IA INTERNATIONAL ASSOCIATION FOR ENERGY ECONOMICS
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Newsletter

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Summer 1997

President's Message

This has been a busy time for me and for the IAEE, with much planning going on for the coming North American meeting. I hope that many of you are planning to attend the 18th Annual North American Conference in San Francisco, this September 7 to 10.

Program Chairman, Jim Sweeney, has done an outstanding job in putting the program together as you will have noticed from the conference announcements as well as the ad on the following page. A total of 34 concurrent sessions, if not a record, is very nearly one. I'm told that the number of papers in the Proceedings of the meeting is a third more than last year.

San Francisco is a great place to hold a conference as we all know. Plan to arrive in time to enjoy some of the optional tours and the sights of the city or stay over after the conference and enjoy them.

Though I couldn't attend the Vienna conference, cosponsored by our Austrian Affiliate, the EFCEE and IAEE, I'm told that it was a great success. The Program Committee, and especially Dr. Gunther Brauner, Dr. Reihard Haas and Dr. Pieter Vander meiren, are due much credit for their hard work and the conference's success. I hope we will have an opportunity to have some of the papers from that meeting carried in future *Newsletters*.

And speaking of papers and the *Newsletter*, I want to make a special plea on behalf of the editors for more members to consider submitting material for publication. I've been very pleased to see the increase in the number of substantive papers carried. We begin, in this issue, a series of articles on the oil industry as assembled by Peter Davies of BP. I think you'll find them particularly worthwhile. Davies has promised a follow-on article for the next issue and Peter Pearson is assembling a series of articles for that issue as well. We encourage responses to these articles from our readers.

It's hard to believe that my year as president is more than half over. Time goes by very quickly. In this vein, I'm especially pleased with the job the Nominating Committee, headed by Kenchi Matsui, has done. The slate they have assembled, and which you will be voting on ballots that will be mailed around September 1, include Hoesung Lee as president-elect, Michelle Michot Foss as vice president of conferences, Hossein Razavi as vice president for publications and Arild Nystad as vice president and secretary. This is an outstanding slate. Each of these persons has already contributed greatly to the Association and deserves the nod of the Nominating Committee.

The ballot will also contain space for you to make suggestions to the Nominating Committee for nominees for next year's election. I urge you to take the time to do this. It is important the committee have an opportunity to reflect your input in the nomination and election process.

Our Mexican Affiliate underwent some difficult times as a result of the recent Mexican recession. I'm delighted, therefore, to see them in a resurgent mode. Luis Vazquez has recently been elected president of the affiliate, succeeding Mariano Bauer, and I'm sure we can expect many good things from Mexico.

Dennis O'Brien

Editor's Note

Commenting that forecasters have been unable to predict oil supply with any degree of accuracy, Peter Davies introduces a series of articles on oil and gas supply developments. In these, Arild Nystad provides a perspective on developments on the Norwegian Continental Shelf concluding that Norway will be a significant oil and gas producer far beyond 2050. James Dyer looks at UK oil production and notes that though the UK Continental Shelf is a mature province and production will probably peak towards the end of the century, it will remain an attractive area of oil companies to operate.

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!!! MARK YOUR CALENDARS — PLAN TO ATTEND !!!

International Energy Markets, Competition and Policy

18th USAEE/IAEE Annual North American Conference - September 7 - 10, 1997
San Francisco, California, USA - Fairmont Hotel

Sponsored by:
USAEE/IAEE

If you're concerned about the future of the energy industry and profession, this is one meeting you surely don't want to miss. The 18th USAEE/IAEE Annual North American Conference will detail current developments within the energy field so that you come away with a better sense of energy supply, demand and price. Some of the General Sessions planned for this meeting are as follows:

Energy: Looking Ahead and Thinking Globally
Creating and Designing Electricity Markets
Asia Pacific Energy Issues in the Next Decade
Are We Ready for Retail Access in California in 1998?
Environmental Regulation and Energy Markets
Climate Change Policy: What is Integrated Assessment Telling Us?
Envisioning and Mapping the Energy Future
Structural Change in Energy Industries
The Changing European Energy System

In the opening session Chauncey Starr, President Emeritus and Founder of EPRI and Hans Jürgen Koch, Director, Energy Efficiency, Technology and R & D, International Energy Agency, will focus on major changes in the energy system in response to new technologies, economics and the growing concern for the environment. Further, luncheon speakers, William J. Perry, former U.S. Secretary of Defense and now with Stanford University and Michael J. Boskin, former Chairman of the President's Council of Economic Advisers and also now with Stanford University, will discuss fundamental U.S. and international economic and security policy issues and will relate these to energy considerations.

At this time, other confirmed General Session speakers include the following:

Don Carroll, BHP Power
James A. Edmonds, Battelle Pacific Northwest Laboratory
Lawrence H. Goulder, Stanford University
William W. Hogan, Harvard University
Lester B. Lave, Carnegie Mellon University
Paul D. Mlotok, Global Business Network
Silvia Pariente-David, DRI/McGraw-Hill, Inc.
Eric Hardiman M. Price, National Economic Research Associates
Wayne Sakarias, San Diego Gas & Electric
Jeong-Shik Shin, Korean Energy Economics Institute
Philip K. Verleger, Charles River Associates
Guy F. Caruso, International Energy Agency
Richard Gilbert, University of California, Berkeley
Michael Grubb, Royal Institute of International Affairs
George J. Hsu, Center for Energy and Environmental Studies
Stephen McMenamin, Southern California Edison
Alex Papalexopoulos, Pacific Gas & Electric Company
Paul R. Portney, Resources for the Future
Richard G. Richels, EPRI
Stephen H. Schneider, Stanford University
Vernon L. Smith, University of Arizona
John P. Weyant, Stanford University

Thirty four (34) concurrent sessions will explore energy themes in depth and will promote exchange among participants. Concurrent sessions will be devoted to each of the following areas: doing energy business in the information age, energy use (demand modeling, indicators of energy use and efficiency, the rebound effect, transport sector), environmental analysis and regulation (modeling, the role of energy technologies, CO_2 emissions, climate change policy), natural gas (international and North American markets, conversion to liquids), oil markets (supply outlook; OPEC decisions and security, inventory management, empirical modeling), electricity markets (modeling, restructuring, market design, market differentiation, strategic behavior, investment, new horizons, outlook for renewables, changes in transition economies), the role of chief economists in energy companies, economic analysis (public policy issues, structure and market power, financial and structural change), energy transmission and access fees.

The 18th USAEE/IAEE Annual North American Conference provides a unique opportunity for leading experts from business, government, universities, and research institutions to discuss and debate the future of energy markets in this era of commodization, decentralization, and internationalization.

San Francisco, California is a wonderful and scenic place to meet. Single nights at the Fairmont Hotel are $167.00 (contact the Fairmont Hotel at 415-772-5000, to make your reservations). Conference registration fees are $425.00 for USAEE/IAEE members and $525.00 for non-members. Special airfares have been arranged through Traveline (for absolutely the lowest zone fares, call Traveline at - 216-646-8525). These prices make it affordable for you to attend a conference that will keep you abreast of the issues that are now being addressed on the energy frontier.

There are many ways you and your organization may become involved with this important conference. You may wish to attend for your own professional benefit or your company may wish to become a sponsor or exhibitor at the meeting whereby it would receive broad recognition. For further information on these opportunities, please fill out the form below and return to USAEE/IAEE Headquarters.

International Energy Markets, Competition and Policy

18th Annual North American Conference of the USAEE/IAEE

Please send me further information on the subject checked below regarding the September 7-10, 1997 USAEE/IAEE Conference.

_____ Registration Information _____ Sponsorship Information _____ Exhibit Information

NAME: ____________________

TITLE: ____________________

ADDRESS: ____________________

CITY,STATE,ZIP: ____________________

COUNTRY: ____________________ Phone/Fax: ____________________

USAEE/IAEE Conference Headquarters

28790 Chagrin Blvd., Suite 350 - Cleveland, OH 44122 USA

Phone: 216-464-2785 Fax: 216-464-2768

Editor's Note *(continued from page 1)*

Finally, F. Collignon examines the oil situation in Angola, concluding that production should rise from 1996s level of 690,000 b/d to 800,000 b/d before 2000.

Mamdouh Salameh looks at oil demand through 2005 and suggests that almost 10 mbd of additional crude will be needed from OPEC by then, of which some 6.5 mbd will be needed from Iraq, Iran and Libya, all of which are subject to a U.S. containment policy. The conundrum is that enforcement of the containment policy is likely to bring higher oil prices than would have otherwise been the case, thus bringing economic harm not only to the United States, but to the world as a whole. Some rationale way out of the containment policy is urgently needed.

Thomas Trumpy puts forth the case for least cost planning to meet the needs for future power generation in Europe and elsewhere. He urges that the analysis must be based on a forty year life of installation and a twenty to fifty year estimate of fuel costs. When this is done, he suggests, realistic planning calls for greater and more efficient use of coal. He further suggests the trend to reliance on gas turbines will peak before 2010.

Gerald Westbrook examines the use of General Circulation Models, the huge simulation models used in climate simulation and asks whether they are really up to the task of providing accurate projections on the matter of global warming. He reviews the status of the models, notes the extraordinary complexity of modeling the climate and suggests that the models not be looked at as the final word, but rather their results be treated with care.

Perry Sioshansi examines the coming of retail access in the electric industry in 1998, both here and in the UK, and discusses some of the issues that are worrying the industries' technical personnel. He notes the enormity and complexities of operating in the new environment and why many of the technical people are skeptical that the details of this will be sorted out by the time retail access begins. He further questions whether the costs involved are fully appreciated.

Fatih Birol looks at the outlook for oil in the dynmaic Asian regions and highlights its growing importance in world energy and oil markets. Oil demand in the region is expected to grow at 5 percent per annum on average to 2010. Transportation and household sectors will be the engine of growth in the oil demand. In aggregate terms, crude oil production in the region is projected to remain sluggish. As a result, the dependency of the region on imported oil is expected to rise significantly. It is expected that reliance on Middle East oil will grow significantly. This could expose the area to the volatility and instability of world oil prices.

Jerzy Michna looks at the effects of criminality on economies in transition and notes that though the statistics are not very good, what there are suggest that the share of GDP accounted for by the *grey economy* is in the range of 30 to 40 percent, considerably higher than in western economies. He urges development of better data as one means of reducing this negative factor in economic development.

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SECOND CALL FOR PAPERS

THE INTERNATIONAL ENERGY EXPERIENCE: MARKETS, REGULATION AND ENVIRONMENT

8-9 December 1997, University of Warwick, Coventry, UK

This academic energy conference, convened by the British Institute of Energy Economics (BIEE), and by the Centre for Management under Regulation (directed by Catherine Waddams) and the Department of Economics at University of Warwick, follows the December 1995 conference on ***The UK Energy Experience: A Model or a Warning?*** This second conference will provide a unique opportunity to review UK and international energy experience in the light of recent progress in energy, environmental and regulatory economics. The conference will bring together, from the UK and elsewhere, university economists and others with specializations in energy issues, postgraduate students and also economists and policy makers working on energy issues in industry, government and related organizations. John Battle, UK Minister for Science, Energy and Industry, has been invited to address the conference as the opening speaker.

TOPICS

As well as keynote talks, likely sessions include: the interaction of economic and environmental regulation; energy-environment regulation and trade; efficiency and environmental opportunities in the supply chain; investment appraisal and modern asset pricing methods; financial and contractual innovation in energy markets; finance and investment, risk and technology; different experiences with electricity pools; competitive markets and energy security; new forms of energy taxation; models of liberalization; liberalization in countries in different development situations; energy in the developing world; networks, natural monopolies and third-party access; decentralization vs. economies of scale; differing techniques of modeling. Papers on other topics will also be considered. Papers will be grouped appropriately under broader thematic headings, including: Environment, Finance and Investment, Pricing and Regulation, Networks (Wires and Pipes), and Centralization vs. Decentralization.

CONFERENCE ORGANIZATION AND PROCEEDINGS

Papers are invited for presentation at the parallel sessions:

- One-page abstracts should be submitted and you will be notified whether your paper has been accepted by early September.
- Accepted papers will be published in the conference proceedings, provided that the completed paper is received by Friday 31 October.

It is anticipated that, as with ***The UK Energy Experience: A Model or a Warning?*** (edited by Gordon MacKerron and Peter Pearson, and published in March 1996 by Imperial College Press), papers presented at the conference will be considered for inclusion in an edited volume from a major publisher.

LOCATION AND COSTS

The conference will be held at the University of Warwick Conference Park. Campus accommodation is offered. Fee, to cover the cost of the conference, including accommodation on the night of Monday 8 December, meals, VAT and conference proceedings: £80 (academic participants, paper presenters and BIEE members), £150 (nonacademics). It is intended to offer reduced rates for postgraduate students.

FURTHER INFORMATION

Please address any inquiries and send abstracts to Mary Scanlan, Administrative Office, BIEE, 37 Woodville Gardens, Ealing, London W5 2LL. Tel: +44-(0)181-997-3707; fax: +44-(0)181-566-7674.

Oil and Gas Supply: The Perpetual Enigma

Forecasters always seem unable to predict oil supply with any degree of accuracy. The experience of the last decade has been no exception when the strength of the oil supply response from a very wide range of countries was unforeseen from both within and outside the industry. Even in more recent years it has proven difficult to predict non-OPEC oil supply. After many years of systematic underestimation, the experience of 1996 was also one of inaccuracy – but forecasters generally overcompensated and began to overestimate the strength of incremental supply. It is too soon to assess 1997 yet. However, the first indications are that some institutions have overestimated non-OPEC supply growth again, as in 1996.

Forecasting gas has, to some degree, been a different challenge. Market conditions are as important as upstream developments. However, the time between discovery and first production is often longer and even less predictable than that for oil and many projects have required complex contractual negotiations before progressing.

In light of the importance of the topic we have decided to establish a new series in the *IAEE Newsletter* with the specific aim of increasing understanding of world oil and gas supply developments. As a result, we will invite well informed analysts and practitioners to write brief articles on the latest developments in the provinces where they have particular expertise and insight. In this first edition we have focused on three *hot spots*: Norway, the United Kingdom and Angola. In future editions we will focus on additional areas, one at a time.

Readers are invited to open a correspondence with either the editors of the newsletter (IAEE@IAEE.org) or myself (daviespa@bp.com). Suggestions as to which provinces we should cover in future editions are welcomed.

Peter Davies
Chief Economist, British Petroleum, London
daviespa@bp.com

Perspective on Oil and Gas Developments on the Norwegian Continental Shelf

*By Arild N. Nystad**

Norway is the second largest oil exporter and the sixth largest oil producer in the world. Norway will supply Western Europe with significant amounts of its gas demand and gas imports. The Norwegian Continental Shelf will continue to be a significant and long term supplier of oil and gas.

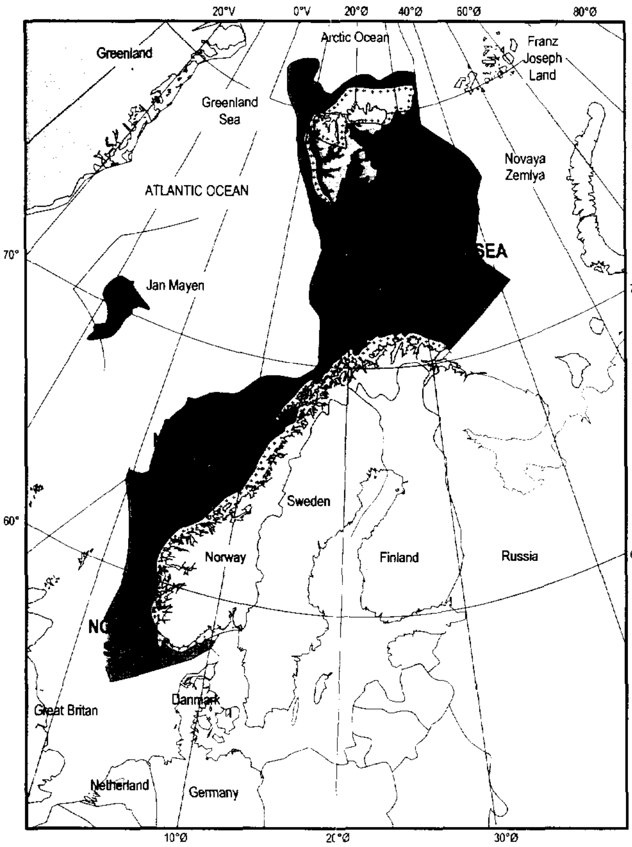
I will give three important observations in order to underline this: the first one relates to the geography and sedimentary areas, the second one relates to the petroleum stocks and the assets, and the third one relates to the production levels and production forecasts.

The areas with sedimentary rocks on the Norwegian Continental Shelf (See Figure 1) makes up 1.1 million km^2.

* Arild N. Nystad, is Managing Director, RC Consultants A/S, Stavanger, Norway.

So far about 55 percent of these areas are opened up for commercial prospecting and petroleum activities. Only 6 percent (60,000 km^2) is currently in active licenses. There is still a multitude of possibilities and options for future prospecting in Norwegian waters.

Figure 1
Sedimentary Basins on the Norwegian Shelf



Let me review the three major areas on the Norwegian shelf.

In the North Sea we have had exploration activities for the last 30 years and have drilled about 700 exploration wells in an area covering 140,000 km^2. The major activities on the Norwegian Continental Shelf during these years have been concentrated in the North Sea. These areas still have very interesting resource potential.

In the Norwegian Sea areas, outside mid Norway, the total exploration areas were increased recently from 70,000 km^2 to 240,000 km^2. These areas contain deep water challenges in water depths between 1000 and 2000 m. One hundred twenty-five exploration wells have been drilled during the last 17 years in the Norwegian Sea. The very first exploration well in the newly opened deep waters is currently being drilled. The Norwegian Seas have an exciting future resource potential.

In the Barents Sea we have had exploration activities since 1980 and 50 exploration wells have been drilled in an area covering 235,000 km^2. So far there has been no commercial success in this vast area. The petroleum industry, however, has embarked on a renewed exploration effort.

Total Norwegian petroleum assets are now, according to the recent estimate from the Norwegian Petroleum Directorate, approximately 80 billion bbl o.e. (oil equivalent) oil and gas. The distribution between oil and gas is about 50/50 – a little bit more oil, however, than gas. These numbers include the accumulated production of 13 billion bbl. o.e. oil and gas which means that only 17 percent of the total assets have been produced the last 25 years. The total number also includes an estimate of 22 billion bbl. o.e. undiscovered resources and 7.5 billion bbl. o.e. improved recovery in proven fields and discoveries. There are, of course, uncertainties attached to these numbers. Total assets are thus estimated to be between 60 billion and 100 billion bbl o.e.

Oil production from the Norwegian shelf is currently 3.2 million bbl/day plus 200,000 bbl/day condensate and NGL. This makes Norway the sixth largest oil-producer and the second largest oil-exporter in the world. The latest forecast suggests that oil production will reach some 3.7 million bbl/day just after the turn of the millennium. The production forecast uncertanties range from 3.2 to 4.2 million bbl/day.

Gas exports to Europe are currently 38 billion Sm^3 annually and are expected to double to approximately 70 billion Sm^3 within 5 years. This will represent a significant share of Europe's gas demand and gas imports. Even with these export levels the total stock of gas resources on the Norwegian shelf is expected to last for another 80-90 years. Gas planners within the major oil and gas companies, as well as within governmental bodies, discuss export levels between 80 and 90 billion Sm^3 in their scenarios.

With gas exports of 70 billion Sm^3, total gas production will reach 110 billion Sm^3. Within 5 years we will increase gas injection into oil and condensate reservoirs from today's level of 16 billion to about 35 billion Sm^3 in order to obtain improved oil and condensate production. Almost 40 percent of total gas production on the Norwegian shelf will be reinjected in the future. This reinjected gas will later be reproduced and exported. This means that there are close links and relations between the management of gas resources and the management of oil and condensate reservoirs on the Norwegian Continental Shelf. This fact significantly improves the total asset value of oil and gas on the Norwegian Continental Shelf to all participants.

Since the first licensing round in 1965, the Norwegian Continental Shelf has developed into one of the leading petroleum provinces in the world. At the same time the Norwegian oil and gas industry has been transformed into an important international position. The offshore challenges, and specifically the deep water challenges, are shared with provinces such as the West of Shetland, the Gulf of Mexico, offshore West of Africa and Brazil, as well as offshore areas in South East Asia. The technology developed in any of these areas is available on the global market for offshore technology.

During the last 25 years we have used about US$200 billion (1996 prices) in exploration, investments and operational costs on the Norwegian Shelf. 50 percent or US$100 billion of these are directly related to investments in field developments and transportation systems.

According to the forecast and scenarios for the next 25 years another US$200 billion in exploration, investments and operational costs is expected. The relative share between investments in new installations and operational costs will be shifted towards relatively more operational cost elements. This also indicates a high level of activity in the Norwegian petroleum sector in the future.

But there are additional challenges related to a mature province like the North Sea where we will experience a shift from oil fields either on build-up or peak towards oil fields in decline, from a production based primarily on oil towards a more equal production between gas and oil, from huge fields of 2-3 billion bbl to a multitude of many smaller fields of 30-60-90 million bbl o.e. and even smaller. All these elements introduce new challenges that have to be solved.

The CRINE project on the UK shelf and the parallel NORSOK project on the Norwegian shelf are significant contributors to reduce costs and increase economic efficiency. In addition to these projects, there are additional cooperative projects between the oil companies and the authorities in order to create win-win situations between the different participants. Projects like DISKOS on data management, FORCE on improved recovery and FIND on improved exploration technologies are all good examples of constructive cooperative efforts to obtain commercial synergies.

The significant increase in oil production on the Norwegian shelf the last 10 years is to a large extent the result of a technology-driven process to improve recovery rates. The average recovery rate of oil fields has increased from 34 percent to 41 percent the last 10 years. We still believe it is possible to further improve this towards 50 percent within the coming 10 years. This is due to the combined effect of seismic technology and improved reservoir description, drilling technology and extended and horizontal wells and injection strategies of water, gas and WAG. All these improvements and additional oil volumes are equivalent to the introduction of a significant new oil province. These technology applications could also be envisaged in other provinces in the world.

We have produced 13 billion bbl o.e. (oil and gas) over the last 25 years of which oil makes up 75 percent. The next 25 years we expect to produce another 30 billion bbl o.e. of which oil will still have the major share of approximately 70 percent. From about the year 2020 the remaining stock for further production is estimated to 35 billion bbl o.e. But at this point of time, gas is expected to make up 75 percent of the assets. The production period from the Norwegian shelf is uncertain but Norway will most probably be a significant oil and gas producer far beyond the year 2050.

The Norwegian Continental Shelf still has a vast multitude of exploration targets and possibilities in all the major areas in the North Sea in the south, in the Norwegian Sea offshore mid Norway and in the Barents Sea in the very north.

There are high expectations for the new deepwater areas in the Møre and Vøring basins in the Norwegian Sea. All the major oil companies active on the Norwegian shelf have shown significant commercial interest in these new areas which were the target for the 15th concession round last year. The water depths vary from 800 m to 1400 m in these very promising licenses.

The existence of huge Tertiary and Cretaceous structures in the Norwegian Sea has been known since the late 1970s. Improved seismic data in the 1980s demonstrated high quality seismic hydrocarbon indicators in several of the major structures. The validity of these indicators was improved by seabottom seismic. Hence even if reservoir quality and source rock is unknown, the industry has great expectations for discovering petroleum in this frontier area. The challeng-

(continued on page 6)

Norwegian Continental Shelf *(continued from page 5)*

ing uncertainty is the amount of oil in addition to gas.

A new era of Norwegian exploration commenced in April when BP spudded the first of the Norwegian Sea deepwater wells on the Nyk High in the Vøring plateau. The well is in 1275 m of water, more than twice the previous record in Norwegian waters, and is the first of five wells planned in the next year to test licenses awarded in the 15th licensing round.

Following the BP well on Nyk High, we then expect, later on this year, new exploration wells on the Ormen Lange by Norsk Hydro as operator, on the Vema Dome by Statoil as operator and on the Helland Hansen by Shell as operator. Saga will drill the Gjallar Ridge in 1998.

There are, in addition, several other important licenses held by other operators. The initially explored licenses are independent and will open up for additional exploration in the adjoining areas.

We are talking here about several world class prospects. All the pre-drilling information available with the best technologies within seismic such as the seismic definition of accumulations, flat spots and direct hydrocarbon indicators and others suggests promising results. Success in the Norwegian Sea can add substantial reserves to the Norwegian reserve base.

When it comes to later field developments in these areas we expect to draw significantly on deep-water experiences from the Gulf of Mexico and deep-water developments in UK waters west of Shetland. Different types of Tension Leg Platforms (TLP) will be candidates. Further, floater concepts in general in combination with sub-sea installations, the Aker Spar concept and other solutions will be evaluated.

The international petroleum industry in Norway will face interesting and rewarding opportunities in the years to come and Norway will continue to be a major oil and gas producer far into the next century. The Norwegian Continental Shelf will, together with other important petroleum provinces like the Gulf of Mexico, continue to be important areas in the world for the development of new technologies and efficient ways to manage exploration and exploitation of hydrocarbons.

UK Oil Production - A Positive Outlook

*By James Dyer**

History

Offshore production from the UK Continental Shelf (UKCS) began in 1967 from the West Sole gas field. First oil production followed seven years later from the Argyll field located in the central North Sea. Since this time around 16 billion barrels of oil have been produced and some 8 billion barrels of oil (of reserves already discovered) remain to be produced. There are currently nearly 125 oil fields onstream on the UKCS which are estimated to produce 2.7 million barrels of oil per day in 1997.

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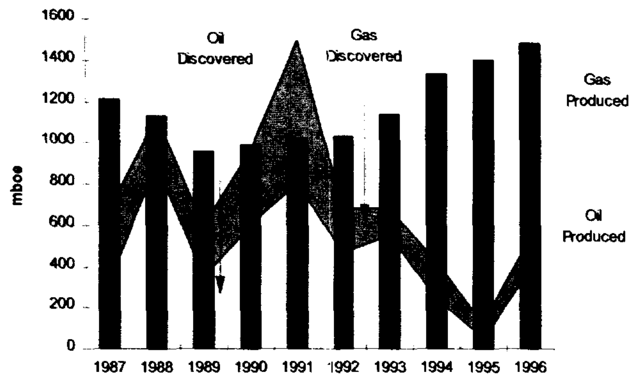
* James Dyer is a Senior Consultant with Wood Mackenzie Consultants, Edinburgh, United Kingdom.

As Figure 2 highlights, for the last five years the volume of oil produced has not been replaced by new oil discoveries (at least those announced). However, there are now other less developed plays on the UKCS such as the West of Shetlands and Rockall Trough where exploration activity has recently been refocused. This has led to a number of significant oil and gas discoveries, with the first development, the BP-operated Foinaven field, due onstream in the second half of 1997.

Figure 2
UK Continental Shelf Production and Discovery Rates (1987-1996)



Business Environment

The future production from UKCS is governed by the business environment in place now and in the future. For new reserves to be discovered there must be an incentive to drill. For reserves already discovered to be brought onstream, there must also be an incentive to develop. These incentives are influenced by both factors specific to the UK and those that are applied externally.

Incentives to drill include the prospectivity of the target province (the chance of finding hydrocarbons). Although the majority of the UKCS' oil and gas provinces are mature there is still geological potential. Of the 83 exploration wells completed in 1996, 17 (or 20 percent) found oil, gas or condensate. Although not a vintage year for exploration success, this compares to a 30 percent average for the UKCS since 1965. Indeed, the disclosure of further discoveries will increase this percentage.

The key area of interest during the most recent UKCS license round was West of the Shetlands where there have been a number of significant oil and gas discoveries. Recently BP announced the discovery of the Suilven oil field which is estimated to contain some 150 million barrels. This is the largest oil discovery since BP found the Schiehallion field, likewise located in the West of Shetlands. The size of the discoveries in this area highlights its importance as a new province and attracts companies requiring significant finds to replace reserves produced.

In so far as the UKCS offers some geological potential, there will be competition for E&A funds between regional divisions of international companies. Other hydrocarbon-bearing regions may offer greater prospectivity; the decision to invest in the UK as opposed to elsewhere will, in part, be influenced by the companies' reserve replacement strategy. Some companies may focus their E&A activity outside the UK.

While the UKCS prospectivity may be on the decrease, most new discoveries are commercially viable due to the intensity of infrastructure already in place and the current fiscal regime.

The upstream fiscal regime is one of the most attractive in the world; the marginal rate of tax is 33 percent for all new field developments post March 1993 and 71 percent for all mature fields. Finally, in the past, the government has been keen to promote political stability, timely development approvals and has withdrawn from state participation. The recent change in government is unlikely to alter this position. The business environment in which companies active on the UKCS operate, reflects the maturity of the province and the competition for E&A and development funds worldwide.

Costs

It is important to remember that oil exploration and production is essentially a commodity. The key to success in any commodity business, particularly one where prices have been so volatile in recent years, is cost control. Although typical North Sea unit costs are significant, the UK industry has been successful in controlling both capital and operational expenditure.

This has in the main been achieved in three key areas:

- Technical innovation (multi-lateral wells, subsea developments and floating production systems – FPS)
- New project financing arrangements (leasing of FPSs)
- CRINE Network program (new business and working practices, contract alliancing and standardization).

Interest in the UK Continental Shelf

On a commercial basis (as opposed to a pure geological one) the UKCS remains an attractive investment area. This is demonstrated by the influx of new players (particularly North American) on the UKCS. These companies are keen to build a position in the UK as a low risk stepping off point for international diversification outside their own mature domestic basins.

In addition, as the oil majors move out to frontier regions, opportunities will continue for "second tier" companies to acquire mature assets. Through their more cost efficient operational bases in the UK and further capital investment (in-fill wells and water injection for example), these companies may realize greater value from remaining potential in the fields and surrounding acreage. This will extend the production life from mature assets and help slow the decline of the UK's oil output once the peak is passed in coming years.

Conclusion

The UKCS is a mature province. However, it will remain an attractive area for oil companies to operate given the commercial viability of their reserves and the continuity of the political and fiscal regimes.

This is demonstrated by the interest shown by both existing and new entrants to the UK. The incentive to explore, appraise and develop within the UKCS is also evident from the increase in E&A activity and investment in mature assets.

Oil production from the UKCS may peak towards the end of the century at around 3 million barrels of oil per day. Further discoveries and the successful management of mature producing fields will result in the decline in oil output being gradual. Consequently, the outlook for the UKCS is positive.

Oil In Angola

*By François Collignon**

From the oil standpoint, Angola forms part of a regional system – West Africa – comprising five countries around the Gulf of Guinea: Nigeria, Cameroon, Gabon, Congo and Angola, together with Chad, which could become a producer in the year 2000, and small fields in Ivory Coast, Equatorial Guinea and Zaire.

In total, this system, which holds about 3 percent of world crude reserves, contributed 5.5 percent of world oil supplies in 1995 with production of 170 million tonnes (3.4 million b/d). Angolan production during that year was 31.5 million tonnes (630,000 b/d), making it the world's 23rd largest producer and the second in sub-Saharan Africa.

Recent discoveries under deep offshore waters are likely to enhance this position and give a new impetus to the oil business in this country.

History

The hydrocarbon reserves in Angola, like those in Congo and Gabon, are associated with the formation of the South Atlantic, the history of which began some 165 million years ago.

Oil exploration has been concentrated in the three coastal sedimentary basins: lower Congo, Kwanza and Namibia. Exploration of pre-saliferous series resulted in a few discoveries in Cabinda. This is far from being complete but has to cope with the technical problems raised by the salt deposits as regards the propagation of seismic waves. Until recently, the exploration of the post-saliferous series was the major theme, mainly in the compensating anticlines geographically located in the conventional offshore area; in other words, at depths of less than 200 meters. In recent years there has been renewed interest in the tertiary turbidite deposits mainly located in the deep offshore, which is at present being rapidly developed.

Although oil exploration began as early as 1906, it was not until 1955 that an initial field of very modest size was discovered onshore close to Luanda by Petrofina. After fruitless exploration in the onshore enclave of Cabinda lying between Congo and Zaire, Gulf began exploration at sea and in 1966 discovered the Malongo field, Angola's first offshore field. Work then intensified and by the time of its independence in 1975 Angola already had 23 fields producing about 175,000 barrels a day, practically all from Cabinda, making Angola the third largest producer in the region after Nigeria and Gabon.

After Angolan independence, the oil sector was thoroughly reorganized: a national company – Sonangol – was established in 1977, and Act 13/78 regulating oil activities in Angola was promulgated on 20 April 1978. This Act authorizes Sonangol, as holder of all mineral rights, to conclude contracts with foreign companies on terms that must be

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(continued on page 8)

Oil In Angola *(continued from page 7)*

approved by the government.

Within this framework, Sonangol began in 1980 to negotiate with a number of companies for the award of 13 Blocks covering the whole of the Angolan offshore region at depths of under 200 m, except for Cabinda. This strategy of openness, allowing free play to competition, subsequently confirmed by the award of deep offshore Blocks, has generally proved its worth since all the main oil companies (except Conoco which left in 1993) are present in Angola.

Elf was awarded Block 3 in May 1980 as operator with a 50 percent interest. The same year Blocks 2 and 6 were awarded to Texaco and Total, respectively. Gulf also made a new significant discovery at Takula. In its first drilling operation Elf hit the bull's eye with the Palanca discovery in 1981. Pacassa was discovered the following year. Block 1 has been awarded to AGIP and Block 9 to Cities. In 1985, output at Cabinda reached 200,000 barrels a day, and Palanca came on stream. Following AGIP which acquired a participating interest of 9.8 percent in the Cabinda association where Chevron took over Gulf's in 1987, Elf took its turn in 1991 and obtained an interest of 10 percent.

In 1992, the deep offshore areas were opened up and Blocks 15, 16 and 17 were awarded to operators Exxon, Shell and Elf, respectively. Shell made the first deep offshore discovery with Bengo in 1994. Chevron was awarded Block 14 in 1995. Blocks 18 and 20 were awarded to Amoco and Mobil in 1996. The same year, Elf made the Girassol discovery. Today practically all the offshore area has been allocated, except for a few deep offshore blocks and the ultra deep offshore area to which the entire industry is now turning its attention.

Legal and Contractual Framework

Within the joint venture or concessionary approach, which is applied only to areas that were producing before independence (offshore license at Cabinda operated by Chevron and the onshore licenses for lower Congo and Cuanza operated by Fina), Sonangol and the companies work together and have access to production in proportion with their share in the association. The fiscal system is conventional with royalty and taxes.

The production sharing contract is applicable to virtually all the Angolan offshore area and to the Cabinda onshore licenses. The operator and his partners constitute a Contractor Group which acts on behalf of Sonangol which alone holds the mineral rights. Under the general arrangements in this type of contract, the Contractor Group runs the operations and is responsible for all funding (exploration and, as appropriate, development and operation). Once a field has been developed, part of the output – the cost oil – is shared between Sonangol and the contracting group. The share of the profit oil allocated to the companies is subject to 50 percent tax.

Current Developments

Oil output in 1996 reached the record level of 690,000 barrels a day, 9 percent up on 1995 (627,700 barrels a day). Chevron is the leading operator in the country: its production reached nearly 400,000 barrels a day in 1996, or a little under 60 percent of national output. This output comes from the three zones (A, B and C) of the Cabinda concession where Chevron has a 39.2 percent interest. As a result of current developments in zones B and C (Kolongo, Sanha and N'Dola, Nemba Sud and Lomba) and of those that will shortly be decided (water injection in zone A, Nemba Nord) output from Cabinda could exceed 500,000 barrels a day by the year 2000. Although it has been explored for a very long time, this particularly prolific province is continuing to be the site of numerous discoveries. Chevron is also the operator in Block 14 offshore from the Cabinda concession and recently made a promising discovery there.

Elf is the operator in Block 3 where it has an interest of 50 percent, and produced 170,000 barrels a day in 1996. The important developments come to an end in 1997 with the drilling of the last Cobo/Pambi wells, the introduction of gas lift in most of the existing fields, and Oombo expected to come on stream in the autumn. With an eye to the future, and in order to renew its reserves, Elf has acquired interests in two of the new deep water licenses which the government offered in 1992. Thus Elf is operator in Block 17 and also involved in Block 16 operated by Shell. Drilling carried out over the last three years led in particular to the discovery of Girassol in Block 17 where appraisal work has just confirmed the importance of the discovery made.

The third large producer is Texaco, operator of Block 2, which produced 95,000 barrels a day last year. A number of current developments suggest that output might increase by 10 to 20 percent over the next few years.

As an onshore producer, Petrofina is building up its output at Soyo (8,000 barrels a day) and will shortly reach 20,000 barrels a day. Finally, Sonangol (Block 4) and AGIP (Block 1) produced 5,000 and 2,000 barrels a day, respectively in 1996.

Outlook

This situation suggests that national output should increase steadily and probably reach 800,000 barrels a day before the year 2000, essentially from Cabinda and the near offshore region in shallow water close to the coast. However these prospects could soon be modified as a result of the recent discoveries made in the deep offshore zone: Girassol, Bengo and, very recently, Block 14, not forgetting those of Total in Block 2.

Girassol is ELF's second exploratory well in Block 17. The discovery made in 1995 under 1365 meters of water was followed by a 3D seismic survey, which was shot and analyzed in record time by processing the recorded data on board. An appraisal well drilled in the winter of 1996-97 confirmed the extent of the discovery, with production tests giving a cumulative output of 18,000 barrels a day. Reserves of at least 500 million barrels are expected and an output of 150,000 barrels a day is predicted for the year 2000. These results and the potential of the zone have boosted the general rush to Angola by the "majors" and oil companies in general.

The estimated figures for seismic and drilling activities in deep water speak volumes, because of the 76 exploration and appraisal wells expected to be drilled by the year 2002, about 30 will be deepwater exploration wells. Also, 3D seismic surveys are coming into general use for drawing up the "inventory" of new zones.

Against this background, the opening up of the deep offshore Kwanza basin (three blocks now being awarded and

ITALIAN ASSOCIATION OF ENERGY ECONOMICS - AIEE

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NOVEM - The Netherlands and ISIS - Italy

Announces

AN INTERNATIONAL CONFERENCE
on

ENERGY EFFICIENCY IN HOUSEHOLD APPLIANCES

to be held in Florence, Italy

10-13 November 1997

Grand Hotel Baglioni

The Conference program covers state-of-the-art energy efficient domestic appliances, as well as the policies and programs to promote the penetration of those technologies. The Conference presentations are drawn from a variety of relevant institutions from the European Union, North America, Latin America, Asia, Australia and International Organizations. Discussions of an international character will take place to promote a global marketing of energy-efficient domestic appliances.

The registration fee, including attendance to all conference sessions, refreshments, gala dinners, papers, as well as social and cultural events in Florence is ITL 350,000 (US$ 230). An attractive accompanying persons program will be provided for all guests. Special hotels rates have been arranged for conference participants. For further information, please contact the Conference Secretariat:

AIEE - Italian Association of Energy Economics
Via Giorgio Vasari, 4 - 00196 Rome, Italy
Telephone: +396-322-7367
Fax: +396-323-4921
E-mail: aiee@euronet.it

three to be offered shortly) and subsequently blocks in the "ultra deep offshore" are already giving rise to very active bidding.

Since 1990, the technologies used for drilling and producing by great water depth have seen rapid developments. Adaptation of the most attractive concepts to the particularly favorable sea and weather conditions of the Gulf of Guinea suggests that development will be speedy (3 years) in spite of its extent (investment over a billion dollars), and with technical costs differing little from conventional offshore operations if the well productivity figures are satisfactory.

Thus it appears that all the conditions are met for the oil business in Angola to experience a new resurgence to give this country, at the dawn of the third millennium, resources commensurate with the challenges it faces.

First Announcement

Climate After Kyoto - The Implications for Energy

Eleventh RIIA/IAEE/BIEE International Energy Conference

Chatham House, London
5 and 6 February 1998

The Kyoto Conference in December 1997, the 3rd Conference of Parties to the UN Framework Convention on Climate Change, is expected to reach agreement on legally-binding targets on emissions of carbon dioxide and other greenhouse gases across the industrialized world. This conference will build upon the success of the 10th conference on *Controlling Carbon and Sulphur: International Investment and Trading Initiatives*, by focusing upon the outcome and implications of the Kyoto agreement for the world's environment and energy industries and upon the likely follow-up steps.

The conference is expected to attract several hundred leading government, industrial and nongovernmental participants. It will provide the first top-level international forum for public discussion of the results of Kyoto and the steps that governments could take to implement the limits that are agreed. Speakers will include leading representatives of the international negotiating community, multinational energy corporations and key governments, multilateral institutions and nongovernmental organizations.

Sponsorship is sought to support participation by developed countries, academics and nongovernmental persons. For further information contact:

Diana Bailey, RIIA Conference Unit
Phone +44 (0) 171-957-5700
Fax: +44 (0) 171-957-5710

O'Brien Speaks to AIEE

On May 21st, IAEE President, Dennis O'Brien, spoke to the Italian Affiliate at the AIEE Members' Assembly held in the Conference Hall of ENI. He spoke on "Energy Industries to 2000".

O'Brien sketched the ongoing changes in the energy field and then described the world's energy scenario for the next century.

According to O'Brien, the leading oil companies will grow stronger and markets will become more concentrated.

Considerable growth is also envisaged for natural gas. Coal will also maintain an important role in Central Asia and Eastern Europe, i.e., those areas having large coal reserves.

O'Brien's presentation was followed by a question and answer session. He closed by expressing his appreciation for the activities and growth of the Italian Affiliate. The AIEE has become one of the largest IAEE affiliates.

During the Assembly AIEE President, Edgardo Curcio, gave a short description of the activities carried out during 1996, including the organization of 16 conferences/seminars, a Postgraduate Course in the Economics of Energy Sources, many articles and contributions to magazines and the technical press, and most of all, an increase of 24 percent in the number of the AIEE members.

Crude Oil Prices on an Upward Trend?

*By Mamdouh G. Salameh**

The consensus among oil market analysts in 1996 was that crude oil prices just had to fall, if not today, then tomorrow. There was much oil available and Iraqi crude oil was about to come to market. Yet, oil prices rose in 1996 by around $8 a barrel, an increase of 44 percent. Even when a limited amount of Iraqi oil did return, there was barely a blip on the price charts.

However, failure to project correctly the oil price upward movement elicited a wide range of explanations. One popular explanation was a perception that oil inventories were at unusually low levels. A theory developed that the oil industry, copying the just-in-time delivery practices that made Japan's motor industry so competitive, had drastically reduced oil inventories and were relying on just-in-time deliveries of oil. So there had to be some buying pressure supporting prices.

Although there may be some truth in that conclusion, it does not provide an adequate explanation for the strong price showing in 1996. The oil industry has always kept oil stocks at the lowest level possible. Supply managers plan to have just enough petroleum in the system so their companies can always deliver a gallon of product on demand. But they fine tune supply plans so that there is the least number of barrels in the pipeline leading up to the nozzle. The reason is simple, holding more barrels than absolutely necessary costs money. One extra day of crude supply worldwide represents $1.5 bn of working capital.[1]

Inventory Management

This style of inventory management has resulted in oil companies keeping usable commercial stocks at levels equivalent to 11 to 13 days of petroleum consumption. Global oil inventories in November 1996 included 11.3 days of usable commercial stocks according to PIW's *Oil Market Intelligence*, down from 12.2 days in September. A decade ago the range was the same, namely 11 to 13 days. Industry performance has been logically consistent. This suggests that the inventory rationale is an inadequate explanation for the strong price rise in 1996. Rather, the cause can be found in the supply/demand balance, specifically underestimating the demand side of the equation.

While inventory management might be sound economically in reducing working capital needs and may not impact on prices in the short-term, the situation could suddenly change if there is a major supply disruption which could send oil companies scrambling for supplies to replenish their dwindling usable stocks. This would definitely push up the prices of crude oil and petroleum products reminiscent of the spot market prices in 1979-81.

The Missing Variable

The fundamental factor in determining oil prices is the supply/demand balance. Oil consumption has been rising robustly and is the factor that most explains the strong support for prices. Demand is on track to reach the 77.3 million barrels a day (mbd) projected for the year 2000, and could probably exceed it by up to 2 mbd.[2]

Nowhere today is oil considered a luxury item of consumption. Developing countries have no alternatives for petroleum to fuel rapid economic growth. Those that have achieved high growth rates now have prosperous societies wanting the good things of modern life, all of which consume energy. For example, the planned sale of 1,750,000 motor vehicles in South Korea this year could add about 10,000 barrels a day (b/ d) to the country's oil demand. This trend is present, in varying degrees, in all the developing countries.[3]

The International Energy Agency (IEA), notoriously cautious in projecting global oil demand, sees demand in 1997 growing by at least 2.6 percent to 73.77 mbd, about 2.00 mbd higher than in 1996.[4] With Iraq back in the market and a projected increase of 1.0-1.5 mbd of non-OPEC production, there should be no shortage of crude oil and prices should remain under $25 a barrel (WTI). Only a major supply disruption could push prices up.

But growing demand also suggests that crude oil prices are not likely to fall below $20 for a sustained period, and may not even fall that low. The bottom line is that demand for oil and consequently oil prices will be strong through the rest of this century.

U.S. Containment Policy & The Price of Oil

However, the price of crude oil could easily hit the $40 mark if restrictions on the oil trade of some Middle Eastern countries are not lifted in the near future. With the production capacity of Iraq, Iran and Libya put out of reach by the blunt economic weapons of the United States, the $40 barrel could be a reality by 2005.[5]

At the rate oil demand is growing these days and despite robust growth in non-OPEC output, it is highly likely that by 2005 - only eight years away - almost 10 mbd of additional oil will be needed from OPEC. On present plans, OPEC will be able to cope with this extra demand for its oil but it needs Iraq to be producing to its considerable potential by then (see Table 1).

Table 1

The Call On OPEC With Constant Nominal Oil Prices

(mbd)

	World Oil Demand	Non-Opec Oil Supplies	Call on OPEC	Planned OPEC Capacity	Needed OPEC Capacity
1992	67.0	40.5	24.4	26.6	26.1
1995	70.3	40.3	27.5	33.0	29.9
1996	71.9	40.1	28.2	33.0	30.2
2000	78.4	39.6	36.7	36.4	39.3
2005	83.6	38.8	38.7	39.0	41.4

Sources: IEA, Centre for Global Energy Studies (CGES).

Putting it differently, if the world is not able to call on 6.5 mbd of extra Iraqi, Iranian and Libyan capacity - that is extra planned capacity from the three countries bearing the brunt of the U.S. containment policy - there is bound to be strong upward pressure on oil prices. Iraq's oil potential is second only to Saudi Arabia, so that it comes as no surprise to find

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[1] See footnotes at end of text.

that Iraq alone accounts for almost half of the additional 11.5 mbd of capacity OPEC is expected to install by 2005. What happens to Iraq is, therefore, of critical importance to the stability of oil prices.

The cornerstone of current U.S. policy towards the Middle East is the dual containment of Iraq and Iran – countries the United States considers a threat to the region. There is more than a suspicion, however, that as long as Saddam Hussein remains in power, there is no chance that Iraqi oil will flow freely again if the United States has anything to do with it.

This is worrying as far as the oil market is concerned, for it is known that the Iraqi oil industry needs time and billions of dollars in investment funds for rehabilitation. The longer Iraq is denied access to investment funds for maintenance and capacity expansion, the greater the pressure on other oil producers to fill the output gap in the years to come – and, failing this – the greater the possibility of higher oil prices. Therefore, what is needed is a novel, imaginative international community approach to the Iraqi question. Limited oil sales are fine for the time being but they do not help solve the world's longer-term need for oil. The world needs Iraq's oil and will be prepared to pay for it. The real problem, however, is how to satisfy this demand for Iraqi oil without Saddam Hussein using the revenues for rearming.

Iran is obviously not as significant as Iraq in terms of the geopolitics of oil. It remains, nevertheless, a populous Gulf state with abundant oil and gas resources that need to be exploited for the benefit of the country and the world at large. The additional 0.6 mbd of oil capacity that Iran plans to have available by 2005 would certainly help satisfy the world's growing demand. As in Iraq's case, investment is needed to bring this capacity on stream and the requisite funds are most likely to come from abroad. However, in Iran's case there are no UN sanctions to contend with, so in principle there is no reason why Iran should not fulfill its potential – except, that is, for the U.S. trade embargo against it.

U.S. Senator D'Amato's bill prohibits those foreign companies investing more than $40 million in Iran from doing business in the United States as well. Companies are in effect obliged to choose between Iran and the United States. As it happens, many U.S. oil companies are also none too happy with a policy that restricts their freedom to invest where they see fit. The international oil industry is thus prevented from bringing low-cost supplies on stream for political reasons.

Libya too has fallen foul of the United States as another country suspected of promoting international terrorism and has, therefore, felt the long retributive arm of U.S. policy. Like Iraq, Libya is subject to a U.S.-inspired embargo that has restricted its ability to expand its oil production and thus its exports.

Libya's proven reserves are 30 billion barrels, seven times those of the UK, yet Libya only produces half as much oil as the UK. For some time now the United States has wanted to tighten the screws on Libya further, but Italy, France and Germany have been opposed to any policy that might deny them additional short-haul supplies in the future.

The Residual Supplier

This policy of containment has already had a big impact on the industry. The world's dependence on oil from just a few oil-producing countries has increased beyond what might be considered reasonable. In 1996, Saudi Arabian oil exports amounted to 45 percent of the Middle East's oil exports and a staggering 20 percent of all the oil traded in the world and there is little reason to suspect that this dependency on one country will change in the foreseeable future. More significant than this is Saudi Arabia's 60 percent share of the world's current spare capacity. Its share could even exceed 65 percent if Iran's actual sustainable capacity is less than assumed.[6]

Last year, the world needed more oil from OPEC, its residual supplier, but this oil was not forthcoming, because Saudi Arabia with almost two-thirds of global spare capacity, decided not to increase production. As a result, oil prices rose in 1996 by around $8 a barrel. This factor coupled with the growing global oil demand was behind the firming up of oil prices in 1996.[7]

What is more, the situation will hardly improve in the years to come if Iraq remains constrained for the foreseeable future and Iranian and Libyan oil industries are prevented from expanding as intended. Indeed, as a result of the containment of the three countries, oil demand may edge very near supply capacity, causing the price of oil to hit the $40 barrel mark by 2005 and imposing additional costs on the global economy amounting to trillions of dollars over the period 1997-2005.

The cost of maintaining production capacity in Iraq, Iran and Libya for the period 1993-2000 was estimated at $14.23 bn while the cost of adding capacity during the same period was estimated at $13.4 bn giving a total of $27.63 bn (see Table 2).

Table 2
The Cost of Maintaining and Expanding Capacity in Iraq, Iran & Libya, 1993-2000

	Cost of Maintaining Capacity		—Cost of Adding Capacity—				Total
	$/db	Total Cost $bn 1993-00	$pdb	Total Cost $bn	$pdb	Total Cost $bn	Total Spend $bn 1993-00
			—1993-95—		—1996-00—		
Iraq	160	3.12	500	1.0	1000	1.0	5.12
Libya	300	4.09	8000	1.2	10000	2.0	7.29
Iran	200	7.02	6000	6.6	8000	1.6	15.22
Total		14.23		8.8		4.6	27.63

Source: CGES; Prof. Adelman, MIT.

So we are faced with the prospect of the world's only superpower pursuing policies that will surely increase considerably the world's dependence on a few countries for extra oil supplies and at the same time causing the price of oil to be higher than otherwise would have been the case.

In summary, growing global oil demand suggests that crude oil prices are not likely to fall below $20 for a sustained period, and may not even fall that low. The bottom line is that demand for oil and consequently oil prices will be strong through the rest of this century. However, if the restrictions against the oil trade of Iraq, Iran and Libya are not lifted in the near future, the $40 barrel could be a reality by 2005.

Footnotes

[1] A. W Jessup, "Price Pressures: Revisited," *The Geopolitics*

(continued on page 15)

Improved Economics in Power Generation: What Long-Term Role for Solid Fossil Fuels?

*By Thomas Trumpy**

This article is not about coal and lignite. It is about realistic *least cost planning* for the future power generation needs of Europe - Western, Central and Eastern - and elsewhere. Responsible planning to ensure competitive energy for an economy requires planning for the economic life and lifetime operating costs of a power plant, rather than seeking short-term financial savings on a long-term productive capital asset. This is obvious and generally accepted. Therefore, consider this article a reminder of economic realities, not as a new discovery.

New Power Plants - A Replacement-driven Market

A modern electric power plant has an expected useful life of over thirty years, including replacement of shorter life elements such as gas turbines.

Industry and communities develop around power plants to benefit from the jobs power plants create:

- Directly (e.g., power plant operation and sometimes coal or lignite mining) and
- Indirectly by access to cheap power and heat which create a favorable local economic environment (e.g., use of cogeneration, combined heat and power - CHP).

Power plant-suckled communities then wish their power plants to be invisible, silent and totally nonpolluting.

The community does not want the power plant to disappear - and fears that employment may disappear if the power plant closes. The community, however, strongly opposes expansion of the power plant!

This is the dilemma of the power plant industry, a dilemma which has lead to increasing difficulty of finding sites for new power plants to meet our need for power. This NIMBY factor (Not in my backyard!) has, in the last thirty years, made power plant sites increasingly *permanent*. Where a CHP plant serves a community the power plant will be maintained even in a politically hostile environment. A good example is the very expensive and environmentally scrubbed Tiefstack CHP plant in Hamburg harbor (coal-fired, fluidized bed with a gas-fired topping and auxiliary turbine).

Tiefstack was not a new plant, it was a replacement plant. Over 60 percent of the *new* power plants planned in both western and eastern Europe up to 2010 will be replacement plants, 320,000 megawatts of replacement plant out of a total of 525,000 megawatts. The European replacement market is half the world replacement market. Increasingly power generators will be forced to repower old power plants at existing sites, frequently sites which now house dependent communities.

Using more efficient, modern technology such as upgrading or repowering will frequently rebuild the power plant, discretely increasing its generating capacity. Modern technology for all fossil fuels permits doubling the generating capacity in the same plant area and with less pollution. The new plant will be nicely boxed in and may have neither a huge chimney nor a visible cooling tower to remind neighbors that there is a power plant in their backyard!

Urban sites are expensive, so new plants in old sites will use all possible means to improve their efficiency. Such means are better technology, combinations of fuel and of technologies better to follow demand curves, and sale of excess heat through CHP, which permits major gains in system efficiency. Such plants may burn high quality hard coal (e.g., in super-critical pulverized fuel plants), coal, lignite, bio-fuel or municipal waste (e.g., in fluidized bed plants) and will generally use gas and oil for topping (generally in simple or combined cycle gas turbines) to provide greater overall efficiency and to cover peak loads with more expensive fuels.

Now let us approach the utilities' *decision tree*. For the reasons stated above, many replacement power plants will be constrained to use existing sites and, despite the high cost of meeting stringent environmental rules, to use whatever fuel or fuels are most available and meet local criteria. In such cases, the power generator must perform a local *least cost plan* within the imposed limits and then agree how to plan tariffs, and who should pay for such higher cost power, which will frequently be gas-fired.

New Power Plants - A Demand Growth-driven Market

There is growing world demand for reliable, economic, clean power. In a paper presented in 1995 at the ASME Cogen Turbo Conference in Vienna, per capita power demand of the areas of the world was estimated.

- In 1992 the air-conditioned United States used 1.2 kW per capita, with no end to growth!
- Western Europe used just over half that, 0.63 kW per capita. The market is expected to reach saturation at 0.8 kW per capita by 2010, still a 27 percent growth per capita, which must then be adjusted for population growth.
- Eastern and Central Europe used 0.5 kW per capita in 1992, and we know much of that use was very inefficient. Use is expected to level off at 0.7 kW per capita by 2030, still an increase of 35 percent, then to be adjusted for population growth.

From 1992 to 2010 Europe is expected to build 205,000 mW of new power plants, plus 320,000 mW of replacement power plant, a total of 525,000 mW of power plant additions, of which 40 percent, 230,000 mW are expected to be gas-fired (see Table 1).

At a conservative average current cost of US$ 1.2 million per megawatt, that is $630 billion, $36 billion per year - and Europe is only 20 percent of world additions.

Assuming no new nuclear plants, and limited contribution from new hydro and renewables to 2010, and assuming that new plants have roughly 40 percent efficiency and 4500 hours annual use, the new 205,000 mW of power plants in Europe will use about 200 mtoe or 1.4 trillion barrels of oil *more* each year.

Meeting Growing Demand for Coal and Gas

We can also express this additional annual fuel need as 300 mtce (million tonnes coal equivalent), but following the ASME paper's assumption of a 40 percent role for gas we will need additional annual production of up to 180 mtce of coal and 130

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Sources and references are available from the author.

billion m³ of gas for the power plants built before 2010.

As we are talking about planned power plants being commissioned in the next 15 years with a life expectancy until 2030 to 2050, we should be sure of availability of fuel supplies for the life of those plants – and for 3 million mW or more of new plants to be built in the world from 2010 to 2030 (See Table 1).

Table 1
Cumulative Power Generation Additions and Replacments Since 1992
The Specific Role of Industrial Gas Turbines[1]

1992 to 2000

Type	New Total GW	New GT GW	New GT %	Replacement Total GW	Replacement GT GW	Replacement GT %	Total Total GW	Total GT GW	Total GT %
EUROPE									
West	85	45	53	100	50	50	185	95	52
East	0			30	15	50	30	15	50
Total	85	45	53	130	65	50	215	110	51
ASIA									
Japan	51	15	29	20	5	25	71	20	28
China	100	10	10	10	-	-	110	10	9
Total	295	65	22	30	5	17	325	70	22
AMERICAS									
USA	75	50	67	70	50	71	145	100	69
Total	105	58	55	80	55	69	185	113	61
WORLD	606	223	37	250	132	53	856	350	41

2000 to 2010

Type	New Total GW	New GT GW	New GT %	Replacement Total GW	Replacement GT GW	Replacement GT %	Total Total GW	Total GT GW	Total GT %
EUROPE									
West	60	35	58	120	60	50	180	85	47
East	60	10	16	70	25	36	130	35	27
Total	140	35	25	190	85	45	310	120	39
ASIA									
Japan	51	25	49	60	25	42	111	50	45
China	200	20	10	40	5	13	240	25	10
Total	580	125	22	100	30	30	680	300	49
AMERICAS									
USA	125	80	64	180	100	56	305	180	59
Total	164	90	72	190	105	55	354	195	55
WORLD	1104	352	32	500	219	44	1604	576	36

[1] Gas turbines (GT) assumed in combined cycle.

Derived from *Power Engineering International*, March/April 1996, p.28, indicated source "The Future World Market for Industrial Gas Turbines", Presentation at ASME Cogen Turbo Conference, Vienna, August 1995.

If the world needs 200 mtce of additional annual coal and lignite production by 2010, I think I can find it at a price under US$ 50 per tce. Twist their arms and the world coal industry will sell all that coal for under US$ 10 per barrel of oil. Some lignite supplies, as at Krasnojarsk, are available at under US$ 10 per tce, US$ 1.50 per barrel. Do you want a firm price to 2010, why not? The reserves are known, and the other costs are labor, equipment and self-produced power. U.S. coal mines sell to power plants on long-term contracts with only cost escalation. Why not in Europe and other parts of the world?

I can find the coal for tomorrow! Who will give me the source and price for the 2020 gas? And 2030? And 2050?

The Cost of Electric Power – Fuel Cost

Why should we start discussing economics of power generation by discussing fuel cost? Because:

- Despite the acknowledged low price of natural gas now, fuel cost is over 60 percent of total cost of power from gas-fired power plants (coal costs between 20 percent and 35 percent of the total cost of coal-fired power plants.)
- The cost of gas per kWh is 150 percent to 300 percent of the cost of coal and lignite.

A recent U.S. Utility Data Institute study compared the cost of U.S. power plants on a 5-year average cost per net megawatt hour. In total costs, nineteen of the cheapest twenty plants were solid fossil fuel-fired. Cheapest was a Wyoming lignite-fired plant. Its cost was US$ .0095 per kWh. The cheapest nuclear plant in Virginia had a cost of US$ .013 per kWh.

The operating costs, excluding capital and fuel, of gas-fired plants were lowest. The cheapest coal-fired plant had nonfuel costs 12.5 percent higher than the cheapest gas-fired plant. Other studies confirm that the operating costs of a coal-fired plant (excluding capital and fuel) can be 30 to 50 percent above gas-fired plants.

However, nonfuel costs are only 25 percent of total costs (with a range of 15 to 30 percent for coal-fired plant). Such costs for gas-fired plants are only 12 to 25 percent lower than for modern coal fired plants with full environmental protection. Even if nonfuel costs of gas-fired plants are 40 percent lower than such costs for coal-fired plants, the *saving* would be under 10 percent of total costs.

At today's bargain prices for gas, gas costs double the cost of coal per kWh. A power plant cannot be economic over its 20+ year life while paying a premium of 100 percent on fuel to save under 10 percent elsewhere. The extra fuel cost already absorbs all the front end capital cost savings of gas-fired power.

Gas turbines are the power industry's Lada – cheap to buy, expensive to run!

When power plants are chosen on short-term advantage, such as 3 to 5 years payback used by third party financiers (Independent Power Producers, IPP) the importance of initial plant costs and speed of purchasing and commissioning are emphasized. This favors gas turbines which will cost the user far more over the plant life cycle. Many comparisons prepared to promote gas limit themselves to twenty or twenty-five year cost analyses so as to avoid showing the savings from coal-fired plant when it is fully amortized – but will run for another ten years at *zero* capital cost, while the gas turbine plant must be repowered.

Least Cost Planning

A *least cost planning* analysis must be based on life of investment for a forty year life of installation and twenty to fifty year estimated fuel costs, not based on spot fuel prices, nor costs of new plant, nor IPP ideas of short-term payback.

First, a power producer must prepare a global plan for the entire installed capacity of the system including present plant, planned plant and needed new or replacement plant through the end of the useful life of the planned plant. This global plan should consider past, present and future for a *minimum* of thirty years:

- Age of plant and life of plant (including retrofit and repowering),
- Efficiency, technologies and possible improvements,

(continued on page 14)

Fossil Fuel's Long-Term Role *(continued from page 13)*

- Logistic needs (fuel, ash and scrubber waste storage and disposal),
- Environmental limits (and remedies and costs),
- All costs for all levels of operation as mentioned above,
- All possible sources of revenue (sale of power, heat and waste; any premium for municipal waste burning or other disposal, and any possible subsidies),
- Expected demand curves, daily and seasonal, and possible strategies to modify them (Demand Side Management, DSM programs, interruptible contracts, programs of grid power purchase and exchanges).

The goals are economic power and heat for a healthy economy and lowest economic levels of pollution for a healthy citizenry. It is important to remember the primacy of the former goal, the economic goal, as in a market economy, money wasted through uneconomic baseload power production will constrain funds possibly available for environmental protection and for investment in *green* energies and DSM and energy savings.

Load Factor – Another Essential Guesstimate

The economic efficiency of a power production system, or of a single plant, is a function, therefore, principally of fuel cost, and of total costs.

However, the other major element in total costs per kWh produced, capital and fixed overheads, is largely a function of the *load*, the number of hours of use of the plant as base load or peak load supply.

For this reason the plan of the functioning of the entire installed capacity, season-by-season and year-by-year is needed to plan the power needs.

For a utility, production of power is its source of revenues; its rate of asset utilization is the means of covering fixed and overhead costs, so management generally will try to sell all the power every plant can produce.

Economically managed power systems have complicated processes to select which of the available capacity will be *dispatched* and in which order. The more hours per year for which a plant is used (dispatched) the more revenue it earns.

For this reason the developer of a power project attempts to obtain *take-or-pay* contracts with its power and heat buyers so that the producer, not the customer, decides when to operate the plant. Unless the price for such supply-push power is negotiated very strictly (i.e., capped), the public interest will suffer if such power costs more than other power available to the grid, and hence to the public. If price-capped IPPs are bankrupted, that is sad, but is it better than forcing the public to pay for uneconomic power?

There are many methods for dispatching power from one or another power plant, and thus allocating power production markets, and revenues, to plants:

- In the case of a monopoly public service as in France, the State decides.
- The United Kingdom chose a short term auction of power to the grid. This apparently equitable system is subject to manipulation by suppliers of rapid response power (gas turbine or hydro-top-spin) who can drive off the market suppliers of lower cost power with longer load-following cycles (particularly classic coal-fired plants). It is also subject to the deliberately obscure *contract for differences* which mitigates the *free market* effect.
- Little Belgium avoids the economic and regional problems of analyzing which plants might provide the least cost power. All fuels are given a theoretical equal cost by the Calorie Pool which assures distribution of work between the linguistic regions, profits for the utility and high prices for consumers!
- The United States has a complicated, legalistic reporting system. It seems to work there.

These are caricatures – but in analyzing the economics of future power production the expected use rate (annual hours amortization) of new plant is most important.

The use rate, baseload or peakload, is most important in comparing the expected production costs of capital intensive plants (nuclear, dammed hydro, coal and lignite) and capital intensive systems (mine-mouth lignite and coal plants).

Contractual commitments and public-private agreements or regulations are needed to define how power plants are managed and will be managed for forty years.

Assumptions must be agreed on expected growth of power use, and on possible load reduction through savings programs, DSM and more efficient use techniques.

General assumptions of use levels must be corrected for the need to cover peak loads, or to provide interruptible tariffs for users who forego peak periods.

Planning and agreeing expected total system load, and its daily and seasonal profile is an unrealistic ideal. It is also a practical necessity, as the choices of the appropriate power production needs are based precisely on the level of use of plant, and on the baseload use compared to peak load needs.

Planning, Guessing and Gambling

Least cost planning is dependent on accurate planning and forecasting of load profiles and of plant use. For example, appropriate choices may be summarized as:

- For over 6000 annual hours: nuclear, lignite, coal and dammed hydro. Plant siting will be determined by resource and water availability, generally as extracting power-only plant, with long-distance transmission of power produced.
- For over 4000 annual hours: flow-through hydro, fluidized bed coal, gas-fired combine cycle plants in co-generation mode.
- For over 2000 annual hours use: top-spin hydro, gas topping on all types of plants (including coal-fired and nuclear), gas turbine combined cycle, motors.
- Under 2000 annual hours use: top-spin hydro, gas turbines, motors, and maximum reliance on grid exchanges, particularly for shorter cycles of demand.

This *decision tree* can be derived for each case from a cost analysis:

Costs=	**Capital Costs +**	**Operating Costs +**	**Fuel Costs**
• type	• front end	• price indexed	• cost based (coal, nuclear) • or price indexed • or economic rent (oil, gas)
• base	• years service or annual hours use	• years service & operating periods	• operating hours +/- tariff fluctuation

- The capital costs are generally fairly well known in advance.
- The selling price of power can generally be indexed on a basis at least equal to the operating costs (for a normally expected annual level of operation.)
- The RISK, the *wild card* element is therefore FUEL COST, the LARGEST COST.

This risk is a purely optional risk, which appears to have no winning chance!

If a cost-based fuel is chosen (uranium, lignite or coal), costs of production and transport are normally all cost of living linked costs: equipment, labor, self-produced energy. Thus long term cost-plus, cost-indexed contracts, as in the United States, are suitable.

Large amounts of coal and lignite are available at a cost equivalent to under US$ 8 per barrel for oil. That is the *world market price* for energy.

Coal is a diversely owned, worldwide industry with present suppliers facing overcapacity for another thirty years at least.

An OPEC-like cartel is unimaginable, particularly for the huge OECD producers.

There is no serious possibility for the price of oil or gas to remain below *twice* the price of world traded coal in the period to about 2040 which we should consider for fuel prices in planning new power plants.

Least cost planning for power production offers three levels of choice of risk:

LOW Risk: cost-based fuel, stabilization of load and total demand.
MEDIUM Risk: some overcapacity, develop CHP, use gas turbines for peak load.
HIGH Risk: Pray for reliable nuclear, cheap renewables, plentiful gas/oil!

The Risk of Risk

How can the power industry achieve improved economics? In many ways, but one clear lesson in economics is that higher risk requires higher rewards.

Deliberate choice of high-cost, high-risk fuel for power generation cannot and will not be economic, except perhaps for topping and peak loads, always backed-up with a reserve of oil for high-priced security for gas-peak-load crises.

Unfortunately choice is needed. Gas turbines are cheaper than coal-fired plant but they cannot burn coal. Many coal-fired plants could burn oil or gas, but once the higher investment costs are sunk, the more economic fuel is used.

The ASME paper from which Table 1 is derived is right. The trend to reliance on gas turbines will peak before 2010 and then decline. The realistic choice is planning now for greater and more efficient use of coal in the next century.

Power producers which choose a high risk path, condemning themselves to produce only high-cost uneconomic power, will be sanctioned by financial markets. They will lose their greatest asset, their credit ratings. They will be required to pay more for capital as well as for fuel. Their plants will be dispatched less; they will sell less power. Despite lower initial investment, they will not cover costs and debt payments.

They will cry WHOOPS as they fall into insolvency, as imprudent IPPs have already done in the United States. Let them fail. Do not save industrial dinosaurs. Elimination of the power industries' *Ladas* will improve industry economics.

As indicated at the start, responsible planning to ensure competitive energy for an economy requires planning for the economic life and lifetime operating costs of a power plant, rather than seeking short-term financial savings on a long-term productive capital asset.

Crude Oil on an Upward Trend? *(continued from page 11)*

of Energy, Issue 19, No 2, February 1997, pp. 4-6.

[2] The Centre for Global Energy Studies (CGES), *OPEC Issues*, London, 1996, p. 59.

[3] A.W. Jessup, "Price Pressures: Revisited," p.5.

[4] CGES, *Oil Market Prospects*, Volume 2, Issue 2, March-April 1997, p.2, Also IEA, *World Energy Statistics*.

[5] Sheikh Ahmed Zaki Yamani, "Containment Is Too Risky," *Petroleum Review*, May 1997, p. 209.

[6] Data from OPEC *Statistical Bulletin, 1996*.

[7] Sheikh Ahmed Zaki Yamani, "Containment Is Too Risky," pp. 210-211.

Global Warming Models: Are they Adequate for use in Policy Development?

*By Gerald T. Westbrook**

Introduction - Reliance on Computer Data

What is the evidence to support the claims that anthropogenic (man-made) global warming will be the major issue it has been depicted to be? Clearly there is no global warming laboratory, no global warming pilot plant in which to conduct relevent experiments. Computer models of the climate have been inserted into such roles. A very major portion of the global warming case is based on results from such models. How good are these? What are their limitations? How can one know that computer simulations of the climate 100 years from now will have any legitimacy? Should they be used in policy developments in areas where the costs could be in the hundreds of billions of dollars? A broader question is how does our government reach sound strategic decisions in areas where science is a dominant factor? There are significant problems looming in this area of society's ability to interface with science, comprehend what is going on and to utilize it's findings. Carl Sagan has indicated that 95 percent of our population may be scientifically illiterate. In addition, there seems to be a rebirth of pseudo-science underway. Finally scientists are caught right square in the middle of the global warming debate and face substantial stress from the politicalization process. This is a situation where one can see the potential for real problems.

A stronger understanding of the computer models behind global warming assessments will provide one with a better position to both understand this controversial issue and to answer some of the above questions. A recent publication[1] provides an excellent and balanced situation review on global warming in general. The objective of this paper will be to provide a situation review on the status of the models used in the global warming field. This review will first highlight the challenge involved in modeling the climate. The complexity involved is staggering. This complexity mandates the use of huge simulation models - the General Circulation Models — abbreviated the GCMs. A very brief summary of the nature of these models will be provided, followed by concerns on their structure/logic and on their performance. This will lead to a discussion of the uncertainties involved in this field.

It is suggested that these climate simulation models, while very useful for research planning and education roles, just might not yet be valid as a basis for national or international policy steps.

The Complexity of Our Climate

The temperature[2] behavior from 1880 to 1995, based on NASA/GISS data, shows three trends:

- a warming of ~ 0.6 °C from 1880 to1939,
- a cooling of ~ 0.2 °C from 1939 to1965,
- an additional warming of ~ 0.4 °C from 1965 to1995.

The total rise in this data set amounts to ~ 0.8°C. (Note that other global data sets show less warming over this period. Indeed, the last UN position on temperature increase over this period was 0.3°C to 0.6°C.)

What are the forces that have shaped this record? Proponents[3] have argued it was the change in the atmospheric concentration of greenhouse gases. If that were the case one would expect a gradual, monotonically increasing profile, with a noticeable upturn after 1945. Instead we get the above three distinct trends. Further, most of the warming occurred over the first trend, whereas most of the greenhouse gas emissions occurred over the third trend. Clearly these emissions could not cause the warming in the first period. Hence, almost all of the 0.6 °C warming in the first trend must be part of the natural rhythm of the climate. It follows that at least some of the remaining trends must also be due to natural forces.

More recently other variables, in addition to the greenhouse gases, have been studied. These have included stratospheric ozone concentration, man made aerosols, volcanic eruptions and solar output anomalies. This writer has periodically strived to enumerate the number of variables that might have some influence on our climate. This has grown to the following sets of variables, listed alphabetically:

- ASLs - Aerosols: would include both natural and manmade species. The natural ASLs would include dust, sea salt, marine based SO_2[4], and volcanic contributions. The anthropogenic ASLs would include SO_2 and SO_x from combustion.
- DMYs - Dummy variables: these are used in econometrics to capture random events. The volcanoes would include such eruptions as Mt. Toba and Mt. Pinnatubo. The melt water pulses would be inflows of fresh water for example by the collapse of ice dams.
- EMAs - Earth Motion Anomalies: are the eccentricity of the Earth's orbit, its tilt and its wobbles. These vary over 100, 41 and 23/19 K year cycles, and lead to major variation in solar insolation time series, the solar energy reaching the Earth at various latitudes and seasons.
- FBKs - Feedbacks: would represent the many complex interactions that exist in our climate.
- GACs - Global Air Circulations and
- GSCs - Global Sea Circulations: these two fields would include such phenomena as the El Nino, and the Southern Oscillation (ENSO); and ocean and deep thermo-haline circulations.
- GHGs-Greenhouse gases: would include[4] CO_2, CH_4, CO, H_2O_V, H_2O_L, O_3, CFCs, N_2O and Others.
- LAGs - Lagged variables: these might be included for independent and/or dependent variables.
- SOAs - Solar Output Anomalies: would include brightness changes over the 11 year sunspot cycle; UV changes over long-term lulls in sunspot activity; and changes in sunspot cycle length.
- SSAs - Solar System Anomalies: would include the orbital

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[1] See footnotes at end of text.

tilt, asteroidal dust and interstellar dust.

Other variables would become important as interest increases on timing and location, such as:

- Location: Hemisphere, Latitude, Altitude; and
- Temporal: Summer/Fall/Winter/Spring, Night/Day.

A Description of the General Circulation Models – the GCMs

The delineation of the spectrum of climate variables has been used as a vehicle to help convey the complexity of the task at hand. While multiple regression models have been used in this field, it was decided long ago that the overall job could only be tackled by very large simulation models.

The development of the GCMs has been striking, and represents the outstanding creativity in the scientific community today. Many models have been built. In 1990, modeling of the global climate was being carried out intensively by at least 14 major groups in the U.S. and about the same number in the rest of the world. These models were originally designed for research planning and education, not policy development. This begs the question: are they good enough for this more demanding task?

The GCMs are based on dividing the world up into a multiplicity of cells. One report indicates models vary from 800 to 11,000 rectangles and 5 to 15 layers. The physical processes in each cell would be simulated and both material and energy transfer would be permitted between cells. Typically temperature, humidity, air pressure and wind speed would be included in each cell in the atmosphere. Simulation of the ocean would be done in a like fashion, but the interface with the atmosphere would likely be weak. Finally the system would then be subject to some external forcing mechanism, such as incremental radiation retention via an increased concentration of GHGs. Again the key question remains: Is it good enough?

Concerns about the GCMs: Structure and Logic

1 Model Stability: Several years ago separate atmospheric and hydrospheric (ocean) models were coupled, but the simulation was less than perfect and in some cases, unstable. The practice[5] has been to arbitrarily adjust the amount of heat and moisture flowing between these spheres until the model produces a reasonable representation of the present climate. In most cases these factors have been large.

2 Model Sensitivity: The variety of GCMs yield a range of forecasts from 1 to 5°C when forced with a doubling of CO_2 – or an equivalent CO_2 doubling (ECD)[6] –, a range far too broad to be acceptable.

3 Role of Water Vapor – H_2O_v: The GCMs would not predict very much warming due to CO_2 changes alone. The models rely on a major amplification factor[7] from the estimated H_2O_v in the atmosphere. The simulation of this feedback is controversial and, in general, not accepted by the skeptics.

4 Atmospheric Retention of CO_2: The GCMs tend to exaggerate the CO_2 retained in the atmosphere. These models use a constant retention[8], typically around 56 percent. Recent studies have shown this area is very complex and dynamic, aspects not captured in the models. For example, one paper[9] reported, over a 12 year period, values from 24 percent to 81 percent to 43 percent to 85 percent and finally back down to 21 percent retention.

5 Impact of Inclusion of Man-made Aerosols in the Models: Proponents claim addition of ASLs dramatically improves the GCMs. Skeptics note that inclusion, while a step in the right direction, actually worsens the comparison in North America and Europe. These are the two regions with the maximum emission of ASLs. They are the regions where the ASL effect should be the strongest. Data[10] in the Table 1 summarizes results for past 100 years and highlights this discrepancy. While the inclusion of ASLs in the global simulation brings GCM results very close to the observed, the opposite is true for the two key regions.

Table 1

	ΔT °C	ΔT GCM Results °C	
Region	**Actual**	**GHGs**	**GHGs/ASLs**
Globe	0.50	0.78	0.48
N. America	0.83	1.09	0.19
Europe	0.77	0.51	0.13

6 Grid Spacings: These vary between GCMs, from 10° by 10° (Latitude, Longitude) down. The smallest grid spacing noted by this writer is 2.8° by 2.8°. The atmosphere would also be divided into as many as 18 layers. With a 5° by 5° grid size, one is talking of large, non-homogeneous regions the size of New Mexico, or from San Francisco to Lake Tahoe to Death Valley and back to LA. Improved models will generally need more spatial detail to better simulate the processes involved. For example ASLs are released in a very non uniform manner over the globe. Unlike CO_2, they have a short shelf life. More spatial detail would be useful here. The down side of this type of change is a huge increase in computer time.

Concerns about the GCMs: Performance

1 Temperature Changes over past 100 years: Ground Based Data (GBD), vs GCM Predictions – For the GBD increase the most recent UN estimate is 0.3 to 0.6°C. For the GCMs, with some allowance for the ASL cooling effect, recent case studies have predicted warming from the 0.48°C reported above, to ~ 1.5°C[11], a range of about 0.5 to 1.5°C. While the low end of this range overlaps the GBD range, the GBD data contains a significant portion of natural warming. Hence it is fair to conclude that the GCMs still exaggerate the amount of warming that is occurring.

2 Temperature Changes over past 100 years: Satellite Based Data (SBD), vs GCM predictions – The SBD[12] shows almost zero warming in the 18 year satellite record. Proponents argue that the SBD is flawed[13]. Skeptics reject that position. To the extent that the SBD can be considered a surrogate for the surface temperature, the disparity between SBD and GCMs is even greater than for GBD.

3 Night vs Day Warming: The spread[14] between daily maximum and minimum temperatures is getting smaller. This is thought to be due to a gradually increased level of clouds. This change could be due to the observed warming, to the increase in ASLs, to the increase in GHGs in general, to jet aircraft exhausts, to natural forces or a combination of all of the above. Increased clouds will reduce energy coming in during the day and help retain more of this energy at night. Hence, most of the warming that has occurred has been at nighttime. Daytime temperatures display little or no warm-

(continued on page 18)

Global Warming Models *(continued from page 17)*

ing. One report cited values of 0.84 to 0.28 °C or a ratio of 3/1. In contrast, the GCMs have predicted a ratio of 11/10.

4 Winter vs Summer Warming: The ratio of winter to summer warming has been reported at 4.2/1, consistent with more nighttime during the winter. One scientist noted: *Know of no GCMs that predicted such a desirable result.* This is a favorable trend in the sense that it would lengthen the growing season.

5 Arctic Warming: The GCMs have always predicted maximum warming would occur in the polar regions. Actual results show little warming. For example, three studies, based on an average span of 72 years, averaged 0.1 °C warming (Range -1.5 to +1.1 °C). Three other reports on GCM results, over an average time span of 36 years, predicted 2.0 °C warming (Range 1.7 to +2.3 °C), in only half the time.

Uncertainties

It is easy to get the conviction that there is a consensus from the scientific community that global warming is here and action must be taken immediately. Indeed, many proponents are making this claim every chance they get. Yet this area is endemic with uncertainties and an on-going debate exists. Clearly there are major problems with the computer models. In addition there are major uncertainties in the background processes and on how to simulate these. One report[15] by the noted sceptic, R. Lindzen, charges the amplification mechanisms used in the GCMs depend on what is likely to be a severe misrepresentation of the relevant physical processes. A second report [16] – by a writer who has been more than friendly to the proponent's side in the past – summarized: we shouldn't be surprised by the shortcomings of the GCMs given the number of climate processes that are poorly understood or totally unknown.

A recent report[17] provided an estimate of eight potential climate change forcings, including the basic greenhouse gases. The other seven forcings included a mix of ASL forcings and a fairly narrow and limited solar forcing. These were estimated in Table 2 as, in watts per square meter:

Table 2

Forcing	Expected Value W/m^2	Range W/m^2	Confidence
Basic gases – CO_2, CH_4, N_2O, CFCs	2.4	2.1 to 2.8	High
Sum of the eight forcings reviewed	2.7	-0.6 to 4.1	Very Low

The above expected values can be compared to the 153 W/m^2 energy input from the sun, and the 299 W/m^2 basic greenhouse energy flux.

Additional inputs on uncertainties found in climate simulations has been given in recent testimony.[18] *....the effect of humidity alone is about 20 W/m^2. An additional uncertainty of 25 W/m^2 stems from calculating the heat flow from the equator to the polar regions. This gives rise, finally, to area-by-area "flux adjustments" of up to 100 W/m^2 in some areas of the coupled ocean-atmosphere simulations.*

Summary

This critique of the GCMs does not mean to imply they have no merit. Rather, its purpose is to argue that the results of the GCMs needs to be put into a better and more objective frame of reference. The models, while surely useful, are far from perfect and as such they shouldn't be placed on a pedestal and treated with awe. The noted hurricane forecaster, Dr William Gray, recently commented[19] on this subject. His remarks are paraphrased as follows: *The models have been superb when used for the next 5-10 days, but when modelers move out onto the climate area the complexity becomes too damn much.*

The above rather damming summary of logic and performance concerns, plus the very high level of uncertainty present would suggest the GCMs are not yet sufficiently developed and tested for use in the policy arena. One proponent, in what otherwise was a very good paper[20], has presented, what to this writer is a rather incredible argument namely: that the burden of proof that a model result is not valid, should be on the critic not on the modeler. This is 180 degrees opposite to the situation in industry, where anyone who developed a new computer system to simulate or optimize, say large petroleum or chemical processes, had to prove to hard nosed management that what they had was right. It is 180 degrees opposite the situation faced by any software company that wants to market, for example, a new econometric model. The burden of proof is on the developer. The developers/users of the GCMs should be no different.

Footnotes

[1] National Geographic Research & Exploration, Global Warming Debate, Spring 1993.

[2] The estimation of the average annual temperature for the Earth is a difficult task. Several major databases have been developed that differ in geographic coverage; in extent of inclusion of measurements from land, sea and ice-snow surfaces and in the tightness of admission standards. This work involves obtaining temperature records from tens of thousands of measurement systems (weather stations, ships, other). It involves understanding the history of each system and its surroundings and an assessment on whether it can be accepted into the data set and if so if any corrections are needed for possible biases.

[3] In this essay proponents refer to those who believe that serious consequences are imminent unless mankind reduces its emissions of greenhouse gases immediately. Skeptics do not believe that case has been made yet, for such a future.

[4]

CFCs – Chloroflourocarbons	CH_4 – Methane
CO – Carbon Monoxide	CO_2 – Carbon Dioxide
H_2O_V – Water vapor	H_2O_L – Water, liquid
N_2O – Dinitrogen oxide	NO_x – Misc. Nit. Oxides
O_3 – Ozone	SO_2 – Sulfur Dioxide
SO_x – Misc. Sulfur Oxides	

[5] Kerr, R., Climate Modeling's Fudge Factor, *Science*, 265, 9-9-94.

[6] Each greenhouse gas contributes a unique amount to the overall greenhouse effect. As such the impact of a doubling of CO_2 can be defined by CO_2 alone, or by the sum of the contributions, referred to as the ECD – the Equivalent CO_2 Doubling.

[7] Lindzen, R., "Errors Hurt Global Warming Theories," *NY Times*, 11-30-90.

[8] Keeling, C. D. et al, "Atmospheric Retention of CO_2," *Nature*, 375, 6-22-95.

(9) Francey, R., "Changes in oceanic and terrestrial CO_2

uptake," *Nature*, 373, 1-26-95.

[10] George C. Marshall Institute, "Are Human Activities Causing Global Warming, 1996."

[11] Mitchell, J.F.B., et al, "On Surface Temp., GHGs, and ASLs: Models and Observations," *J. of Climate*, 8, 10-95.

[12] In concept, the satellite based data (SBD) should be far superior to the ground based data (GBD), except for its short history. Instrument changes and station environment problems are far better defined. And there is no comparison on the degree of coverage of the planet. However proponents argue there are several things wrong with the SBD, such as it does not measure the Earth's surface temperature and its values are obfuscated via ozone depletion. On the first point a comparison of SBD and weather balloon data (WBD) shows an excellent agreement between 5000 and 30,000 feet, with neither record showing a warming trend. On the second point comparisons of temperature trends per decade, between GBD and SBD, shows flaws in the O_3 hypothesis. For example, in the tropics, with ~ zero O_3 depletion, data shows the largest gap between GBD and SBD trends. And in the Antarctica, a region of maximum O_3 depletion, get the best fit. Hence the O_3 hypothesis can be rejected.

[13] World Climate Report, "Does O_3 Fall Explain Differences between Satellite & Ground Based Temp.?", 1, 3-4-96.

[14] Karl, T., et al, "Asymmetric Trends of Daily Max. and Min. Temp.", B.of the American Meteorol. Soc., 74, 1993.

[15] Lindzen, R., "Absence of a Scientific Basis," *National Geographic Research & Exploration*, 9(2), 1993.

[16] Kerr, R., "Dark Clouds Promise Brighter GCM Future," *Science*, 267, 1-27-95.

[17] Schwartz, S., et al, "Uncertainties in Climate Change Caused by Aerosols," *Science*, 272, 5-24-96.

[18] Baliunas, S., "Uncertainties in Climate Modeling," Testimony to the Senate Committee on Energy and Nat. Res., 9-17-96.

[19] Gray, W., Colorado State University, "Predicted Hurricane Activity for 1997: Is Global Warming Causing More and Bigger Hurricanes?", Speech at the National Hurricane Association meeting, Houston, TX, 4-25-97.

[20] Trenberth, K., "The Use and Abuse of Climate Models," *Nature* 386, 3-13-97This critique of the GCMs does not mean to imply they have no merit. Rather, its purpose is to argue that the results of the GCMs needs to be put into a better and more objective frame of reference. The models, while surely useful, are far from perfect and as such they shouldn't be placed on a pedestal and treated with awe. The noted hurricane forecaster, Dr William Gray, recently commented (19) on this subject. His remarks are paraphrased as follows: The models have been superb when used for the next 5-10 days, but when modelers move out onto the climate area the complexity becomes too damn much.

London Week

December 6-10, 1997

- Saturday 6 December: European Affiliates EFCEE/IAEE meeting including working lunch.
- Sunday 7 December/Monday am 8 December - transfer from London to Warwick University.
- Monday and Tuesday 8 & 9 December – BIEE/Warwick Second Conference on:

The International Energy Experience: Markets, Regulation and Environment

This is a residential conference - See "Call for Papers"

- Wednesday 10 December: East European Workshop No. 5.

These are all full-day events.
Precise London venues to be advised.

Contact: Mary Scanlan
Administrative Office, BIEE
37 Woodville Gardens
London W5 2LL, United Kingdom
Phone: +44 (0) 181-997-3707; Fax: +44 (0) 181-566-7674

Note: The eleventh annual London RIIA/IAEE/BIEE conference-

Climate After Kyoto - The Implications for Energy

will be held at Chatham House on February 5 & 6, 1998 - See separate notice.

AIEE Energy and Economics Books

The Energy Sources Between Crisis and Development by Vittorio D'Ermo is published.

The Italian Affiliate, AIEE, has started to publish a collection of books on energy economics addressed both to energy sector experts and the public at large.

Energy sources, electricity cycles, energy policies, energy saving, and energy from waste are some of the main topics covered in the books.

Moreover, the books will thoroughly analyze the problems arising from privatization and liberalization of the energy markets, thus addressing an ever changing reality.

At the end of May, the first volume, *The Energy Sources Between Crisis and Development* by Vittorio D'Ermo, Vice President of AIEE, was published and presented to the press, to experts and to AIEE members.

The book covers the trend of energy sources and their development, particularly in the last few years, as well as new perspectives on European energy markets resulting from privatization and deregulation. It will be used as a basic textbook of the Master in Economics of Energy Sources organized by AIEE with the LUISS Guido Carli University of Rome.

The book is in Italian and its selling price is ITL 16,000 (US$ 10).

21ST ANNUAL INTERNATIONAL CONFERENCE OF THE IAEE

Chateau Frontenac, Quebec, Canada, 12-17 May 1998

Theme

Experimenting with Freer Markets: Lessons from the Last 20 Years and Prospects for the Future

The last 20 years have witnessed a relaxation of the institutional constraints that had previously framed the development of energy industries in many areas of the world, especially North America and Europe. This headlong move into freer markets has transformed many of these industries, which are now considered as models for similar initiatives in other sectors and other areas of the world. This conference aims to provide an opportunity to step back from the developments of the last twenty years and assess the consequences of this increased reliance on market forces: What have been important areas of success? Where have the achievements fallen short of expectations? What would we do differently now? The experience acquired during the last few decades can also shed some light on future directions for change: What remains to be done? What role should we aspire regulation to play in the context of freer markets? How do environmental and sustainable development considerations factor into this trend? How relevant is this experience for other energy industries and for other countries and regions of the world? The conference will provide a unique forum where these and related issues will be debated by experts from around the world.

CALL FOR PAPERS

Deadline for Submission of Abstracts: 1 December 1997

Abstracts may be submitted for plenary as well as concurrent sessions. Anyone interested in organizing a session should propose topics, objectives, possible speakers to the Program Chairman well in advance of the deadline for submission of abstracts. Abstracts should be between 300 and 500 words, giving an overview of the topic to be covered. Full details, including the title of the paper, names of the author(s), affiliation(s), address(es), telephone, fax, and e-mail numbers, should also be sent. At least one author from an accepted paper must pay the registration fee and attend the conference to present the paper. All abstracts, session proposals, and related inquiries should be directed to:

Andre Plourde

Programme Chairman

21st Annual International Conference of the IAEE

Department of Economics, University of Ottawa

P.O. Box 450, Station A

Ottawa, Ontario K1N 6N5, CANADA

Telephone: 613-992-4910

Fax: 613-562-5999

E-mail: plourde.andre@fin.gc.ca

DEADLINES:

Abstract Submission Deadline: 1 December 1997

Notification of Abstract Acceptance: 15 December 1997

Manuscript Submission Deadline: 2 February

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Is IT a Disaster Waiting to Happen?

*By Fereidoon P. Sioshansi**

There is an old adage that says when disaster hits, those who refuse to panic are those who don't know what's happened. And this may be the case for the "official" calm that currently prevails while people on both sides of the Atlantic prepare for the arrival of 1998 and the logistical implementation of retail access in a number of jurisdictions.

What disaster? Many within and outside the industry are convinced that the policymakers who have restructured the electric power industry to allow customers to switch retailers (or suppliers, as they are called in the UK) don't have a clue about the enormity and the complexities of operating in the new environment. Among the things that the technical "nerds" in the industry worry about are the following:

- **Independent System Operator (ISO) and the Power Exchange (PX)** – Will it work? Will it be fully functional? Will it be tested and reliable? Some skeptics are not so sure. Enormous effort and money is being spent on system development (e.g., California PUC has approved $250 million for the development of the ISO/PX), but no one is sure the work will be done on time, or that it will work.
- **Settlements & Reconciliation** – Utilities currently buy and sell at wholesale level. But all customers in a given service area buy from the same (monopoly) retailer. In the competitive arena, both the volume and complexity of these transactions will balloon. Each competing retailer has to figure out – quickly – how much its customers used in aggregate hourly and pay the generators for the delivered energy. Would the various players be able to figure out who bought what from whom, got what he bought, and paid for it? This is not as trivial an issue as it may sound because most customers' meters will not be read for weeks or months after the fact. But the parties need to settle based on estimates, and then reconcile for any errors or deviations. Easier said than done.
- **Metering & Billing** – Moving from an environment where most customers buy a highly bundled product and get extremely simple bills (total kWh consumption for the month multiplied by a fixed $/kWh price) to a far more complex environment gives every information technology (IT) expert and computer billing nerd a chill and many a sleepless night. Further complications arise because customers may be able to switch suppliers at will, and retailers are allowed to charge customers whatever they please. Moreover, there are currently no established protocol or standards for meter accuracy, data transfer among utilities, bill collection, and data processing. None of this, of course, is rocket science, but given the large numbers of potential transactions, and potentials for introducing errors, it begins to look like rocket science.

The upshot is nervousness among the IT and billing system "techies" in the industry – many of whom are skeptical that all this will be sorted out by the time retail access is to be rolled out in California and a few other states on the East coast in January 1998. The same may be said of the UK, where theoretically the remaining 22 million customers are to go shopping for competitive suppliers over a six-month period starting in April 1998.

Among those singing the IT blues is a commentary by Anthony Hilton of UK's *Evening Standard* (11 March 1997). Hilton is not pro- or anti-competition. "Competition in the supply of electricity may or may not be a good thing but the way it is being introduced is potentially suicidal. Whether it succeeds or fails will depend on the computer systems of the electricity companies being able to track their changing customer base, to know who is connected to whom, and so on. But with just a year to go before testing is due to start, the specification for the computer build has not yet been finalized because the regulatory and other goalposts have not been fixed. Starting to build when the specification has not been fixed is the most disastrous thing you can do with a computer project. Launching without someone in overall charge is the second most stupid thing. Allowing inadequate time for testing before going live is the third. Doing any of this without a budget is the fourth. And guess what: this one misses on all four."

What worries Mr. Hilton goes beyond the technical issues. "We are talking serious money here. The chief executive of one small electricity retailer told me that in his company, competition will require the total rebuilding of between 50 and 60 percent of all his internal computer systems at a cost of some £50 million (approximately US $75 million). Multiply that by 14 electricity companies and you are looking at a conservative $700 million (approximately US $1,050 million) of IT spending."

The matters don't look better on this side of the Atlantic – and the costs of system upgrades in billing, metering, and customer information systems (CIS) are expected to run into hundreds of millions of dollars-per-company – certainly for the top 100 or so. Multiply that across the whole industry over the next several years and you begin to get a sense of the scale of the problem. For software gurus and system techies, this spending spree looks like a real gold rush. For the utilities that don't get it right the first time, there will be many follow-ups and more money down the IT drain.

* Fereidoon P. Sioshansi is a Senior Consultant with the National Economic Research Associates (NERA), San Francisco, CA. This is an edited version of his article that appeared in the May1997 issue of *EEnergy Informer*.

Asian Oil Demand: A Long-Term Analysis

*By Fatih Birol**

The economic performance of many Asian economies during the past three decades has been impressive.[1] China, East Asia and South Asia - the dynamic Asian regions (DARs) - have a remarkable record of high economic growth; stronger, indeed, than any other region of the world during the last decade with an average annual 8 percent rate, compared with 2 percent elsewhere. The three major developing countries with the largest populations - China, India and Indonesia - are in the process of implementing structural reforms aimed at linking them more closely to the global economy. To a greater or lesser extent most of the East Asian countries have taken steps to liberalize their economies, including measures to open foreign trade and investment regimes, reduce subsidies and fiscal deficits, privatize state enterprises and control inflation. While some countries commenced such a process more than a decade ago, others have undertaken policy reforms only recently. The result in many of the economies in the region has been increased competition and efficiency.

The importance of the DARs in the global economy is also growing rapidly: 25 percent of world GDP in 1996, approximately twice as high as in 1973. The Chinese economy, measured in terms of purchasing power parities, is already the second-largest in the world. And since the 1970s, the DARs' share in world population has been more than 50 percent, with around 3 billion people, China alone accounting for 1.2 billion.

Accompanying the substantial growth in economic activity has been a rapid increase in energy consumption, which, coupled with rich coal, oil and gas reserves with which some of these countries - not least China, India, Indonesia and Malaysia - are endowed, make them one of the most important regions in international markets. The DARs currently account for about 18 percent of total primary energy demand, implying a substantial gain of almost 10 percentage points in the last two decades (Table 1), mainly because of their rapid economic development. Total primary energy demand in China increased threefold in the last two decades, and that of East Asia fourfold. The DARs have the lion's share of world demand for solid fuels, not least because China and India consume high amounts of coal. It increased to more than 30 percent in 1993, up from 18 percent in 1973. The DARs as a total have also experienced very high growth in oil and gas consumption, the demand for each growing three and nine times respectively between 1973 and 1993. Total electricity generation has increased more than five times in the same period. The DARs now account for more than a fifth of world carbon emissions, compared with a tenth in the 1970s.

Since their strong economic growth can be expected to continue, the long-term implications for trends in energy consumption are likely to be substantial, as is the impact on a series of related issues, such as environmental problems, investments in energy infrastructure, security of supply and trade. Developments in these energy markets, moreover, are expected to have a growing impact on international energy.

Table 1
Shares of the Dynamic Asian Regions in the World
Percent

	1973	1993	2010
GDP in PPP terms	13.2	23.0	35.9
Population	51.9	53.4	53.1
Primary Energy Demand	8.4	17.8	26.2
Solids	17.5	34.3	46.8
Oil	5.9	15.1	23.2
Gas	1.1	5.4	11.5
Nuclear	1.3	4.6	10.8
Hydro/Others	0.9	2.6	6.7
Electricity Output	5.7	14.6	23.3
CO_2 Emissions	10.0	21.9	31.0
Net Oil Import Dependence	NA	36.8	64.9

Outlook

As with any projection, a number of assumptions have to be made, in this instance combining those on baseline GDP and population growth with rising world energy/oil prices and historical trends in energy efficiency.[2] One of the major results of projections made by the IEA in the *World Energy Outlook*-1996 Edition is the strong increase of energy demand in the DARs, with energy demand up by 5 percent a year to 2010 - a substantial market gain in total world demand, and 45 percent of the increase between now and then. The share of DARs could thus exceed a quarter of world energy demand by 2010.[3] In absolute terms total primary energy demand in China is expected to double over the projection period, and the increases in East and South Asia to increase by more than that. This area's current level of primary demand of over 1400 Mtoe is expected to exceed 3000 Mtoe in 2010.

The projections presented in this paper refer only to the commercial energy sector and exclude the consumption of traditional fuels or biomass, such as fuel wood, animal and vegetal wastes, and bagasse. Indeed, one of the striking features of the energy markets of the DARs is the continuing extensive consumption of traditional fuels. Although estimates vary widely, it is known that biomass continues to meet a substantial proportion of the region's energy demand, particularly in the household sector - especially in rural areas, where a large part of energy demand is met by traditional fuels, although it is true also of a large number of the urban poor.

In spite of the strong increase in primary energy demand, one of the notable - and enduring - aspects of the DARs' energy profile in aggregate terms is the very low energy consumption per capita. The expected average energy consumption per person in 2010 in China and East and South Asia will be 1.1, 1.2 and 0.4 tonnes of oil equivalent (toe) respectively - substantially lower than that of OECD countries in the 1970s (about 4 toe per person) or the current OECD figure of 4.6 toe (even allowing for traditional fuels).

Coal and oil will continue to dominate markets for

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[1] See footnotes at end of text.

primary fuels, with more than 80 percent of primary energy demand in 2010. On a global scale, it is projected that the current share of the DARs in world demand for solid fuels will increase from a third to about a half by 2010. China plays a special role in both DAR and world demand for solid fuel, particularly since the current quarter-share of China in world coal consumption is expected to reach nearly a third by 2010. Similarly, India, also a major producer of coal (third after the United States and China), is projected to contribute to some 17 percent of the region's solid demand in 2010. Most coal use in the region is expected to be in industry, in particular for iron and steel production, as well as in power generation - with severe environmental implications, both regionally and globally.

Another important outcome of the projections is the long-term oil outlook of the region. The oil demand of the DARs is expected to increase substantially up to 2010, with an average annual growth rate around 5 percent. In absolute terms, DARs total oil demand in 2010 is projected to be close to 22 mbd. The DARs will then account for 42 percent of the increase in world demand for oil between now and 2010. Since their oil production is expected to be sluggish, their dependency on imported supplies is likely to increase substantially. The DARs currently import around 40 percent of their oil consumption, a figure expected to grow to 65 percent in 2010. While non-OPEC supply is projected to absorb a significant proportion of the increase in world oil demand in the medium term, in the longer term, the largest potential remains in six OPEC countries: Saudi Arabia, Kuwait, Iran, Iraq, United Arab Emirates and Venezuela. These countries are endowed with resource bases that can be exploited at relatively low cost.[4] This long term picture of world oil supply suggests that the current reliance of DARs on oil supplies from the Middle East will increase significantly. It is also important to note that as a result of sectoral developments discussed below, the petroleum product mix in the DARs is expected to register a continuous trend towards a lighter product mix.

East Asia currently consumes the most oil of all developing regions, with demand expected to rise rapidly by around 4 percent as an annual average, resulting in a demand of over 10 million barrels per day (mbd) in 2010, by when the current regional dependency on oil imports of 50 percent is expected to rise to over 75 percent. South Korea is the largest oil consumer in East Asia, but since it has no reserves of its own it depends entirely on imported oil. Korea is one of the major oil importers in the world, with an import volume of crude of around to 1.6 mbd in 1994 and a dependency that year on imports from the Middle East of 77 percent. Korea's dependence on Middle Eastern oil is likewise expected to increase substantially.

Indonesia and Malaysia are the two largest oil-exporting countries in the region. Indonesia is a mature oil-producing country, with only a limited potential of increasing its current capacity of around 1.5 mbd. Crude oil production in Indonesia will gradually decrease, and its impact on the oil market will decline. This is despite the concerted effort to substitute gas and coal for current oil use in Indonesia's energy sector. Malaysia, which produced 0.8 mbd in 1995, is facing fast-growing domestic demand, threatening its status as an exporter.

Oil demand will increase more strongly in South Asia than among all other developing regions, more than 6 percent a year on average up to 2010. The current dependency of South Asia on imports - 61 percent of total demand - is therefore projected to increase to almost 90 percent. India, as an important oil producer and the largest consumer in the region, is expected to become increasingly dependent on imports, its current 55 percent dependency projected to grow considerably, imposing a serious foreign exchange burden on the economy. Currently, imported oil accounts for about one-third of India's total import bill and that makes the economy vulnerable to world oil price changes. For example, the unexpected increase in world crude oil prices in 1996 cost India more than an additional 2 billion dollars.

Oil demand in China is also expected to grow strongly, at 5 percent per annum, reaching a level of around 7 mbd by 2010. Prospects for China's production are highly uncertain, resting as they do on assumptions about the potential and the pace of development for the Tarim and other basins in the northwest part of the country. While holding great potential, China's oil output is assumed to increase modestly over the outlook period. This, combined with the projections for oil demand, suggests that the country may have to import close to 3 mbd of oil in 2010. The shift in the sources of Chinese crude imports is therefore important. Before 1992 China's imports primarily came from Asia, but since 1993 the volume of crude imports from the Middle East has exceeded that from Asia. China thus becomes a more important player in the world oil trade.

The main factors behind the strong growth in oil demand are, clearly, strong economic growth, urbanization and the growing desire for mobility. In contrast with the OECD countries, oil will continue to be an important fuel in all end-use sectors, mainly in the household and transportation sectors.

High growth in oil demand in the household sector is mainly driven by rising income levels. It is empirically evident that there is a strong relationship between household sector energy/oil demand per capita and GDP per capita. However, it is also interesting to note that at higher income levels - around $1000 per annum - a trend towards saturation is observed.[5] There are also demographic determinants of oil demand in the household sector of the DARs, such as population growth, household formation and the degree and rate of urbanization. The continuing transition from traditional noncommercial fuels (wood, animal and vegetal waste, and so on) to modern commercial fuels (oil, electricity) also helps to explain the high demand growth in the household sector. Noncommercial energy in these regions is mostly used in the household sector for cooking and heating. In this context, a typical shift from noncommercial traditional energy to petroleum products is the case of switching from using fuelwood to LPG for cooking purposes. This is, of course, not a straightforward trend and there exists other substitution processes, such as the substitution of electricity for kerosene in uses such as lighting.

As with the household sector, the impetus to high oil demand growth in the transportation sector of DARs will come from increasing economic activity, rising per capita income levels and the continuing process of urbanization. The expansion in the vehicle fleet is expected to remain strong.

(continued on page 24)

Asian Oil Demand *(continued from page 23)*

Passenger vehicle ownership rates in the countries of DARs are substantially below those of industrialized countries. Even allowing for possible impediments to expansion such as congestion or government regulation, there remains much room for growth in vehicle numbers. Urbanization in DARs will require more transport for people (commuting to work), food and manufactured goods (distribution to new and more distant destinations) as well as increased investment in infrastructure.

In general, oil demand in the power generation sectors of DARs is expected to grow at lower rates than that of electricity demand. This is in line with the trend of (at least) the last decade. Coal and gas fired capacity is expected to increase significantly. In DARs, similar to other developing regions, the choice of fuel for power generation is usually determined by the fuel that is locally available.

There are other reasons that explain the rapid growth of oil demand in DARs. The lack of gas infrastructure in most of the countries limits interfuel substitution, namely substitution of gas for oil and other fuels. Moreover, existing energy pricing polices for domestic petroleum products can also play a significant role in encouraging high oil demand growth. The retail prices of many petroleum product types are relatively low when compared with that of international markets (Table 2). Domestic energy pricing in most of the countries in the region has been influenced by sociopolitical motives, such as equity for low income groups. In this context, large subsidies were introduced in the past and, in a number of countries, remain today in one form or another. This is especially true for the pricing of domestic petroleum products, albeit in varying degrees for different fuel types. In general, the retail price of kerosene (to protect the poor segments of population) and fuel oil (to promote the industrialization process) are kept lower than their economic costs, while gasoline prices are usually set (relatively) higher. Broadly viewed, the prices of petroleum products in a number of countries in the region are mostly below their economic costs. This leads to "wasteful" consumption. However, it is also to be noted that many of the countries of DAR are in the process of revising their existing pricing policies and reducing regulations on their energy sectors.

Table 2
Selected Petroleum Product Prices 1995/96
Prices in USc/l

	Gasoline	Diesel
India	59.0	22.3
Indonesia	32.4	17.6
Malaysia	44.1	25.1
Thailand	34.1	26.4
Korea	77.0	27.4
Phillippines	37.6	27.3
Spot Prices (Singapore)	14.8	17.1
Japan	114.8	71.6
OECD Total	107	5.9

Sources: *Key Indicators of Developing Asian and Pacific Countries*, Asian Development Bank (1996), *Energy Prices and Taxes*, IEA/OECD (1997).

Environmental Implications

A major aspect of the high growth in energy and oil demand is its impact on the environment. The long-term trends in CO_2 emissions of the DARs are of central importance not only for the region itself but also for the world as a whole. By 2010 the total CO_2 emissions from the developing regions of the world are likely to overtake those from the OECD area. The DARs are major contributors to world carbon emissions, and their share is likely to increase substantially over the next 15 years to around 50 percent of the annual increase in world emissions of CO_2.

Among all developing countries, China will remain the largest single source of CO_2 emissions and is projected to more than double its emissions (by around 2.7 billion tonnes) by 2010. China's projected increase in emissions is, therefore, only slightly lower than the projected increase for the whole of the OECD.

The rapid increase in emissions from the DARs is a result not only of high growth in energy demand but also of the structure of the fuel mix. As discussed above, the energy markets of DARs rely heavily on coal, the most carbon-intensive of all the fossil fuels. The poor quality of coal and standards of low energy-efficiency exacerbate already high carbon emissions.

Uncertainties

Projecting long term global energy and oil involves considerable uncertainties. These include policy changes, the geological potential of unexplored regions, technological developments, the use of noncommercial energy in developing countries and the future preferences of energy users. The links between energy supply and demand, energy prices and economic activity are also imperfectly understood.

Furthermore, several assumptions must be made in order to derive the projections presented in this paper. These include two key assumptions, namely, the development of economic activity and energy/oil prices. In this context, the question of "*the sustainability of high economic growth rates of DARs for the future*" is an important one. Assumptions based on the extrapolation of past economic growth trends into the future could provide misleading results. For example, in the context of East Asian economies, due to high income elasticities, a one percentage point difference in GDP assumptions (in 2010) would result in an under- or over-estimation of oil demand of about 2 mbd. Therefore, the figures presented in this paper should be seen as a likely outcome only if the assumptions upon which the projections are based actually come to pass and assuming economic agents continue to behave as they have in the past.

Noncommercial fuels play a significant role in the energy markets of DARs, although these are not included in the figures presented in this paper. The use of these traditional fuels in developing countries as a total is estimated to account for about one third of total energy consumption today, or some 11 to 14 percent of world total energy consumption. The omission of noncommercial energy use in developing countries is an important component of the uncertainties involved in the projections provided by this paper. In fact, the dynamics of interfuel substitution between commercial and noncommercial energy in developing countries is an important factor which shapes the evolution of the level and the structure of energy demand in developing energy markets. Without taking noncommercial energy use into consideration, estimating the income and price elasticities of energy demand for developing countries is likely not to reflect the real responses of consumers.

The issue of technological development is another factor underlining the uncertainty of the energy and oil demand projections. Growing importance of developing countries for world energy and environmental trends underlines the significance of the technology related uncertainties surrounding these regions. One of the key uncertainties is whether future development in these regions will follow a path similar to that which OECD regions have followed. There is some evidence to suggest that the development of developing countries may not necessarily follow the same pattern as the OECD. The significant effects of having access to a supply of external capital, technological leapfrogging and a more globalized economy (relocation of heavy industries) could mean that development in developing countries could proceed in a different manner. This would result in a different pattern of energy demand in developing regions, such as DARs.

Conclusion

The outlook for oil in the DARs to 2010 highlights their growing importance in world energy and oil markets. Oil demand in the region is expected to grow at 5 percent per annum on average. Transportation and household sectors will be the engine of growth in oil demand. In aggregate terms, crude oil production in DARs is projected to remain sluggish. As a result, the dependency of the region on imported oil is expected to rise significantly. Some countries in DARs will become major net oil importers. Moreover, as a result of projected trends in world oil supply, it is expected that the DARs' reliance on Middle East oil will grow significantly. This could expose the DARs to volatility and instability of world oil prices.

Current levels of petroleum products prices in many countries of DARs are significantly lower compared with those on international markets. Furthermore, the price ratios among different petroleum products are not determined on economic grounds. The removal of price distortions for some petroleum products, in levelling of the playing field, would significantly affect energy market developments in many countries. The lifting of energy price regulations and allowing market forces to set the prices of petroleum products, could dampen the rapid increase in DAR oil demand and hence reduce oil intensity.

The projected high growth trends in oil and electricity demand will put pressure on the supply side of energy markets of DARs. The need for additional capacity in the refinery industry and electricity sector is an important implication of the long term outlook of this region. Since many countries in the DARs may find it difficult to generate sufficient funds from domestic savings to carry out the investments necessary to expand power generation systems, they will have to attract foreign funds. This in turn may require restructuring and deregulation of the power generation sector in many of the countries in DARs.

Footnotes

[1] This paper is mainly based on the *World Energy Outlook*,

(continued on page 27)

The Jane Carter Prize

The British Institute of Energy Economics, the International Association of Energy Economics and the Association for the Conservation of Energy invite the submission of essays for the 1996-97 award of the *Jane Carter Essay Prize*. This is offered annually in memory of Jane Carter, former Chairman and Vice President of the BIEE, President of the IAEE and Head of the Energy Conservation Division of the U.K. Department of Energy. The prize for 1996-97 will be a cash award of US$800 together with a plaque.

Essays can be on any aspect of energy efficiency and conservation. The aim, however, is to encourage new thinking on energy conservation policy. The emphasis of the essay should, therefore, be on the policy rather than the scientific or technical aspect of the subject.

The competition is open to anyone under the age of thirty-five. Essays should not be more than 8,000 words long. The winning essay will be considered for publication in a range of energy journals and a summary will be published in the *IAEE Newsletter*.

Essays should be submitted in English, in triplicate and in typed form, by 30 September, 1997 to:

Mary Scanlan, Administration Secretary
British Institute of Energy Economics
37 Woodville Gardens
Ealing, London W5 2LL
United Kingdom

Essays should include a 150 word summary. The name, address and age of the author should be on a separate sheet which can be detached from the essay which will be judged anonymously. Manuscripts will not be returned.

Conference Proceedings
18th IAEE International Conference
Washington, DC, July 5-8, 1995

The Proceedings from the 18th International Conference of the IAEE held in Washington, DC, are now available from IAEE Headquarters. Entitled *Into the Twenty-First Century: Harmonizing Energy Policy, Environment, and Sustainable Economic Growth*, the proceedings are available to members for $55.95 and to non-members for $75.95 (includes postage). Payment must be made in U.S. dollars with checks drawn on U.S. banks. To order copies, please complete the form below and mail together with your check to:

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Implications of Economic Criminality on Economic and Energy Policy in Countries in Transition

*By Jerzy Michna**

Economies in transition (first of all, the Polish economy) are entering the stage at which the losses created by the economic recession at the beginning of the transformation process are being recovered. It is reasonable to say that the main impediments experienced at first have been overcome. At present the countries in transition are striving to optimize social-economic policy so as to develop their economies in the most effective way and as fast as possible (2,3).

Some impediments that originated at the beginning of the transformation processes in Central and East European countries, still exist (3), but their diagnosis, (particularly as far as the results and methods of quantification are concerned) is more difficult than ever (1).

This is because changes in management have been introduced without (or with very little) experience; in addition there are a great number of factors to be considered and the relation between them and the changes they describe are fuzzy in nature.

For further development of the system and its transformation it is very important to be able to estimate covert activities that do not comply with the principles of moral behavior.

The observance of these principles is deemed ethical. But in each society there are individuals and organizations who do not observe ethical principles and commit wrong-doings deemed punishable and criminal.

In each country economic activities, irrespective of the degree of economic liberty, are organized by a system of laws, including: economic law, property law, enterprise law, etc.

The activities of the government and other economic institutions designed to influence the level and distribution of social products are called economic policy.

In economic policy, it is possible to distinguish four main areas:

- *Order policy*, where the main goal to create order in the economic system; the bases for such policy are the legal standards which create the long-term framework for the economic operation of the state (or other economic institutions),
- *Business conditions policy*, which influences long-term price and employment fluctuations,
- *Distribution policy of the state*, which creates and distributes social assistance benefits.
- *Structural policy*, which is determined by a system of laws that support the development of the economy and especially civil engineering activities.

In spite of the existing systems of principles and governmental activities, economic criminality can be observed all over the world, and in very diversified forms. The reasons, although different from country to country, may be generally divided into: political, economic and social. In analyzing criminality in each country, the following criminal activities may be observed:

- *Corruption*, the moral decay of political life whereby public position is used to achieve profit,
- *Speculation*, operation based only on simple facts (without any consideration given to scientific research results and analyses),
- *Manipulation*, the exerting of influence or control over some individuals without them being aware of it,
- *Protection*, supporting persons or institutions by special methods and behavior (preferential rights, priorities),
- *Monopolization*, control of the market by only one producer (or one buyer) and the resulting capability of dictating prices,
- *Organized criminality*, organised groups formed to achieve (punishable) activities; they can act openly (lobby) or clandestinely (Mafia), and
- *Grey economy*, part of the economic activities for which no (or not all) taxes are paid.

All the above criminal activities are very difficult to quantify, both as to their range and the effects they produce, as there is limited access to the required information and the possibility of obtaining falsified information. Therefore, the parameters describing them are fuzzy.

Practically, in the course of research and analyses – still not very numerous – it is not possible to quantify and project the dimensions of some parts of criminal activities. The applied methods do not provide generally accepted results. Therefore, results can only be estimated as a value in a probable time interval.

Despite the fuzzy nature of the above mentioned factors, research shows (2,4) that considerable economic criminality also occurs in developed countries. But, typically, there is a wide range. For example, Prof. F.Schneider's (1994) evaluation of the percentage of GDP obtained from the "grey economy" showed the following percentages:

Italy - 23.4%, Belgium - 19.6%, Great Britain - 18.4%, Sweden - 16.7%, France - 14.2%, Netherlands - 13.9%, Germany - 13.1%, USA - 8.6% and Austria - 6.7%

It can be posited that for each country, the degree of economic criminality is influenced by problems experienced by the country. The differences between economic criminality in the developed countries and in countries undergoing a transformation from centrally-controlled to market economy result mainly from a different organization of social and economic life and the stabilization of some trends in the development of a given country. This means that there should be fewer sources of economic criminality in the transformed countries. Such a conclusion is confirmed by the results of the latest research carried out in some Central and East European countries concerning the estimation of the share of the "grey economy" in GDP (4). All results have stressed essential difficulties in obtaining data; nevertheless, the share of the "grey economy" in these countries is estimated to be in the range of 30 - 40 percent of GDP.

The economic conditions in the countries that have undergone the transformation process are influenced by the following factors (1,4):

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- Level of economic efficiency. There were great differences in the level of economic efficiency between economic entities operating in the centrally-controlled economies; it must be stressed that these differences did not arise due to inefficiency of work but arose as a consequence of applying the principles of central planning methods - especially in the area of distribution of investments, innovation and renovation funds,
- Destabilization caused by the introduction of change,
- Relative low level of products and services and the subsequent unstable position on the world markets,
- Extensive replacement of elites,
- Changes in economic policy objectives,
- Changes in external policies,
- Structural and legal changes,
- Industry restructuring,
- Dynamic development of environmental protection activities,
- Privatization of state property,
- Relative low income levels,
- Big diversification of economic offerings from institutions representing the developed countries,
- Considerable decrease of economic cooperation between former Comecon countries,
- Essential changes in statistical data,
- Low efficiency of control over some state institutions such as banks, tax offices and police forces,
- Low level of telecommunication systems,
- Uncertainty of references provided by local firms and enterprises, and
- Uncertainty of references provided by foreign companies and enterprises.

The influences of the above transition period problems are also observed in the directions of these countries' energy policies. Consequently, (1,4) the observed implications of economic criminality to the energy efficiency sphere are as follows:

- Decrease of the official parameters of energy intensity of countries which transform their economies,
- Smaller state budget subsidies and fewer possibilities of supporting energy conservation activities,
- Implementation of solutions that are not most efficient and innovative,
- Development of noncompetitive companies and enterprises,
- Opening the possibilities for the operation of external companies and enterprises without the best references,
- Inefficient privatization; the main concern being given to the price that could be fetched for the privatized company,
- Smaller support of efficient changes in the structure of the home economy,
- Inefficient use of capital directed to environmental protection activities,
- Strengthened power of monopolist companies by means of energy prices and tariffs construction,
- Essential share of speculation - making profits from energy policy,
- Increase of relatively inefficient decisions at the state and municipal levels,
- Lowered efficiency of using external capital sources,
- Support of inefficient and expensive services performed by foreign companies and enterprises,
- Lowered demand for research - especially with regard to home research institutes, and
- Considerable enrichment of some institutions and individuals whose achievements in the implementation of real innovation are questionable.

The discussed studies (1,4) have also shown that, in spite of the considerable impact of economic criminality on the economic growth of the countries in the transition period, there are few recommendations on how to decrease the sphere of criminal activities. To illustrate their range the relation between the level of economic criminality and energy conservation effects may be examined. The research results have also stressed the global character of economic criminality and its tendency to grow (also in the developed countries).

Therefore, for the sake of the common good it is necessary to develop research and studies that could contribute to the reduction of this negative phenomenon that occurs in the course of the global economic development.

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[2] See, Chapter 1 of the *World Energy Outlook* for a detailed presentation and discussion of key assumptions for the projections.

[3] For a discussion on the outlook for all fuel types in DARs, see also "*Long-Term Trends in Asian Energy*" by F. Birol and T. Inui, *The OECD Observer*, No. 201 August/September 1996.

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[5] See, *World Energy Outlook*, Chapter 1, pp. 41-45.

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