to safeguard Iraq's oil.

George W. Bush: (*speaking 16th March 2003*) We w'll make sure that Iraq's natural resources are used for the benefit of their owners, the Iraqi people.

COMMENTARY:
As no doubt they should. But there's a bigger point. It hardly matters who owns and profits from Iraqi oil – so long as it provides a growing and uninterrupted supply to the West. Regime change could boost Iraqi output – some say – by three or even four times. Almost equal to Saudi Arabia. Could this be the real motive?

Richard Hardman: It is a war about oil. Because production is falling all over the world, Iraq has become crucial to the continuation of supply to the West, and hence the West's living standard.

COMMENTARY
Internationally, France and Russia refused to join the attack. They too may have been partly oil-motivated; Total and LUKoil stood to lose most from regime change. But by last week America – and Britain – were ready to go it alone.

A week into the invasion U.S. and British forces have gained a lot of ground. But the resistance has been far tougher than expected.

For a war supposedly not about oil, military planners made a high priority of securing the oilfields. Apart from a handful of wells torched by Iraqi troops, the huge southern oilfields were taken largely intact. But other major oil-producing regions are still in Iraqi hands. There is still a danger, as in Kuwait 12 years ago, that massive sabotage may hit oil production for months, if not years to come.

Whatever happens, rebuilding Iraq will be a huge job. Only American companies have been invited to bid for contracts. Vice President Dick Cheney's old firm, Halliburton, has already got one of them. But what about the real business of carving up the future oil concessions?

Russia's LUKoil and France's Total were once the best placed foreign oil companies. But their years of negotiations with the Saddam regime now may now be a liability.

It seems the Iraqi opposition, once in power, intends to settle scores.

Dr Salah Al-Shaikhly: Some people would be equal more than others. The French, they may stand at a disadvantage. Definitely those who have helped us all along with regime change, obviously they should have a little edge over the rest.

Q: So Britain and America may be rewarded for being so hawkish, if you like, about the invasion?

Dr Salah Al-Shaikhly: I think even in economics, this is quite acceptable, in addition, as well as the politics.

COMMENTARY
So how will the Irish fare in the post Saddam oil scramble? They're small, and like the French and the Russians, they don't have a final contract. But still they're hopeful.

John Teeling: We're well placed because the oil administration will stay the same. They may change the head but the body will stay the same. So I would be very confident that we will be asked to undertake the exploration programme in the very near future.

COMMENTARY
Whoever gets the oil concessions, the Iraqis will want to raise production from the pre-war 2 million barrels a day. They'll have to, to pay for reconstruction. Opinions vary on how much more they could eventually pump, but the Opposition has big plans.

Dr Salah al-Shaikhly: The long-term view, I think we can reach as much as six million barrels a day within seven to ten years. But that would need huge investment.

COMMENTARY:

Even if Iraq does meet these ambitious targets, ironically the effect on world supply could be short-lived. Iraqi oil reserves, although vast, represent just 4 years of world consumption. And by the time Iraqi oil is flowing freely, global oil production may already be in terminal decline.

Richard Hardman: Iraq, if it produces the 5 million barrels a day that I predict, will provide a very useful breathing space. But overall production is set to decline in world terms in the next ten or fifteen years. So although it provides a breathing space, it's not going to be the palliative that we hope.

COMMENTARY
In the 1970s it was American oil production which first went into terminal decline. In the 1990s the North Sea followed. By 2010, most other producers apart from the core Gulf states may also have passed their peak. Many in the industry are now convinced we're fast approaching the day when total world oil production starts to fall. For Shell, it's not a question of IF but WHEN.

Ged Davis, Shell International: It will not be this year, next year. Within twenty years if we have very high demand rates, we will be facing an issue. We have an issue ahead of us: probably sometime in the second quarter of this century we'll be looking at the decline of oil.

COMMENTARY
But Shell's prediction of falling oil production after 2025 may be optimistic. Scientists commissioned by the German government will this week announce that 2017 is the critical date. BP has no official forecast, but one scientist working for the company predicts decline could start as early as 2014. Colin Campbell and his group of independent geologists think sooner still.

Colin Campbell: By about 2010 we face the onset of the permanent decline of production at about 3% a year. So it's a two-phase crisis. It starts with a price shock due to control of the market by a few countries, and it is followed by the onset of physical shortage, which just gets worse and worse and worse.

COMMENTARY
Global oil decline will put all previous oil shocks in the shade. In the 1970s, OPEC turned off the taps, causing global recession. But at least they could turn them back on again. This time producers will pump as fast as they can, but still the shortages will grow. This time, it's forever.

Richard Hardman: The major impact will be the realisation that cheap energy is no longer part of the future, and therefore energy is going to be priced high whichever source we get it from. Therefore there are going to be lifestyle changes.

COMMENTARY
Those changes could be radical if alternatives to oil are not found soon. Unlimited use of cars, and cheap flights around the world, may well be a thing

of the past. International trade – the very basis of the global economy – will suffer.

Richard Hardman: It'll be a poorer world. It'll be a much more restricted world in every way.

COMMENTARY
There are many good reasons for getting rid of Saddam Hussein. It seems the U.S. Administration privately thinks one of them is oil. The war is certainly not about anything as trivial as the profits of individual companies. But it may well be about opening up Iraq's reserves as world oil production approaches terminal decline. Ironically, even if that strategy succeeds, we in the West will not be protected for long.

Matt Simmons: High prices are going to usher in a reality of the seriousness of our energy problems. Physical shortages are a real, real serious concern.

Richard Hardman: This is going to lead to severe international tension. And we could look back in 20 years time and see the present crisis as the first of the oil wars.

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