

IA INTERNATIONAL ASSOCIATION FOR ENERGY ECONOMICS EE Newsletter

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Winter 1998

President's Message



I was most pleased by your election of me as president-elect last year, and the opportunity to move up to president this year. I consider this a high honor. The list of individuals who have served as IAEE president is both distinguished and inspiring.

First, let me thank Dennis O'Brien on your behalf for his excellent job as 1997 president of the Association. I very much enjoyed working with him and I wish him well in his move to the University of Oklahoma's Institute for

Energy Economics and Policy. A full description of his new responsibilities will be found further in this issue of *The Newsletter*. His assignment sounds stimulating and exciting and what a great opportunity for him following his outstanding career in government and industry.

I inherit an Association that is "on the go" and running very smoothly. My thanks to my immediate predecessors for this. Our publications are of increasing interest and growing in stature and acceptance in the energy world. Attendance at our conferences is growing and their subject material both broad and stimulating. And thanks to Administrative Management Services, headquarters is functioning very well.

I was pleased to be able to attend the North American Conference in San Francisco last fall. It was very well attended - a tribute to both its broad topical coverage and to its organization. And, of course, San Francisco, California is always a nice place to visit. My compliments to the USAEE for this outstanding conference.

BIEE conferences are always stimulating. Unfortunately I was not able to attend the BIEE conference in Warwick in December on *Markets, Regulation and Environment*, but I have been told it was no exception. The BIEE and Warwick organizers did an outstanding job. I hope we'll be able to carry some of the papers in coming issues of this *Newsletter*.

As the new year begins, we say good-bye to several officers and welcome several new ones. Peter Pearson completed four years as vice president for publications and has left behind an extremely strong publications team. I'm

pleased to report that thanks to Peter's efforts *The Energy Journal* editorial staff of co-editors Campbell Watkins and Adonis Yatchew and associate editor Geoff Pearce have agreed to serve for another five years. The *Journal* is in very capable and strong hands. Our *Newsletter* continues to grow in stature and coverage. Increasingly the articles are timely and thought provoking. Recently we introduced the concept of theme articles for each issue with members of Council being responsible for putting these articles together. If you have thoughts of themes you would like to see explored please get in touch with either me or Hossein Razavi our new publications vice president. And, as always, Dave Williams, our *Newsletter* editor, invites your article submissions.

Arild Nystad did such an outstanding job as vice president for conferences that when his four years were completed we wouldn't let him go, but rather moved him over to vice president and secretary, succeeding Len Coburn who held the secretary's job for four years. Len's job as secretary was that of quiet steadiness. During his term he contributed much to the success of Council meetings. His input and counsel will

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Editor's Notes

Suhail Khan provides an indepth look at the petroleum picture in Venezuela. He examines the resources available in the country, then the organization of Petroleos de Venezuela (PDVSA) to oversee the management and extraction of these resources and then the various development schemes that have been put into place to provide foreign capital and know-how. Finally he discusses the long term production and capacity objectives of the Venezuelan petroleum industry.

Paul Tempest reports on the 15th World Petroleum Congress and International Petroleum Exhibition held in Beijing last October. He notes that China is facing a serious

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Plan To Attend The
21st IAEE International Conference

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

May 13-16, 1998 – Québec City, Canada

Le Château Frontenac Hotel

Overview

You are cordially invited to attend IAEE's 21st International Conference to be held in Québec City, Canada, May 13-16, 1998 at the Château Frontenac Hotel. This year's theme is "*Experimenting with Freer Markets: Lessons from the Last 20 Years and Prospects for the Future.*" The IAEE is the largest association of energy economists in the world and holds an annual international conference each year. These conferences have gained wide spread respect for providing timely energy economics information as well as bringing together some of the world's leading energy experts, thus creating a forum for enriched dialogue and networking within the field. Mark this conference on your calendar and plan to attend. This is surely one event you will not want to miss.

Programme

The programme is designed so that you will come away with a better sense of energy supply, demand, policy and market deregulation. General sessions include:

Freeing Electricity Markets	Conservation and Efficiency
The Structure of the World Oil Market	Experimenting with Freer Natural Gas Markets
Non-Traditional Energy Sources	Electricity Market Deregulation in North America
Regional Trends in the World Oil Market	The State in Energy Markets

Altogether there will be three dual general sessions and forty-five concurrent sessions. The response to the call for papers has been outstanding and about 170 papers will be presented. Energy experts from all over the world will discuss timely topics. Almost every aspect of energy economics will be addressed.

Speakers

Many of today's top energy experts will address this conference. Below is a partial listing of some of the speakers.

John Ferriter	John Lichtblau	Robert N. McRae
Denis Babusiaux	Lee Schipper	Jacques Percebois
Marian Radetzki	Mark Jaccard	Joyashree Roy
Perry Sioshansi	Alexander G. Kemp	M. A. Adelman
Ulf Hansen	E.G. Read	Larry E. Ruff
Derek W. Bunn	Dermot Gately	Eirik Amundsen
Eric Hirst	Michael C. Lynch	Carol A. Dahl

Registration

Québec City is a beautiful place to meet and to enjoy life at an affordable price. Single nights at the Château Frontenac Hotel are \$Can 135. The conference registration fee is \$Can 675 for IAEE members and \$Can 710 for non-members. In addition, several technical tours have been added for nominal fees. Several social events are included in the registration fee. The meeting venue offers a wide variety of restaurants, shopping opportunities, and cultural visits. Although Québec is a French speaking city, most stores and restaurants provide services in English. It is a city of about half a million habitants and is located on the St-Lawrence River, one of the largest rivers with its source in the Canada-US Great Lakes. It has been the birthplace of French civilization in North America and one of the focal points of Canadian history.

For a complete programme announcement and registration form, please fill out the following form and return it to the address below.

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be missed.

Arild brought both sophistication and improvement to our International Conferences. We're fortunate in having a headquarters staff with a great deal of experience in conference organization and management and with Arild's help this expertise will now play a part in future IAEE conferences. One of Arild's last efforts (along with IAEE headquarters) was the publication of a most complete Conference Manual. This will be a useful guide to any affiliate wishing to host an international meeting. Affiliate leaders should have received a copy by now. Stepping into the vp for conferences position is Michelle Michot Foss, who has had a great deal of experience in organizing conferences of her own. We wish her well.

Finally, we welcome Hoesung Lee as the new president-elect. Hoesung is well known in the energy field having been president of the Korea Energy Economics Institute where he is now an advisor. I look forward to working with him closely during this year.

Our International Conference in Quebec City, Canada is rapidly approaching. Be sure to mark your calendars with the dates of 13-16 May. The topic, *Experimenting with Freer Markets: Lessons from the last 20 Years and Prospects for the Future*, is especially timely. And Quebec City in May is very inviting. Plan to come a few days early or stay a few days afterwards to enjoy this delightful city and its surroundings.

I look forward to seeing many of you in Quebec City. Bonne année. Happy New Year.

Charles Spierer

Future IAEE Events

Annual Conferences

May 13-16, 1998	21st IAEE International Conference Quebec, Canada <i>Chateau Frontenac Hotel</i>
October 18-21, 1998	19th Annual USAEE/IAEE North American Conference Albuquerque, NM, USA <i>Hyatt Regency Albuquerque</i>
June 9-12, 1999	22nd IAEE International Conference Rome, Italy <i>Hotel Parco dei Principi</i>

GEE to Host 4th European Conference

IAEE's German Affiliate, the GEE, will host the 4th European Energy Conference, entitled, *Energy Markets: What's New?*

The topics of this conference will include new corporate strategies in a deregulated framework, the use of spot, options and futures, the potential of joint implementation in CO₂ strategies, voluntary agreements, and so on.

The participants in this conference will have preferential access to the LXIV International Conference on Modelling Energy Markets which immediately follows this conference

Editor's Note (continued from page 1)

energy policy dilemma: while petroleum production is rising, it is unlikely that it can keep pace with the rise in demand. The result is increased dependence on external supply, focused on the Gulf, thus exposing China to the political turbulence of the Middle East. What China really needs, he point out is a quantum leap in vehicle efficiency. His article summarizes imminent breakthroughs in automobile design as reported by a panel at the congress.

Bob Ebel examines the expected growth in electricity demand in China and the Chinese nuclear plan to satisfy this demand, noting that this market could produce more than \$1.6 billion per year in U.S. exports to China and more than 25,000 technical support jobs. He concludes that it is in the United States' and world's interest to ensure that China operates these nuclear plans as safely as possible and that it is time to lift trade barriers with China and allow the U.S. to participate in this nuclear program.

Guy Caruso and Erich Unterwaurzacher examine the progress made in energy restructuring in Eastern and Central Europe and the challenges that still lie ahead. They note that energy demand in this area started to grow again in 1995 following a decline of some seven years. Energy efficiency in the area is still substantially below that of Western Europe, however, and they suggest a number of challenges that need to be met to raise this, including price and legal and regulatory reform and the need for privatization and private investment.

Ferdinand Banks puts forth the case for the world now being in the run-up to the last phase of the *conventional* oil cycle; meaning that in a few decades conventional oil will be seen as being on or nearly on its last legs as the most prominent hydrocarbon resource. He goes on to discuss the need to focus more on the reserve-production ratio. He also briefly discusses the oil futures market and indicates why it is not as well understood as it should be.

Mamdouh Salameh explores Islamic Fundamentalism and its links to oil in the Middle East. He notes that the economic principles of Islamic thinking include a prohibition of interest and a prohibition of waste. The former argues for a lower oil depletion rate than might otherwise be the case, thus keeping "oil in the ground" for future generations. The latter argues for less military spending (which is looked upon as a waste) and the redirection of expenditures for improving the welfare of the people. He estimates that for the region as a whole, military expenditures have taken up 30 percent of the region's oil revenues.

Fereidoon Sioshansi comments on the restructuring of the electric utility industry which gets under way in California this year and notes the savings and confusion that will ensue. He also reports on some of the marketing efforts being made to attract customers. Is electricity becoming a "loss-leader"?

(September 11). The Conference on Modelling is being organized by the Applied Econometric Association in Berlin.

See the Call for Papers ad on page 10 of this Newsletter for additional information or contact Prof. Dr. Georg Erdmann, Technische Universitaet Berlin, TA8 Einsteinufer 25, D-10587 Berlin; Fax: +49-(0) 30 3145 269 08; e-mail: erdmann@ensysl.fb10.tu-berlin.de

World Oil Supply

This latest article in our ongoing series on world oil supply discusses the situation and prospects in Venezuela. Venezuela has become a world oil *hot spot*. In 1996 it generated the second largest growth in oil production in the world (after Norway) and seems certain to remain among the leading sources of output growth over the coming decade. As Suhail Kahn's article shows, the process of *apertura* in Venezuela in recent years is fundamental. It is transforming conventional oil production, heavy oil, investment flows, the state oil company PDVSA and other related sectors including petrochemicals and natural gas.

Peter Davies
British Petroleum, plc

APERTURA - The Opening of Venezuelan Petroleum Sector: New Investment Opportunities

Suhail A Khan*

Venezuela is once again the new frontier for petroleum activity and indeed the country is poised to become an important factor in the world energy markets as a focus of investment and growing exporter of crude and products. Venezuela is now offering attractive returns on many business opportunities along the entire petroleum value-chain, from exploration to marketing, and in other key areas including coal, Orimulsion and petrochemicals.

APERTURA - Strategy for Growth

Complementary to Venezuela's successful international downstream investment strategy, the *Apertura*, or the opening process, has triggered a surge of big foreign-oil interest in the upstream activity in the country. Venezuela is now open to private sector capital, which is accelerating Petroleos de Venezuela's efforts towards achieving the goal of doubling its productive capacity. Increased petroleum activity is also having a profound impact on the country's own economic development, creating new investment opportunities outside the oil sector.

Global Competitiveness

Since 1992, through four successful international competitive bidding rounds, Venezuela has decisively implemented the strategy of inviting foreign capital and technology to accelerate oil and gas development. Currently, there are 58 international oil companies operating in Venezuela, from 14 countries, covering the globe from Canada to Australia and from China to Argentina. Venezuela will benefit not only from the capital contribution to increase production that these companies are bringing, the country will also benefit from the introduction of the latest oilfield technologies, new business methods and initiatives, such as Crine, outsourcing and alliancing.

Strong interest shown by international oil companies highlights Venezuela's global competitive advantage in the oil industry. Venezuela is the gateway to Latin America and commands a strategic position in the Atlantic Basin. It possesses one of the world's largest hydrocarbon resource-base, has a competitive low-cost structure, a well-developed

* Suhail Khan is Senior Advisor to the Managing Director, Petroleos de Venezuela (UK).

service infrastructure, and the availability of high quality engineering and professional human resources.

PDVSA - A Global Company

Petroleos de Venezuela (PDVSA) has managed the Venezuelan petroleum industry since 1976 with the mission to maximize creation of value for the shareholder, ensuring financial and operational strength of the corporation and the integration of the industry with society. Today, PDVSA ranks second among the world's largest oil companies, according to *PIW*, and has grown at a steady rate of 5-6 percent during the past several years.

A key element for PDVSA's success during the past decade has been its international downstream investment strategy through partnerships with leading oil companies in major consuming markets. PDVSA strongly believes that the oil business is not about risk aversion but about sharing it with others through strategic alliances, with the objective of growth and long-term survival for both partners. This strategy has enabled PDVSA to achieve the desired growth and become a global corporation.

With worldwide 1996 sales of 34 billion U.S. dollars, PDVSA is the most important company in Venezuela, currently contributing over 80 percent of country's export income, 60 percent of the fiscal revenues and 25 percent of the GDP. During 1996, corporate earnings rose 59 percent to 5.4 billion dollars. The company is investing at a rate of 5-6 billion dollars per year, maintains a strong capital structure and employs 47 thousand people.

Worldwide Operations

PDVSA coordinates the Venezuelan oil and gas business through a well-developed infrastructure in Venezuela. Domestic facilities include over 325 producing oilfields, a network of more than 50,000 km of major pipelines, six refineries with a combined processing capacity of 1.3 million barrels per day (mmbd), and several loading terminals together with a fleet of 25 tankers.

Domestic activities are complemented with assets in the Caribbean, the United States and Europe. PDVSA affiliate Isla operates a Curacao refinery under a long-lease agreement, and two other affiliates Bopec and Borco, own and operate strategically located oil storage terminals in Bonaire and the Bahamas respectively. In the United States, through subsidiaries Citgo and Unoven, PDVSA has built a very strong position. With almost 20 percent of all U.S. oil imports, PDVSA is the single largest supplier to the U.S. market. Currently, PDVSA owns six refineries with a total capacity close to a million barrels per day and supplies over 7 percent of the U.S. gasoline market through its transportation and distribution network of 66 terminals and 15,270 branded gasoline stations. In Europe, the company has joint-ventures with VebaOel and NesteOy, which provides PDVSA with access to over half a million barrels per day of processing capacity in nine refineries with their corresponding transportation and marketing networks in Germany, Belgium, Sweden and the UK.

Organizational Restructuring

In response to modern times, PDVSA has embarked on a radical organizational restructuring, in order to make way for new challenges of growing competition, adding value and improving cross business coordination. The modernization

process has replaced the horizontal structure of three main subsidiaries, Corpoven, Lagoven and Maraven, with a single vertically integrated company, PDVSA Oil and Gas. The new company consists of three more focused business divisions – PDVSA Exploration & Production, PDVSA Manufacturing & Commerce and PDVSA Services.

The upstream division, PDVSA Exploration & Production, also includes the newly created PDVSA Faja Orinoco, to coordinate the heavy Orinoco crude upgrading projects; PDVSA Bitor/Carbozulia, to supervise the Orimulsion and coal mining units; and PDVSA CVP, which will handle all the upstream joint-ventures.

The downstream division, PDVSA Manufacturing & Commerce is responsible for refining, commerce and supply activities. It also supervises Deltaven, which is setup to supply the domestic and Latin American products markets; Interven which coordinates the international downstream joint-ventures in the United States and Europe; PDVSA Marina which manages the company tanker fleet; and PDVSA Gas which is created to supply the domestic natural gas market.

PDVSA Services was created to provide shared services to all the oil and gas activity on a competitive basis and groups together Bariven for procurement of equipment and services; PDVSA Engineering & Projects; and PDVSA Information Technology.

In addition to PDVSA Oil and Gas, four other businesses will continue to report directly to the PDVSA Presidency. These include: PDVSA Chemicals, which supervises the petrochemicals sector through its own plants and a group of 21 joint-ventures; Palmaven, which supplies fertilizers in the domestic market; Intevp, the research and technology arm; and CIED, the training and management development center.

The process has also permitted PDVSA to restructure and trim itself down to become a true corporate center with four vice-presidencies: Planning, Finance, Human Resources and Public Affairs; and a group of corporate units.

Large Resource-Base

Venezuela possesses the largest hydrocarbon resource-base outside the Persian Gulf, estimated at 432 billion barrels of oil equivalent (bnboe). In addition to 73 bnb of proven crude oil reserves and 25 bnboe of proven natural gas reserves, there is an additional potential for 50 bnb of light crude oils, and 40 bnboe of natural gas reserves yet to be found in the large sedimentary basins currently under exploration. The Orinoco Belt, meanwhile, contains the world's largest known deposit of heavy and extra-heavy crudes and bitumens, estimated at 1.2 trillion barrels in-place; of which about 270 billion can be economically produced using known technologies. This is an enormous resource-base, enough to support a production of 10 million barrels per day for the next 100 years.

Business Strategy

PDVSA's business strategy is based on the premise that the world economy has entered a moderate but sustained growth cycle with low inflation and low interest rates. Global oil demand is expected to grow from the current level of 73 million barrels per day to 85 to 90 mnbd in 2006. In this scenario, it is reasonable to assume that in the long run, high resource, low cost producers will have an opportunity to supply increasing volumes to meet the growing world de-

mand.

Given its huge hydrocarbon resource base, PDVSA sees ample opportunities to expand its activities significantly. The business strategy is designed to respond to increasing competition and the challenge of strengthening its cost competitiveness, profitability and market positioning through deeper integration with the global markets.

Expansion Plan – Opportunities for Private Capital and Technology

The company has embarked on an aggressive expansion plan with the objective to significantly increase its production and processing capacity. Based on PDVSA's assessment of market opportunities, the core target of the development plan is to increase crude production capacity from the current 3.7 million barrels per day to 6.4 million barrels in 2006. During the next 10 years 20-25 bnb of new reserves need to be discovered and developed in order to replace production and to increase capacity. This is an enormous task – 3 mnbd of new capacity, comparable in magnitude to all of the UK North Sea.

Other aspects of PDVSA's expansion plan include an 8 fold increase in the production of Orimulsion, from current 5 million tons per year to 32 million tons per year in 2006; and coal production is planned to increase by 4 fold from 5 to 21 million tons per year. In refining, the goal is to increase and upgrade domestic and overseas refinery capacity to produce increasing volumes of cleaner products. This would require increasing the deep conversion capability to further reduce the production of high sulphur fuel oil, and to improve the quality of gasoline and distillates. In the petrochemical sector, production capacity will double from 8 million tons per year to 16 million tons by year 2006.

PDVSA's expansion plan offers many opportunities and incentives for investors and suppliers. The expansion plan envisions a total investment of 65.4 billion U.S. dollars. PDVSA's management is convinced that the most economically viable way to achieve its expansion targets is by entering into partnerships with private investors who have capital, technology and profitable markets, but themselves seek to increase their long-term supply of oil and gas.

In order to facilitate private sector participation, several options have been developed which are based on provisions of the existing legal framework in Venezuela. These include operational contracts or profit-sharing agreements for exploration and production, strategic associations for the exploitation of heavy Orinoco crude, and joint ventures for the development of liquefied natural gas, petrochemical and coal projects.

Upstream Development

Operational contract scheme invites private capital in the oilfields with proven and partially developed reserves on a service-fee basis. Through three rounds of international bidding, 38 companies, both large and small, are already operating in Venezuela. Currently, operational contractors are producing over 210,000 barrels per day of oil, and planning to invest 5 billion dollars to increase production to more than 750,000 barrels per day by the year 2006.

Under a profit-sharing-agreements scheme, where PDVSA is a minority stakeholder, a joint-venture partner assumes the full cost and risk of exploration. In the case of

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APERTURA... (continued from page 5)

commercial discovery and development, partners share the profits, after reimbursing the exploration cost, paying all the taxes and an additional participation for the State (PEG). Through the first PSA bidding round last year, 8 exploratory blocks have been awarded to several consortia consisting of 14 companies who plan to invest over 5 billion dollars. The expectation is to find 7 billion barrels of new oil with an estimated production capacity of 540,000 barrel per day by 2006.

Orinoco Belt

PDVSA has designed a two-pronged strategy to exploit the enormous Orinoco Belt resources. The first scheme involves association agreements with major oil companies to upgrade extra-heavy crudes into synthetic oil for export or further processing into lighter products. These partnerships are based on the premise that the most effective way to produce extra-heavy oil is to integrate the production and upgrading infrastructure in Venezuela with the processing and marketing facilities of potential partners in the United States or Europe. Recognizing that these projects involve higher economic and market risks, Venezuelan tax law has been revised to allow the strategic associations for heavy crudes and offshore natural gas to enjoy a lower corporate tax rate of 34 percent compared with 67.7 percent for conventional crudes. Strategic associations ensure supply stability for crude-short partners and also enhance the possibilities of financing the entire project. Currently, PDVSA has a portfolio of six association projects with Conoco, Exxon, Total-Statoil-NorskHydro, Arco-Texas-Phillips, Mobil-Veba and Coastal. These consortia plan to invest over 13 billion dollars to develop a capacity of almost 700,000 barrels per day.

The second scheme for Orinoco Belt exploitation is the innovative Orimulsion; a water-bitumen emulsion designed to compete with coal and natural gas as a base-load fuel in the power sector. Currently, PDVSA's subsidiary Bitor is supplying 5 million tons annually of Orimulsion to power plants in Canada, UK, Denmark, Lithuania, Japan and China. Bitor and its partners plan to invest over 2.1 billion dollars to increase production capacity to around 32 million tons by 2006.

Natural Gas

The strategic association concept has also been extended to the natural gas business. Sucre Gas, a joint venture with Exxon, RD/Shell and Mitsubishi is studying the feasibility of exploiting vast offshore gas reserves in Eastern Venezuela. The Cristobal Colon project involves the construction of a 7 billion dollar plant to produce and export 6 million tons LNG per year to the United States and Europe. In the domestic market, the expansion plan contemplates investments of the order of 2.7 billion dollars in natural gas processing, transmission and distribution infrastructure to the year 2006.

The expansion plan also contemplates development projects to manufacture products with high commercial value from intermediate refinery streams from the domestic refineries. Private capital is invited to build an industrial park with several projects worth 1.8 billion dollars to produce industrial products including aromatics, polypropylenes and paraffins.

Petrochemicals

Venezuelan petrochemical industry enjoys many com-

petitive advantages. These include: abundant reserves of low-cost rich associated gas availability, a well developed oil industry ensuring reliable supplies, a well developed transport and loading infrastructure, low corporate tax rate of 34 percent, and most important of all, low-cost access to major export markets in the United States and Latin America. The petrochemical sector in Venezuela is undergoing restructuring, especially as regard to the legal framework, with the aim of eventual privatization. Five specific areas are targeted for significant growth: aromatics, fertilizers, plastics, oxygenates, and methanol. Output is expected to increase from current 7.7 million tons per year to 16.5 million tons by 2006 requiring investments on the order of 5 billion dollars.

Coal Sector

The Venezuelan coal sector is also open to private capital. Subsidiary Carbozulia has joint ventures with Ruhr Kohle, Shell Coal, and Evan Energy and plans to increase production from the current 4.6 million tons per year to 21 million tons by 2006. Additional partnerships with the private sector will be established for securing investments on the order of 1.4 billion dollars.

Outsourcing Non-Core Activities

PDVSA's strategy is to concentrate on its core business and to capitalize on outsourcing opportunities for non-core activities through the private sector. During the 1997-2006 period, the company plans to outsource 4.2 billion dollars worth of industrial services including: gas processing and injection, oil and gas transport, operation of oil terminals, power generation, steam and hydrogen supply for refineries, information technology, telecommunication, and environmental protection and conservation activities.

Entire Value Chain is Open for Private Sector

PDVSA's medium-term business plan reflects an expanded vertical integration strategy which combines our successful past experience in downstream integration with the challenge to expand our production capacity, all of this in the context of Venezuela's transformation towards an open market within the global economy. Through creative partnerships with international oil companies, the plan seeks to integrate every aspect of the entire value-chain, from upstream to downstream, under the general framework of associations and strategic alliances. The ultimate objective is to strengthen our position in today's increasingly competitive global markets and ensure long-term outlets for increasing volumes of Venezuelan hydrocarbons.

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DISTRIBUTED RESOURCES:

TOWARD A NEW PARADIGM OF THE ELECTRICITY BUSINESS

Edited by Adonis Yatchew and Yves Smeers

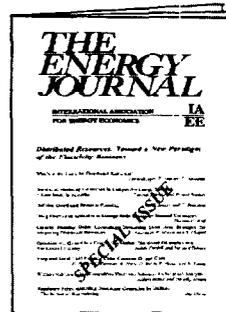
As electricity industries worldwide move toward restructuring, rationalization and increased competition, a variety of factors are combining to increase the prominence of distributed resource alternatives. These factors include: increased cost-effectiveness of small-scale generation; reduced confidence in long lead-time large-scale projects; increased pressure to find cost savings; changing regulatory relationships; new developments in technology; growing emphasis on environmental factors; and greater uncertainty about long-term load growth. This new special issue examines the emerging distributed resources paradigm. The DR paradigm promises to increase efficient use of resources by tailoring resource acquisition and rate design to local conditions. Several distinguished authors present their views in this concise, balanced and readable primer to the DR paradigm.

CONTENTS

- What's in the Cards for Distributed Generation?
- Distributed Electricity Generation in Competitive Energy Markets: A Case Study in Australia
- Defining Distributed Resource Planning
- Using Distributed Resources to Manage Risks Caused by Demand Uncertainty
- Capacity Planning Under Uncertainty: Developing Local Area Strategies for Integrating Distributed Resources
- Control and Operation of Distributed Generation in a Competitive Electricity Market
- Integrating Local T&D Planning Using Customer Outage Costs
- Winners and Losers in a Competitive Electricity Industry: An Empirical Analysis
- Regulatory Policy Regarding Distributed Generation by Utilities: The Impact of Restructuring

This issue is co-sponsored by EPRI, one of America's oldest and largest research consortia with some 700 members.

ABOUT THE EDITORS: Dr. Adonis Yatchew is professor of economics at the University of Toronto, and joint editor of *The Energy Journal*. Professor Yves Smeers of the Catholic University of Louvain has been lecturing for 25 years, chiefly in Industrial Engineering, and has written over 50 major articles in this field. He has served as a consultant for international organizations and various energy companies in Belgium, Canada, France, Germany, Norway and the UK.



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China Petroleum - A Sense of History in the Making

By Paul Tempest*

The elaborate arrangements of the 15th World Petroleum Congress and International Petroleum Exhibition held in October in Beijing under the patronage of President Jiang Zemin, reflect the arrival of China among the top half-dozen oil producers in the world. China is already top coal producer and a major natural gas producer. Yet China is facing a serious energy policy dilemma.

Some 58 chairmen of major corporations, 38 Ministers and 5186 delegates assembled for a week of high level discussions and carefully prepared technological exchange and review, with the Chinese hosts deploying a total staff of over 800. It was by far the most meticulously organized congress in the 65 year history of the WPC and was followed by an extensive program of site visits to all parts of China.

Tianamen Square, the largest in the world, was especially decorated with flowers, illuminated and closed to the general public. A red carpet carried the delegates, diplomatic corps and top cadres of the Chinese Administration from the square into the still forbidden part of the Forbidden City, where for the first time for this sort of purpose, *The Temple of The Imperial Ancestors*, built in 1520 AD and renamed by Mao *The Working People's Palace*, provided a dazzling backdrop to a reception and entertainment of 8500 guests. Then followed a comprehensive introduction to Chinese regional cuisine. Earlier the Great Hall of the People had provided an equally impressive venue for the Opening Ceremony and musical, gymnastic, opera and ballet entertainment where 4800 guests were served a 24 course banquet simultaneously without the slightest fuss or delay. A half-hour fireworks display had showed how computerized control will revolutionize fireworks displays in the 21st Century. The Chinese, who invented the art were again effectively demonstrating a new technological ascendancy and an ability to cope with large numbers, just as their medieval invention of the compass also changed the course of human history and gave man a new sense of direction.

The scale of China, one fifth of humanity, is ever-present. Walking around the *Temple of the Imperial Ancestors* with Wang Tao, for 11 years the President of the China National Petroleum Corporation, reminded me of my first meeting when I asked him how many people worked for CNPC. One point six, perhaps one point seven, he had replied. No need in China to even mention the word million. By comparison, the current worldwide staff of the two most powerful oil and gas multinationals in the world, Exxon and Shell, each are close to 100,000 which was the range of uncertainty conveyed by Wang Tao's reply. On this hallowed spot, I could not help but think that even the Imperial Ancestors themselves might not be too displeased with this brilliant, creative display of traditional skill and rediscovered culture, so long stifled by revolutionary zeal and conformity and narrow-mindedness.

The Yin and Yang, the compass and the gunpowder, the fireworks and the fountain, the power and the poverty.

* Paul Tempest is Director General, World Petroleum Congress, London, England. He was president of IAAE in 1986.

Contrasts spring readily to mind in China. As far as petroleum in China is concerned there is good news and there is bad news.

As far as domestic petroleum production is concerned, there is very good news. The heirs of the Chinese drillers who 2500 years ago perfected the techniques of drilling very many feet through solid rock and distributing natural gas by bamboo pipeline have reason to be pleased. The scale and style of the 15th World Petroleum Congress demonstrated beyond doubt the willingness of the Chinese authorities to attract foreign capital and the scramble by the foreign companies to secure a foothold.

The bad news is all on the demand side of the petroleum equation. Only within the past five years has China moved from being a net exporter of oil to being a major and growing importer. Domestic production is unlikely to keep pace with demand. The implications of this imbalance for the next two decades are profound. China must have its incremental oil to underpin its continued and remarkable level of economic growth. This gives added urgency to the search for new domestic resources, but it also signals increased economic dependence on external supply focused on the Gulf. There is a perceived geopolitical imperative to forge a political and commercial partnership with the three largest (and most unpredictable) leviathans of petroleum supply - Iran, Iraq and Saudi Arabia, whose mutual antagonisms remain the cornerstone of U.S. containment policy and protection for the industrialized world against a repetition of the deeply damaging Gulf supply discontinuities of 1973-74 and 1979-80 which threw global economic activity into a period of disorder, inflation and unnecessary extended recession. China's potential exposure to economic dependence and to the political turbulence of the Middle East is a very raw nerve in their thinking.

Amongst the Congress plenary speakers, the Secretary General of OPEC and the Executive Director of the International Energy Agency had, therefore, more to say than the predictable rhetoric of sterile consumer/producer dialogue. This has become more or less irrelevant as the global oil and gas markets have taken over fully the role of price-setter and supply-allocator. The markets today also indicate, perhaps too easily, a very low chance of further global supply discontinuity. The IEA is concerned that China, unlike other major importers, does not hold the recommended 90-day level of strategic stocks as a cushion against supply interruption. OPEC, on the other hand, foresees, with some enthusiasm, the emergence of one large new customer who within ten years could begin to rival the oil import dependence of Japan, Western Europe and the United States.

What China thinks it needs most at present is advanced technology to maximize domestic production of oil and gas and, if possible (but unlikely) to achieve self-sufficiency. What it really needs is new technology to make the existing supply go much further. Further relaxations on the bans of the private use and ownership of automobiles indicate an imminent surge in the national stock of vehicles with incalculable consequences for demand for imported petroleum.

Already in Florida and California the prototypes of family saloons with hybrid engines not much larger than a bicycle pump, composite lightweight bodies and elaborate but cheap electronics have been tested and run for the last five years. They use about 20 percent of the petroleum consumed

today by the average family saloon. The world record for distance traveled in a powered vehicle using one gallon of petrol is now approaching 10,000 miles. There is, therefore, immense opportunity now for increasing the efficiency of automobile fuel consumption.

For the Chinese, not surprisingly, a quantum jump in vehicle efficiency would provide solutions to many of their energy problems. Yet, from their point of view, the automobile, steel and petroleum industries in North America, Europe and Japan appear reluctant to forge ahead in this direction. Indeed, several key Chinese experts I have talked to find it difficult not to conclude that the Chinese economy is faced with a competitive conspiracy of free market forces, institutional self-interest and imposed technological delay which works to the disadvantage of the entire less-developed world. While the world's bankers and oilmen have no difficulty in financing new exploration and production for oil and gas without too much consideration of the consequent environmental impacts, the new technologies of efficient energy use are starved of capital, bought up at distressed prices, stifled and shelved.

Governments, for their part, rant on about environmental protection but have neither the will nor the wit nor the wherewithal to provide effective stimulus to new technologies of energy use. They excuse their lamentable lack of interest by a naive belief in and reliance on market forces to solve this and other problems.

The usual answer given in the West to these allegations is that too much is being expected too soon. That is probably right. Nonetheless, I think that the Chinese have a point which needs addressing seriously.

Imminent Breakthroughs in Automobile Design

Report from Beijing WPC Panel

- **Lean-Burn** – The lean-burn engine creates an air-fuel mix of 24:1 (current conventional engines 15:1). Stable combustion is achieved with enhanced fuel economy of about 20 percent. Several engines are already in production.
- **In-Cylinder, Direct-Injection** – The in-cylinder direct-injection engine injects fuel direct into the cylinder head. A complex (and still costly) system of pumps and nozzles are needed but it achieves an air-fuel ratio of 40-50:1 with enhanced fuel economy of 30-35 percent and a marked redirection in noxious emissions.
- **Cleaned-up Diesel** – Injectors can now store pressurized fuel to achieve greater pressure-change control. Engine noise is reduced. Nitrogen oxygen emissions are cut by 20 percent. Together with catalytic converters for diesel engines, fuel savings are likely to be substantial once the various systems have been fully developed and tested.
- **Electric-Hybrid Vehicles** – This combination of a single small gasoline engine with multiple electric motors may provide fuel savings of 50-80 percent. The electricity generated by braking is returned to the battery. This technology is a marked advance on electronic vehicles

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It's Time to Lift Trade Barriers with China: Participating in China's Nuclear Program is in the Best Interest of the United States

*By Bob Ebel**

As the economic and strategic reasons for the United States to assert its presence in Asia have grown, U.S. policy towards China has taken on increasing importance. At the U.S.-China summit in Washington later this month, President Clinton may certify China has met the conditions necessary to lift trade barriers that have prevented commercial nuclear trade since 1985. The administration is correct in doing so.

The Center for Strategic and International Studies has recently released a review of these issues entitled *U.S.-China Commercial Nuclear Commerce: Non-proliferation and Trade Issues*. The Steering Committee that developed the report was chaired by former National Security Advisor Brent Scowcroft; Senators Frank Murkowski, Max Baucus and Representative Doug Bereuter cochaired.

The report concluded, "If the president can certify the congressional conditions have been met, it is strongly in the U.S. national interest to participate in the Chinese nuclear program."

Over the last several years, China has taken significant steps to enter the nuclear non-proliferation community by joining the Nuclear Non-Proliferation Treaty, signing the Comprehensive Test Ban Treaty, and cooperating with U.S. efforts to halt North Korea's nuclear program. These are very sensitive issues, and if the United States fails to acknowledge this process, continued Chinese cooperation on such importance issues will be jeopardized.

We must recognize no other country that supplies nuclear technology has followed the United States' lead in eschewing trade with China. For that reason, the question is not whether China should develop a nuclear program but rather whether the United States, long recognized as the global leader in nuclear technology, will forfeit this role and stand alone as the only nation in the world that excludes itself as a participant in the Chinese nuclear energy program.

Electricity is the fastest growing source of energy in China, and China represents the largest single market for power generation equipment to meet growing electricity demands. China, which already has a few nuclear reactors, has announced an ambitious plan to add a total of 50,000 megawatts of new nuclear energy by 2020. To put this in perspective, China's program requires the construction equivalent to two new nuclear power reactor orders each year. Access to this market could produce more than \$1.6 billion per year in U.S. exports to China, with more than 25,000 U.S. technical jobs supported by those exports.

There are also important environmental issues that must be taken into consideration. China is the world's largest user of coal and, in fact, by the year 2015, China is projected to be the largest emitter of greenhouse gases in the world. Because nuclear plants do not burn fossil fuels, the development of nuclear energy can play an important role in avoiding the emissions of greenhouse gases.

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* Bob Ebel is Director, Energy and National Security Program, The Center for Strategic and International Studies, Washington, DC.

China Petroleum... (continued from page 9)

which need frequent recharging. The high-torque engine gives immediate and good acceleration. CO₂ emissions are halved and carbon monoxide, hydrocarbon and nitrogen oxide emissions can be cut to 10 percent of the level stipulated currently in Japan (which already has strict standards).

- **Natural-Gas Powered Vehicle** - Natural gas vehicles use compressed natural gas or liquid petroleum gas. LPG requires very strict safety standards. CNG is likely to become the No. 2 fuel after gasoline, particularly in town use and urban delivery fleets. (CO₂ emission are cut by 20 percent). More development is needed to reduce the weight of fuel pumps and to extend the range.
- **Electric Vehicles** - Electric vehicles have zero emissions, almost no vehicle noise and high energy efficiency. They are used extensively for urban delivery fleets but the current state of battery technology severely limits their range.
- **Conventional Development** - Fuel efficiency is being gradually enhanced by electronically controlled fuel injection, better design of combustion chambers, a greater use of lightweight materials, improved dynamics, more efficient drive systems, flex lock-up for automatic transmission, new tire technology.
- **Unconventional Development** - Solar and hydrogen-powered gas and gas turbine engines still need much further development.

It's Time to Lift Trade Barriers (continued from page 9)

It is also in the United States' and the world's interest to ensure China operates nuclear power plants as safely as possible by allowing China to benefit from the strides made in America to standardize designs and to improve the safety of this technology. The United States has been a world leader in commercial technology since President Eisenhower's Atoms for Peace program and clearly is a model for safety.

Where every plant is unique, reactor engineers, regulators, and operators must learn different systems. For this reason, China is expected to select *families* of standardized reactor designs from the large number of designs now available. Given the United States' investment in reactor safety and standardized plant designs, it would be regrettable from both global safety and national economic perspectives if the window into the Chinese nuclear power market were to close and deny access to American designs for decades to come.

Engaging with China on nuclear issues and establishing a presence in the country to assure the highest levels of safety, security, and environmental protection will help promote American interests in the years ahead. It is clear if China meets the condition for presidential certification required to commence bilateral nuclear cooperation, failure to proceed will strip United States of valuable leverage to secure further progress or to prevent reversals in the pursuit of American non-proliferation objectives with China.

Announcement and Call for Papers GEE/IAEE European Conference on: *Energy Markets: What's New?*

Berlin, September 9-10, 1998

Topics Include

- How to define a new corporate strategy in a deregulated framework?
- How to cope with new environmental policies?
- How to take advantage of spot, options and futures?
- How to reduce CO₂ emissions through joint implementation?

Those who wish to present a paper are kindly asked to submit an abstract prior to April 15, 1998 to:

Georg Erdmann
Conference Chairman
Technical University TAB
D-10587 Berlin, Germany
Fax: +49-30-314-269-08
e-mail:erdman@ensysl.fb10.tu-berlin.de

Or, submissions can be sent to one of the members of the scientific committee:

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Denis Babuisaux	+33-147-527-066
Edgardo Curcio	+39-632-249-21
Ole Jess Olsen	+45-467-544-03
Peter Pearson	+44-171-594-93-04
Wolfgang Pfaffenberger	+49-441-798-37-15
Charles Spierer	+41-227-742-400
Paul Tempest	+44-171-255-14-72
Fritz van Oostvoorn	+31-224-563-338

Participants in this GEE/IAEE European Conference will have the opportunity to attend the 64th International Conference of the Applied Econometric Association on *Modeling Energy Markets* at a reduced fee. This conference will be held in Berlin on September 10-11, 1998, immediately following the GEE/IAEE European Conference. For more information contact Georg Erdmann at the above address/fax.

IAEE Headquarters Moves

IAEE Headquarters has moved to new space in the same office building. The new suite number is 350; however, the old suite number will still reach us. All other numbers remain the same: Phone 216-464-6365; fax 216-464-2737 and e-mail: iaee@iaee.org. The street address remains 28790 Chagrin Blvd. Cleveland, OH 44122, USA.

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The IAEE currently meets the professional needs of over 3300 energy economists in many areas: private industry, non-profit and trade organizations, consulting, government and academe. Below is a listing of the publications and services the Association offers its membership.

- **Professional Journal:** The *Energy Journal* is the Association's distinguished quarterly publication published by the Energy Economics Education Foundation, the IAEE's educational affiliate. The journal contains articles on a wide range of energy economic issues, as well as book reviews, notes and special notices to members. Topics regularly addressed include the following:

Alternative Transportation Fuels	Hydrocarbons Issues
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Energy Management	Nuclear Power Issues
Energy Policy Issues	Renewable Energy Issues
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- **Newsletter:** The *IAEE Newsletter*, published four times a year, announces coming events, such as conferences and workshops; gives detail of IAEE international affiliate activities; and provides special reports and information on an international basis. The newsletter also contains articles on a wide range of energy economics issues, as well as notes and special notices of interest to members.
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2/98 News

Energy in Central and Eastern Europe: Progress and Challenges

*By Guy Caruso and Erich Unterwurzacher**

Since the collapse of the communist regimes in central and eastern Europe and the Soviet Union in the late 1980s, transition economies have progressed at varying paces in modernizing and restructuring their energy sectors. Many countries have managed to stabilize their economies, which have undergone a significant decline in GDP during the first half of the 1990s. Some countries have done so surprisingly quickly, but others lag behind or have experienced setbacks in recent years.

Most transition economies still need to undertake major efforts to develop open and efficient energy economies that are able to cope with the challenges of today's global energy markets. The success of energy sector reform crucially depends on continued efforts to further liberalize energy prices, to establish an equitable and transparent legal framework, to increase private participation in the energy sector and to foster entrepreneurial initiative. These issues remain as important as they were in the early years of transition.

Economic Performance is Promising

Economic growth is resuming in central and eastern Europe (CEE)¹ and the former Soviet Union (FSU) in 1997 after seven years of continuous decline in measured GDP. Six economies in CEE are now growing at rates of 4 percent or more. In 1995 and 1996 the Polish and Slovak economies grew by about 5 percent, more than twice the rate of the European Union (EU). However, in some countries in eastern Europe growth has slowed for the third year in a row, with Albania, Bulgaria and Romania experiencing sharp setbacks. Bulgaria and Romania still have substantial tasks ahead to stabilize their monetary and fiscal regimes. Economic contraction has ended in the FSU. Preliminary estimates for Russia indicate that 1997 recorded modest growth for the first time since 1990.

Successful macro-economic consolidation is also reflected in a substantial decline of inflation and stabilization of unemployment. Inflation performance has continued to improve despite several setbacks. With the exception of Bulgaria inflation in the region declined from the high two digits in the early 1990s to around 10 percent. The persisting high levels in Bulgaria and to some extent in Romania are of particular concern – in Bulgaria inflation was close to 600 percent in 1997.²

Recognizing the success in overcoming the difficulties of economic transition and the efforts in modernizing capital markets and fiscal regimes, the most advanced transition economies (the Czech Republic, Hungary and Poland) have already been admitted to the OECD.

Energy Demand Started to Grow Again in 1995

Due to the economic collapse, energy demand in CEE had declined by more than 25 percent in 1994 compared with its 1987 peak. In 1995, energy demand began to grow again, at about 3.3 percent for the region as a whole. Preliminary

data for 1996 indicate a further growth of around 4 percent.³ Contrary to the developments in CEE, energy demand in the FSU declined in 1996, falling about 2.6 percent.

There are also structural shifts within the composition of energy supply leading to a declining share of coal and growing demand for natural gas – in power generation and households – and oil, in particular for transport fuels. In the most advanced CEE countries demand for transport fuels has grown at about 10 percent a year since 1994. Electricity demand is also expanding strongly as countries restructure their industries. In 1996, electricity demand was close to its previous peak recorded in 1988.

Reduced coal use has led to significant improvement of local and regional air quality, in particular regarding sulphur dioxide emissions and particulates. With respect to global environmental concerns, the contracting energy demand had also significantly reduced the CEE region's CO₂ emissions. In CEE, CO₂ from fuel combustion declined by about 20 percent during 1990 to 1995.⁴

Policymakers will need to pay attention to the implications that oil and electricity demand growth will have on energy security, the environment and infrastructure investment. The surging electricity demand, for example, together with the shut-down of coal-fired power plants is leading to increased reliance on nuclear power plants, which in some countries are of Soviet design and are considered of higher risk than those in OECD countries.

Energy Intensity Gap Has Narrowed But Is Still Substantial

The combined effects of raising energy prices, economic restructuring and accelerated turnover of capital stock has improved energy efficiency. Nevertheless, the efficiency gap between western and eastern Europe remains significant. Although the comparison of energy intensities at an aggregate level is prone to misinterpretation, available information indicates that transition economies are using energy much more inefficiently than western European countries. The main reasons are an aged and inefficient capital stock in industry, high losses in energy production, transmission and distribution systems, the relative importance of energy-intensive industries and inefficient energy use in the building sector. If calculated as primary energy supplies per unit of economic activity, energy intensities in 1995 in CEE were about twice as high as in western Europe.

Economic prosperity is a driving force to enhance energy efficiency. It is evident that energy efficiency improvements have been disappointing and measures to enhance efficiency as yet have achieved only limited results. Only those countries which have experienced several years' economic growth have witnessed declining intensities. In the Czech Republic and Poland, respectively, intensity declined by 8 percent and 17 percent between 1991 and 1995. Policymakers are called on to act more swiftly – most importantly on price reform – so that this largely untapped energy resource can be exploited more rapidly.

Sluggish Energy Price Reform Is An Area Of Concern

After seven years of transition, energy prices for network energies, such as electricity, gas and heat, still show substantial deficiencies. Prices are generally below economic levels. In some cases, price increases have been below inflation and consequently end-user prices decreased in real

* Guy Caruso is Director of the Office of Non-Member Countries at the International Energy Agency (IEA) where Erich Unterwurzacher is responsible for Central and Eastern Europe.

terms. Cross-subsidies from industrial consumers to households are common. Electricity prices for industries are about 75 percent of the levels of western Europe. Prices for household supplies are even lower and only about 50 percent of those in western Europe. Many governments still use electricity, gas and heat prices as a social policy instrument for providing support to low-income households.

In contrast, prices for oil products are generally liberalized, and pre-tax prices reflect market levels. However, as the share of excise taxes are much lower, end-user prices remain much below western European levels. Relatively low end-user prices together with real income increases in some transition economies explain the surging demand for transport fuels.

The consequence of governments' reluctance to liberalize energy prices is substantial. Energy utilities are unlikely to have sufficient income to modernize their infrastructure or to invest in new capacity. In many cases these industries rely on direct state support or bilateral aid, such as grants for environmental protection and nuclear safety investment, or sovereign guarantees. Clearly, such a policy is not sustainable in the medium and longer term.

The negative impact of (cross) subsidies and uneconomically low energy prices goes beyond the relatively narrow issue of insufficient demand-side investment. Low energy prices not only reduce the incentive for energy efficiency, they also stimulate demand. Consequently, energy companies are forced to invest in capacity that could otherwise be avoided. This has resulted in some countries in a "supply-side shift" of investment. The price-induced shift is amplified by the fact that governments are generally more willing to provide budgetary support for capacity extensions than implementing measures to enhance efficiency. The apparent preference of government and industries alike for large-scale investments for which financing can generally be obtained more easily, for example, from multinational financial institutions, and for which project management is less difficult, is also explaining the supply-side shift. A lack of project management capacity for small-scale energy efficiency projects, which increases the project risk of demand-side investment, is an additional reason. Expertise continues to be concentrated in utilities and government offices which in the past have focused on large-scale, supply-side projects.

Some Progress In Legal and Regulatory Reform

A stable and transparent legal framework for energy sector operations is an essential feature of modern energy systems and reduces uncertainty and investment risk. However, energy sector reform has not been a top priority and lags behind macro-economic reform efforts. Even countries that have succeeded in stabilizing their economies and have opened the country to foreign investment, remain reluctant to reform the energy sector. Consequently, most of the CEE countries still need to accelerate the establishment of a modern legal and regulatory framework. With few exceptions, such as Hungary and Poland, essential legislation is still missing. In other countries, the Czech Republic, Slovakia, Slovenia and Romania, energy legislation is under preparation or undergoing inter-ministerial review procedures.

A more open energy economy and an energy industry which is exposed to competition could best be served by separating ownership, regulation and government. Hungary

is most advanced and has created an Energy Office as an independent regulator for the gas and electricity industries. The recently approved Polish Energy Law foresees a similar institution that should be established soon. Other countries would benefit from such efforts.

Foreign direct investment (FDI) is essential to provide capital investment, to reduce the burden on budgetary expenditures, and to accelerate capital stock turnover. FDI provides the countries with new technologies and modern management practice, thereby improving the performance of the energy sector and enhancing efficiency. Sound economic policies, an open economy, low inflation and stable exchange rates are necessary conditions for attracting foreign investment. Not surprisingly, the countries that have attracted most of FDI are also those which are at the forefront in macro-economic reform and economic recovery. For the more advanced CEE countries, per capita FDI inflow is similar to the European Union, whereas in Romania and Bulgaria FDI is less than one tenth that of the EU.⁵

Ownership and Privatization

Private capital is an essential feature for modern energy economies. Private ownership generally enhances efficiency, accountability and productivity. The involvement of foreign companies also provides access to modern and efficient technologies, such as combined-cycle gas turbines for power production. Private investment reduces the financial burden on the state, which is important for transition economies where financial resources are even more scarce than in the west. But private ownership of energy industries, and in particular in the electricity and gas sectors, is still the exception. Since 1995 only Hungary has partially privatized its gas distribution and electricity industries. In Poland and the Czech Republic, some local electricity gas utilities have been somewhat successful in attracting private and foreign capital, but no large-scale privatization of core gas or electricity industries have yet been undertaken. The new Romanian government has declared its willingness to undertake macro-economic reform but still needs to decide on the structure of the energy industry and the level of private sector involvement and foreign investment that it wants to achieve.

Slow progress in privatization can partly be explained by governments' reluctance to relinquish state ownership and control over energy industries, which are sometimes considered as strategic enterprises. A close and often opaque relationship between governments and the management of energy industries, which can be frequently found as one of the legacies of the former central-planning system, also works against privatization.

Central and Eastern Europe Is Key To Western Europe's Energy Supplies

Energy markets and trade help forge the links between east and west. The region's importance for east-west energy trade almost certainly will substantially increase in the coming years. The integration of CEE into European and world energy markets, the increased role for transit of gas from the FSU and the closer links in electricity will shape the development of energy economies in eastern Europe. Transition economies need to be prepared for the challenges that lie ahead. The Energy Charter Treaty which will come into force in 1998 will be a milestone and should assist in

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Energy in Central and Eastern Europe (continued from page 13)

removing barriers to energy trade and investment.

The location between the resource-rich east and western European markets provides a unique opportunity and challenge for CEE countries to become important partners in pan-European energy trade. Russia, together with Turkmenistan, supply more than 25 percent of total western European gas needs. As Russia seeks to expand its export capacities, for example by constructing a second major pipeline to western Europe, Poland could become a key player for transit of essential supplies to western Europe. Transit countries, like Ukraine, Slovakia and Poland (once the Yamal pipeline is completed), are and will remain essential to security of supply for many western European countries. There are also signs that the role of Romania and Bulgaria in European gas trade will increase as these countries will transit gas to Greece and the successor states of the former Yugoslavia.

In the electricity sector, technological improvements have allowed Hungary, Poland and the Czech and Slovak Republics to operate their electricity networks jointly with the western European Network (UCPTE) since autumn 1995. The connection of these networks not only provides for enhanced system stability and customer service, it is also essential for increasing electricity trade and energy security. It is likely that the UCPTE network will soon embrace south-eastern European countries, whose technical conditions at present do not allow network integration. With support from the EU Phare program, utilities and equipment manufacturers are studying the requirements for and consequences of including these countries in the UCPTE network, which would eventually stretch from Portugal to Bulgaria.

Enhancing Energy Security Remains A Key Priority

The CEE region's dependence on energy imports is significant, with some countries, such as Bulgaria, Latvia, Lithuania and Slovakia, importing more than 60 percent of their energy needs. Oil and gas resources are extremely limited in the region and most of the supplies are imported from Russia. The dependence on one supplier for oil, gas and, to some extent, nuclear fuel supply, raises additional energy security concerns. As the only significant domestic energy source is coal, which is gradually losing market share and whose production in the region is often not economic, it is likely that the region's import dependence, which was close to 30 percent in 1995, will increase.

Import diversification is an essential part of energy policy objectives to enhance supply security. The construction of alternative supply routes would allow CEE countries to diversify their imports, but these are only gradually emerging. The re-opening of the Adria pipeline after disruption caused by turbulence in some successor states of the former Yugoslavia, and the completion of the Ingolstadt - Kralupy - Litvinov pipeline allows Hungary, the Czech Republic and Slovakia to diversify oil imports. Continuing cost-advantages of Russian imports, for instance in the case of Slovakia, has minimized the use of these alternative supply routes. The recently established gas link between Hungary and Austria has reduced Hungary's dependence on Russian gas. An agreement for gas supplies between the Czech Republic and Norway that was concluded in 1997 will also improve diversification.

With the exception of Hungary, which became the 24th member of the International Energy Agency in 1997, CEE countries are generally ill prepared to cope with energy supply disruptions. Oil stock levels are much below the Agency's stock holding requirements of 90 days of net imports. Given their high import dependence, there is no room for complacency, and CEE economies and import-dependent countries of the CIS need encouragement to establish emergency legislation and to implement a fair and equitable financing mechanism for stock holding.

For Bulgaria, Croatia, the Czech Republic, Lithuania, Romania, Slovakia and Slovenia nuclear energy is seen as a pivotal component of energy and environmental policies. Those countries which operate certain types of Soviet-type nuclear which are considered of higher risk, such as Bulgaria, Lithuania and Slovakia will need to continuously enhance plant safety to operate these plants in accordance with international safety practices. Although investment in safety upgrading has been significant, capital requirements will remain substantial for plant decommissioning and the back-end of the fuel cycle.

These investments together with those for traditional environmental protection measures, such as flue gas cleaning, are likely to be undertaken only if private capital takes the lion's share. However, this will require a business climate which is open, stable and transparent.

Footnotes

¹ Central and Eastern Europe includes Albania, Bulgaria, the Czech Republic, Hungary, Poland, Romania, the Slovak Republic, the successor states of Yugoslavia and the Baltic States.

² Transition report 1997, EBRD 1997.

³ *Energy Statistics and Balances of Non-OECD Countries, 1994-1995*, IEA/OECD, Paris, 1997.

⁴ *CO₂ Emissions from Fuel Combustion, 1972-1995*, IEA/OECD, Paris, 1997.

⁵ *World Investment Report, 1997*, UNCTAD, Geneva, 1997.

Election Results Announced

The polls for the 1998 Association elections closed on November 1 with Hoesung Lee being elected President-elect, Hossein Razavi elected Vice President of Publications, Arild Nystad, Vice President and Secretary and Michelle Michot Foss elected Vice President for Conferences.

Hoesung Lee is an Advisor to the Korea Energy Economics Institute having previously served as its President. He holds a BA in Economics from Seoul National University and Ph.D. in Economics from Rutgers University. Previously he was President of the Korea Resource Economics Association and Advisor to the Energy Minister and the Minister of Energy and Resources. He was IAEE Vice President for International Affairs in 1994-95, and has served as an appointed Council member, Chairman of the Korea affiliate and on the President's Advisory Board. He is a board member of Hyundai Corporation and Co-Chair of IPCC Working Group III.

Michelle Foss is Director of the Energy Institute of the University of Houston's College of Business Administration and an Assistant Research Professor in the Department of

Decision and Information Sciences. She holds a BS from the University of Southwestern Louisiana, an MS from the Colorado School of Mines and a Ph.D. from the University of Houston. Dr. Foss has done extensive consulting on energy and other natural resources, environmental permitting and industrial siting in the United States, Mexico and Indonesia. She has broad IAEE involvement including being a past president of the USAEE Houston Chapter, serving on the Board of Editors of *The Energy Journal* and as chair or cochair of various conferences.

Arild Nystad is Managing Director of RC Consultant in Norway. He holds an M.Sc. and Ph.D. from the Norwegian Institute of Technology and a postgraduate degree in Petroleum Engineering and Petroleum Economics from Ecole Nationale Supérieure du Pétrole et des Moteurs at IFP. He was formerly Director, Petroleum Resource Management Division of the Norwegian Petroleum Directorate; Chief Scientist at the Centre for Petroleum Economics at Chr. Michelsens Institute and Scientist at the Continental Shelf Institute, both in Norway. He was IAEE Vice President for Conferences from 1994 through 1997 and was instrumental in the establishment of the Norwegian Affiliate.

Hossein Razavi is Director of the Energy Sector, Europe & Central Asia of the World Bank. He holds a BS and MS in Engineering and a Ph.D. in Economics from the University of Maryland. He was formerly Chief of the Oil & Gas Division of the World Bank. His IAEE involvement includes serving as an appointed Council member in 1994 and as member of the Board of Editors of *The Energy Journal* since 1995.

Pindyck and Johnson Honored by IAEE

Robert Pindyck and Anne-Marie Johnson have won the 1997 IAEE Outstanding Contributions to the Profession Award and the Journalism Award, respectively.

Pindyck is Mitsubishi Bank Professor of Applied Economics at the Sloan School of Management, Massachusetts Institute of Technology. He received his SB, SM and Ph.D. degrees from MIT, joining the faculty after receiving his doctorate. He is also a Research Associate with the National Bureau of Economic Research and has been a Visiting Professor of Economics and Fellow at the Institute of Advanced Studies, Tel-Aviv University.

He has consulted widely including with the Department of State, Department of Energy, Federal Energy Administration, Federal Reserve Board of Governors, The World Bank, a number of foreign governments and many private businesses.

Additionally, he serves or has served on the editorial boards of the *Journal of Economic Dynamics and Control*, *Energy Economics*, *The Journal of Energy and Development*, *Energy Systems and Policy* and the *Journal of Industrial Economics*.

The Outstanding Contributions to the Profession Award has been given annually since 1981 to an individual deemed to have made an outstanding contribution to the field of energy economics and its literature. Michael Hoel of the University of Oslo won the award in 1996.

Anne-Marie Johnson is an Associate Editor of the *Middle*

East Economic Survey. Before joining MEES in 1993, she was with *Petroleum Intelligence Weekly* and prior to that with Chevron and Mobil where at one time or another she served in planning, operations, shipping and transportation.

She received her BA from the University of California, Berkeley and an MA from the Fletcher School of Law and Diplomacy at Tufts University.

She has been covering the oil and gas industry for more than ten years.

The IAEE Journalism Award is given annually for excellence in written journalism on topics relating to international energy economics. The 1996 Award winner was Isabel Gorst with *Petroleum Intelligence Weekly*.

The IAEE Awards Committee this year included Robert Mabro, Walter Mead, Mohan Munasinghe, and Peter Odell with Tony Finizza, Chairman for the Outstanding Contributions Award and Isabel Gorst, Amy Jaffe, Al Troner and Finizza for the Journalism Award.

Award Recommendations Solicited

The IAEE Awards Committee, chaired by Immediate Past President Dennis O'Brien, seeks recommendations from the membership for the Association's 1998 Awards.

Annually, the Association makes two awards: The *Outstanding Contributions to the Profession* Award and the *Journalism* Award. Occasionally, it also makes an award for *Outstanding Contributions to the Association*.

The *Outstanding Contributions to the Profession* award is made to an individual judged to have made singular contributions to the field of energy economics and its literature. The award was won in 1996 by Michael Hoel and in 1997 by Robert Pindyck.

The *Journalism Award* is made for excellence in written journalism on topics relating to international energy economics. It was won in 1996 by Isabel Gorst and in 1997 by Anne-Marie Johnson.

The *Outstanding Contributions to the Association* award is made to an individual judged to have made a distinguished and significant contribution to the IAEE and its well-being. It was given in 1993 to Toyooki Ikuta and in 1994 to Melvin Conant.

Recommendations should include a letter citing reasons why the committee should consider the individual being nominated along with samples of the individual's work that would be relevant to consideration.

Recommendations should be sent to:

Dennis J. O'Brien, Director
Institute for Energy Economics and Policy
Sarkeys Energy Center
John A. Brock Chair for Business and
Economics
100 East Boyd, Room 510
Norman, OK 73019, USA
e-mail: dobrien@ou.edu
e-mail: dobpetrod@aol.com
Phone: 405-325-4701
Fax: 405-325-3180

An Outlook on the Supply of Oil

By Ferdinand E. Banks*

Summary

This article argues that we are now in the run-up to the last phase of the (conventional) oil cycle, which means that in a few decades, conventional oil will be recognized as being on – or nearly on – its last legs as the most prominent (and valuable) hydrocarbon resource. A certain amount of attention is paid to the concept known as the “length-of-life of global oil reserves”, because in numerical terms this reduces to 45-50 years; this is essentially meaningless from a geological point of view. (It is also meaningless from an economic point of view given the distribution of oil reserves). Instead, more emphasis needs to be placed on the reserve-production ratio. There is also a brief discussion of the oil futures market. This market is invaluable where risk management is concerned, but it seems to be true that it is not as well understood as it should be. (This is one of the reasons why it is possible to spread so much misinformation on the place of futures in the new deregulated gas and electricity markets.) The claim here is that the long-term derivatives market is (and will likely remain) the swaps market, although it may be true that exchange traded futures and options can be combined with swaps or similar price protection schemes in order to form more comprehensive and flexible derivatives.

Introduction

Although it is estimated that 500 million years were required to create the stock of (conventional) oil that we began consuming in large amounts about 1860, the present age of oil will soon be approaching its last phase. Expectations are that by 2060 there will still be sufficient oil in the crust of the earth to fuel the lamps of China and California, although most likely there will not be enough to keep your Cadillac in the fast lane.

What about unconventional oil? Recently, in *Nature* (1997), Professor Henrik Houthakker (of Harvard University) expressed a poignant belief that technical progress will soon make up for increasing natural scarcities by developing acceptable substitutes, and/or lowering the extraction/exploration costs of new reserves. There is no point in shouting to the high heavens that he almost certainly is wrong, or for that matter elaborating on the futile experiments with, for example, tar sands and oil shale that took place after the first two oil price shocks. Instead, I prefer to say that while some – and possibly a great deal – of unconventional oil will eventually be available, it is unnecessarily reckless to believe, on the basis of evidence available at the present time, that it will be adequate from a quantitative point of view.

The consumption of crude oil at the present time is about 70 million barrels per day (70 mbb/d), and increasing at 1.5 to 2 percent per year (1.5-2%/y). As will be emphasized below, the challenge posed by producing an amount of new oil equal to roughly 1.4 mbb/d every year from a declining

*Ferdinand E. Banks is Professor at Nationalekonomiska Institutionen, Uppsala University, Uppsala, Sweden. This is an edited version of a paper given at a BIEE conference, 7-8 December, 1997, and is a shortened and nontechnical version of materials from his forthcoming textbook, *Energy Economics: A Modern Introduction* (1998).

reserve base (and/or from unconventional resources) may turn out to be too much for the firms and governments managing the global oil industry – unless, of course, they can count on being compensated for their efforts by some very healthy price increases.

If we turn to mainstream economic theory, the price alluded to above should rise to a level where an industrial substitute for the natural product can be produced in an amount sufficient to replace the natural product. No further speculation on this matter will take place in this paper because I do not want to encourage another wave of esoteric theories and manipulations based on the pseudo-scientific Hotelling model/hypothesis. Instead, as I have also done in my forthcoming textbook, I argue that economists – to include myself – must take a back seat to geologists and certain corporate players where consideration of the oil supply is concerned. Put another way, this aspect of energy economics is becoming too important to be left to economists.

One more topic can be broached here. At the present time much enthusiasm seems to be directed toward the possible replacement of conventional fuel (i.e. petrol/gasoline) in existing or a new generation of vehicles. According to Joanna Walters in a recent issue of *The Sunday Observer*, “tomorrow’s world of vehicles that run on alternative power is around the corner”. Suddenly I find myself thinking of the Tommy Dorsey orchestras rendition of the popular tune from World War II, *It Seems To Me I’ve Heard That Song Before*. It is definitely true that a new generation of vehicles is going to be necessary, and we can expect to see them on the highways and parked outside the better discos in the not too distant future, but whether a sufficient number of them are “right around the corner” remains to be seen. I doubt, however, whether they are going to appear *en masse* for a long time yet, and also whether (natural) gas is going to play the part in this transposition that Ms. Walters (and others) believe that it will play, because, like oil, there is less (conventional) natural gas in known deposits than many persons have deluded themselves into thinking, especially when the growth in world population and the escalating demand for electricity is brought into the picture.

This short paper is intended for easy reading, with the topics taken up elaborated on further in my textbook. A possible exception is the brief section on derivatives, but these materials seem necessary due to the deluge of untruths about electricity derivatives that the more sensitive of us are being exposed to on a daily basis, as well as some chronic misunderstandings about oil derivatives. A major problem in the latter case is the lack of attention paid to oil swaps. For example, two-thirds of Metallgesellschaft’s derivatives position was in swaps, although a great deal of effort seems to have gone into concealing this not very concealable fact.

First the Bad News

Marvin Davis, the Denver and Hollywood investor who seems to be right most of the time, puts it as follows: “You don’t have to be a cockeyed genius to see this coming.” The problem is, however, that when the subject is oil, seeing is not always believing.

Davis says that he is scouring the globe for oil, and he is being joined by assorted billionaires and multi-millionaires who have picked up the scent of a coming oil boom. The large and not so-large oil companies are also stepping up their

exertions, looking for what they call *new plays*, but at the same time upgrading their technology in hope of pressing more oil from the properties under their control.

Often they receive help from their governments who, unlike the television audience, are familiar with the underlying supply and demand fundamentals, and want to avoid an energy crunch. Many members of the energy bureaucracy are fully aware of what escalating oil prices mean for such things as inflation and productivity, and political stability. They also realize that with every passing day the world becomes more dependent on Persian Gulf assets; and that population growth and galloping consumerism in the developing countries in general – and Asia in particular have brought about a ravenous appetite for private transportation and the motor fuel that goes with it. That appetite is not going to go away.

As to be expected, everyone does not share these concerns. Several of our most prominent academic energy economists find the above kind of talk alarmist, while the American Petroleum Institute seems to think that there will always be enough oil, arguing that existing deposits are constantly being augmented from underground sources and that, as one of their spokesmen put it, “With all the reserves in place now, we have a 50 year supply of oil even if we didn’t find another drop.” Unfortunately I cannot formulate a knowledgeable comment on the first of these claims, other than to say that it doesn’t sound very useful in a world where (on the average) 70 mbb/d of oil are bought. As for the second, it will be shown that it is considerably less than useful.

The curse of modern macroeconomics is its tendency to resort to algebraic overkill instead of observation and common sense. Similarly, we don’t need the Hotelling hypothesis or option pricing theory to tell us what is going on in the great world of oil. A simple parameter, the reserve-production (R/Q) ratio is capable of telling us a large part of what we need to know about that subject. It works as follows.

If the R/Q ratio falls below 10 (or 9 or 11, depending on the deposit), then the deposit is being ‘damaged’ in the same manner that sucking too hard on a straw will damage an ice-cream soda. The damage will be manifested by a reduction in the total amount of oil that can eventually be removed from the deposit. This *minimum* R/Q ratio can be designated the critical R/Q ratio, and in my teaching I usually take it as 10.

Now for the important point. When the R/Q ratio reaches the critical value, this critical value will determine production, in the sense that production must adjust in such a way as to hold the critical value (approximately) constant. For example, assuming a critical R/Q ratio of 10, suppose that we have $R = 150$ units of oil reserves to start with, and we want to extract 10 units per year for as long as possible. The initial R/Q ratio is 15, and after 5 years it has fallen to the critical value of 10. ($150/10, 140/10, 100/10$). For R/Q to remain at 10, production (Q) in the next period will be 9.09. In the period following that it will be 8.26, and so on. (The formula that can be used here is production in period, t , is $Q(t) = R(t-1)/(1+\theta)$, where θ is the critical R/Q ratio, and $R(t-1)$ are reserves in period $t-1$. This expression is derived in my textbook.

For what it is worth, the life of this deposit is not $150/10 = 15$ periods. Instead, it approaches infinity. More relevant, when production turned down, two-thirds of the

deposit (= 100 units) was still in the ground. In the real world however, on the average, the production from a deposit will turn down with about half the deposit still below the surface. (And, conceptually, nothing in the discussion above changes if the amount of reserves is growing relative to the annual production, unless this growth is very large – which is not the case for reserves outside the Middle East.) Thus, the contention above that we have, for example, 50 years of oil even if we do not find more is misleading. In fact, once we look at the global distribution of oil reserves we see that it is dangerously misleading, because most of these reserves are owned by countries without the slightest interest in making the fantasies of the American Petroleum Institute come true.

Economics is an observational rather than an experimental science, and it occasionally happens that single events can tell us a great deal. I began watching the R/Q ratio in the United States when it was about 12, and nobody was more surprised than myself when it sailed past 10 without any pronounced effect on the aggregate flow of oil from that country’s deposits. However when it was approaching 9, the inevitable happened in the form of one of the largest declines in oil output in modern American history. Furthermore, there will be no recovery from this situation – no genuine oil production cycle. Instead, according to the U.S. Energy Information Administration (EIA), in 10 years the United States should be importing 60 percent of its oil consumption, perhaps 10 mbb/d, for an annual cash outflow of 100 billion dollars, if they are lucky.

At the present time I occasionally observe the R/Q ratio in the oil producing world outside OPEC. This is somewhere between 17 and 18, and slowly falling. In a decade it should be approaching the magic number, whatever that happens to be. Not only that, OPEC is also undergoing some important compositional changes. If we move to a 10-15 year horizon, then according to Leo Drollas, chief economist and deputy director of the Centre for Global Energy Studies (London), such OPEC stalwarts as Libya, Algeria, Nigeria, and Indonesia will be well past their prime where oil is concerned. I can also mention that the North Sea, which seems to figure so prominently in the ruminations of many energy professionals (although its total reserves are only 1.5 percent of the world total), will at best be a minor oil province at that stage of the game – or, as it might be better put, that stage of the run-up to the oil market end-game.

What all this means is that the Middle East, with 65 percent of the world’s oil reserves, but just over a third of global production, will gradually assume an unambiguous leadership of the supply side of the world oil market. Earlier this year the associate director of the Cambridge Energy Research Associates in Paris, reacting to news of a higher oil output in the North Sea, said that “OPEC’s fate is not in its own hands”. The truth is, as Professor Milton Friedman found out almost two decades ago, OPEC’s fate has been in its own hands since October, 1973, and never more so than at the present time. In the major OPEC oil producing countries both exploration and investment are down to minimal levels, with output pressing on (maximum) capacity, because the decision makers in those countries have come to understand that the lower the gap between output and capacity, the less the temptation – and need to sell oil for

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bargain basement prices.

This arrangement has led to what Paul Tempest, Director General of the World Petroleum Council (London), has called a "paradox": the great majority of investment spending on oil is taking place in high cost, relatively oil poor regions outside OPEC and/or the Middle East, and thus causing reserves in these regions to be depleted much faster than elsewhere. As Tempest makes clear, a consequence of this behavior is that even sophisticated observers are "dazzled by buoyant production growth among non-OPEC producers". These observations, and their significance, need to be understood by everyone who is seriously interested in how much we are going to have to pay for oil in ten or fifteen years.

More of the Same

As far as I can tell, those wealthy investors in the United States who plan to become wealthier via ownership of the right energy shares and properties, are looking more at demand than at supply. As the very successful Richard Rainwater expresses it: "Rising global demand paints a picture for me that doesn't have any other outcome. The price of oil is going to have to come up."

What he should have added was, it will keep 'coming up'. For example, given the present global oil consumption, and an average rate of increase of 1.5-2%/y, about 3 million extra barrels of oil per day will have to be found by midnight, December 31, 1999, when the New Year's eve parties start ringing in the next century. Turning to important periodicals such as *The OPEC Bulletin* and *Petromin*, we can get a great deal of information about ongoing and proposed undertakings in every corner of the world that will be of assistance in mustering that extra 3 mbb/d. There doesn't seem to be anything exciting happening North of the Bay of Fundy, or within shouting distance of Tierra del Fuego, but we have been assured by various experts that "lessons learned in the North Sea, a hostile environment, are applied elsewhere."

In perusing the aforementioned lists of projects, I see new output coming on stream in hostile, friendly, and neutral settings. A hundred thousand barrels a day here, a hundred thousand there, maybe even an extra half-million or more, eventually, from Colombia. According to Lawrence Goldstein, president of the Petroleum Industry Research Foundation (New York), the increased demand for oil up to the year 2000 will largely be met by increased non-OPEC supplies. As for OPEC, they will find themselves "in a stagnant volume environment at best".

He might be correct. I expect the non-OPEC countries to squeeze out most of that extra 3 mbb/d, even though the arithmetic looks a bit tricky, and one of Mr. Goldstein's predecessors at the Foundation clearly stated that OPEC had "turned the corner, and was moving back into the driver's seat." He is almost certainly not correct, however, in saying that in the 5 years after that, which will be distinguished by still another 6-7 mbb/d being required, non-OPEC supplies will rise to the occasion. When the world wants those extra supplies, they will have to go to OPEC, and the longer they wait, the harder they will have to *work* their own deposits. As a result, the steeper the decline in non-OPEC production is going to be when it finally takes place: it is going to resemble the precipitous downturn experienced earlier in the United

States. It does not need to be said, I hope, that when the oil importing countries find it necessary to approach OPEC for the greater part of the supplies that some mistakenly believes they can obtain elsewhere, they will have to have more than their hats in their hands.

Among the most prominent of these consumers will be the automobile and motorcycle owners of Asia. Philip Abelson, the former editor of *Science* magazine, recently said that these countries are going to require enormous amounts of motor fuel, and they will be able to export the labor intensive goods needed to buy this fuel, even if its price is rising. As a result, in order to keep this price – and the price of oil from which it is produced – from exploding upwards, Abelson calls for a concentrated research effort to find alternative fuels. Whether this effort will be put forth or not remains to be seen, but personally I cannot see it having much effect in the near future if it began tomorrow.

Many students of world oil demand have zeroed in on China as the country in which the future of the oil price will be determined. This makes sense, perhaps, but I suspect that more attention needs to be paid to Russia. If that country pulls itself out of the (macroeconomic) doldrums, which is not impossible, but is unable to put its oil production and distribution apparatus in order, then instead of a *research effort* to find new motor fuels, something on the scale of the Manhattan Project might be necessary. Eastern Europe is also going to be a very large demander of motor fuel (and petrochemicals), but unlike the Former Soviet Union, they do not have much to offer in the way of supply.

Casual watchers of the world oil scene are mostly concerned with the motoring habits of our friends in Shanghai, Kuala Lumpur, and Bombay, but little or nothing is mooted about the needs of farmers and others in, for example, rural Mexico, Thailand, and Botswana. I seem to remember giving a lecture once called *The Price and the Value of Oil*, in which I came to the conclusion that – despite what we teach in microeconomics – price may not always be an unequivocal measure of value. Clearly, a liter of oil in the tractor of one of those farmers is of more value than it is in my Volvo should I get a sudden urge to wheel into Stockholm in order to find out whether Madonna has cut a sensual new version of *Papa Don't Preach*, and the same thought applies to oil as an input into fertilizer. In addition, where energy resources are concerned, oil has a unique flexibility that makes it invaluable to those countries that are still far from the *Tiger* category. As Paul Hawken pointed out many years ago, developing nations can make virtually any sacrifice except drastically reducing their input of energy, while in the long run, not being able to economize on energy could make the industrial countries more vulnerable.

A Simple But Important Observation About Oil Futures Markets

As far as I was concerned, the two main topics at the 18th international meeting of the International Association for Energy Economics (IAEE), were electricity deregulation – which generally reduces to reregulation; and the oil futures markets in the wake of the widely advertised misfortunes of Metallgesellschaft (MG). Where the first of these topics is concerned, people like myself tried but failed to show that even hardened derivatives traders are running the risk of overdosing on aspirin because of gyrations on the (Scandina-

vian) electricity futures markets, and this continues to be true. By the same token, it was not revealed – as it should have been revealed – that the hedging of price risk via oil futures markets is not always a straight-forward exercise. Here I can refer once more to the paper by Professor Houthakker mentioned earlier, where it is claimed that obtaining adequate oil in a decade or two will not be much of a burden because long-range planning can be facilitated by futures (and options) markets. In my judgment, this contention is wrong, unless you think that what happened to MG cannot happen to other firms.

Exactly what is the problem here? The main dilemma is that many students of commodity and financial derivatives are so busy trying to confect econometric masterpieces that they have completely disregarded the basic mechanics of futures trading. For example, I have always told my students that beyond 9 or 10 months, the derivatives market in most commodities generally narrows to the swaps market, with activity in futures and options being reduced to a comparatively low level. This has become common knowledge in New York and Chicago, and most likely London and Singapore; but at the Washington (i.e., 18th) meeting, we were grandly informed that futures contracts for crude oil now exist with maturities up to 7 years. When I asked one of the gentlemen active in this market if this were true, his reply was that if contracts of this maturity are what producers and consumers of oil naively desire, then *The Market* will make them available.

What he did not say, however, was that liquidity in such long duration ‘paper’ markets was almost non-existent, and if at some point late in those 7 years a transactor wanted to close a position, then he or she might have to accept a resounding loss. The advantages presented by copious liquidity (i.e., always being able to trade at or near the last quoted price) are why large traders, such as MG, elected to employ short-dated contracts, although ‘rolling over’ these contracts poses dangers of its own. (It might also be useful at this point to note that a protracted shortage of liquidity is the reason why options traded on the Oslo electricity exchange have occasionally been grotesquely overpriced, and why – as I predicted a year ago in my paper *Economic Theory and Electricity Futures Markets* – the Finnish electricity exchange, Elex, has fallen on very hard times).

Another interesting (but false) idea advanced (again) at the Washington meeting was that the major oil producing countries could hedge the greater part of their production on existing exchanges. The sad truth is that if producers were to take this kind of advice seriously, they would swamp the market – driving, for example, the price of paper oil well below that of physical oil, and thereby making it impossible, on average, to lock in the price of physical oil. This will be explained below.

As far as I know, there is no listed market for very long dated futures and options, i.e., with maturities of more than 18 months. Instead, these derivatives are traded by a few dealers, at a price which these dealers think will compensate them for the risks they are taking, which by extension means that entry and exit costs are unknown. Such is the wonderful world of *price discovery* in long term situations. By way of contrast, commodity swaps can (in theory) enable producers and consumers to avoid exposure to adverse price fluctuations by locking in prices for a comparatively long period. How-

ever, since a particular transactor might deem future price fluctuations favorable, many swaps involve fairly short maturities.

Of course, by *rolling* futures positions forward, it is theoretically possible to think in terms of any maturity. As MG found out, however, there are occasions when it is less risky to be exposed to an unknown oil price, then to become involved with a strategy where futures positions were concentrated (or *stacked*) in short-dated futures (and swaps) that had to be rolled forward monthly or bimonthly in order to maintain its hedge over a horizon that, reputedly, was a decade.

It is also a well known fact that under normal circumstances liquidity – as measured by open interest – builds up gradually over the life of a given futures contract, to collapse rather rapidly as the maturity date approaches; but on a very long dated futures, the opposite arrangement would not be unnatural.

Now for the main item of business. I was informed at the Cambridge (UK) meeting of the IAEE, early in the 1980s, that there was not enough liquidity on all the futures markets in this old world of ours, to perform the hedging that some persons insist should and could be performed on futures markets – where these *persons* are often associated with futures exchanges in one capacity or another. Why do they continue to make this mistake? A part of the answer is that they do not understand that where, for example, short hedging is taking place, the price being locked in is the futures (i.e., the *paper*) price, and not the spot (i.e., the *physical*) price. (Short hedging involves protecting against a price fall; long hedging against a price rise).

An example might be useful here. Suppose that at time, t , both the paper price (F) and the spot price (S) were 20, and at time T – the maturity date – the spot price falls to 10. Because (in theory, and for the most part in practice) at the maturity date spot and the futures prices converge, the loss on physicals is completely offset by the gain on futures: $-10 + 10 = 0$.

But now suppose that country X decides to hedge its entire production. Assuming that X is a large producer, the dramatic increase in the supply of futures would then force down the price of these instruments, as per the analysis in my textbook. Suppose (unrealistically) that it instantaneously forced it down to 15. Then the gain on futures ($= 15 - 10 = 5$) would not offset the loss on physicals ($= 10 - 20 = -10$). This is what some observers claim went wrong with MG although I doubt whether it is this simple. In the numerical example here the market moved from neutral, with $S = F$ to backwardation (or inversion), with $F < S$. This is bad news for a short hedger.

But it would have been good news for MG, since they were hedging long. As bad luck would have it, however, MG’s strategy of rolling its short term long positions forward ran into problems when the futures market went into a sustained contango (with $F > S$). Some question can also be raised as to whether a hedge ratio of unity (with the size of the position in futures equal to the size of the exposure) was wise, but that issue will be left to the experts to mull over, since it is not easy to get right.

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Conclusion

Almost 15 years ago I published a book on oil in which I got most things right; but after that I have generally been wrong about the trend price of oil. Since 1983, I have predicted that it must begin to climb. Instead, until recently, the real price slowly descended.

But, as they say, what goes around comes around. When the rest of the energy people claimed that the oil price had to go up, in the 1970s, I joined them, and stayed on long after they left the chorus line. Now they are joining me. Of course, the trend price will not go up tomorrow, and obviously it would be a good thing for all of us who are on the 'buy' side of the oil scene if it never went up, but the only way that I can see this happening is if the Middle East producing countries come to the conclusion that they prefer less money to more. Frankly, I would be extremely surprised if this took place.

"If we were smart," Richard Rainwater has said, "we would be encouraging OPEC nations to put lots of money in the ground, and would be signing the kinds of long term contracts so that enough oil would be coming on line in 1999, 2000, 2004. And we would be willing to pay higher prices today to guarantee us access to that oil." (This, incidentally, is not the kind of "planning" that Professor Houthakker, and certain others, have in mind.)

Readers of my forthcoming textbook will not have a difficult time finding a similar argument in several chapters; however, I find it hard to believe that a consensus of oil consumers are prepared to accept Mr. Rainwater's approach at face value. Instead, I am afraid that too many people are prepared - even anxious - to believe that new technologies and various financial incentives will enable us to find our oil salvation West of those fascinating Shetlands, beneath the Eiffel Tower or the Via Flaminia, or for that matter on the floor of the New York Mercantile Exchange.

Appendix

Where did Hotelling go wrong? Answer, he didn't; but he failed to complete his algebraic analysis: although he recognized the importance of capital, and mentioned it in a greatly ignored paragraph in his paper, he did not include it in his algebra.

For simplicity, let us consider a two period situation. V represents discounted profit, with ' referring to the first

period, and " referring to the second period. p , q , and c represent price, quantity, and average unit cost for the appropriate period; while R is reserves, P the price of a unit of capital, K the amount of capital, and r the rate of interest. Assume constant returns to scale, and no depreciation. The usual Hotelling results can be obtained by operating (in the usual fashion) on a simple Lagrangian where capital costs are (unfortunately) ignored:

$$L = V'(p, q, c) + V''(p, q, c) + \lambda [R - (q' + q'')]]$$

Here, λ is a multiplier, as are α and β in the following expression, where the need to pay the rental charge each period for the (nondepreciable) production factor capital (K) is explicitly recognized. Our Lagrangian thus becomes:

$$L = V'(p, q, c) + V''(p, q, c) + \lambda [R - (q' + q'')] + \alpha (p' q' - c' q' - rPK) + \beta (p'' q'' - c'' q'' - rPK)$$

Now, if the usual operations are performed, we do *not* end up with the well known (but impotent) expression $\Delta p/p = r$, where p is the *net* price. This matter is further discussed in my textbook, but on an elementary level.

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Conference Proceedings 18th North American Conference San Francisco, California, September 7-10, 1997

The Proceedings from the 18th Annual North American Conference of the USAEE/IAEE held in Boston, MA, are now available from IAEE Headquarters. Entitled *International Energy Markets, Competition and Policy*, the proceedings are available to members for \$75.00 and to nonmembers for \$95.00 (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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O'Brien Named to University of Oklahoma Post

Dennis O'Brien, IAEE Immediate Past President, has accepted the position of director of the Sarkeys Energy Center's Institute for Energy Economics and Policy and the John A. and Donnie Brock Endowed Chair in Energy Economics and Policy, as well as faculty appointments in the University of Oklahoma's Economics Department and the Michael Price College of Business. O'Brien assumed his new position in January.

Under O'Brien's direction, the Institute for Energy Economics and Policy will focus on the global energy industry and its relationship with national and state energy industry issues. The institute will provide leadership and bring together the extensive resources of the university in business, economics and energy sciences to address the key economic, political and social policy issues related to energy. The programs of the institute will focus on the oil and gas industry in the United States and abroad; international policy issues related to regulatory change, privatization and trade; and the important trends in economics and geopolitics which will affect the energy industry. In particular, the institute will focus on important energy relationships in the Middle East, Latin America, Asia-Pacific and their relationship with the United States and Oklahoma.

"Dr. O'Brien's extensive global experience, his knowledge of energy policy and active participation in the business community make him an excellent choice for director of the Institute for Energy Economics and Policy. The Sarkeys Energy Center is extremely pleased and fortunate to be joined by such an outstanding leader in his field," said Dr. W. Darrell "Gus" Gertsch, Director of the Sarkeys Energy Center.

O'Brien has held several distinguished positions throughout his career including that of chief economist and manager, economics department of Caltex Petroleum Corporation. Prior to joining Caltex, O'Brien was the Deputy Assistant Secretary for International Energy Security for the Department of Energy. He also held tenured positions and served on the boards of several universities.

In addition to being the immediate past president of IAEE, O'Brien is also executive director of the Energy Forum of the Pacific Economic Cooperation Council. He has served on several international advisory boards, including: the International Advisory Panel of the East-West Center; the Board of Consultants of the Asia Pacific Energy Publications; member of the board and executive committee of the U.S. National Committee for Pacific Economic Cooperation; and the Council on Foreign Relations in New York.

Following service in the United States Marine Corps, O'Brien completed his education at the University of Nebraska where he earned both his Bachelor and Master of Arts degrees. He earned his Ph.D. at the University of Missouri in 1974.

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Oil Depletion in Islamic Fundamentalist Economic Thinking: The Future Trend?

*By Mamdouh G. Salameh**

During a panel discussion on energy security at the 22nd Annual International Energy Conference in Boulder, Colorado in April 1995, I coined the phrase, "The rise of Islamic Fundamentalism in the Middle East and North Africa is inversely proportional to the price of oil." In this article, I will endeavor to explore the links between the region's oil experience and the surge of Islamic fundamentalism. The salient factors are the sudden rise and subsequent decline of oil revenues by the oil-exporting countries of the region.

Islamic fundamentalism is, in essence, a mass mobilization of people against unpopular and unaccountable governments who have squandered the oil wealth of the Middle Eastern and North African oil-exporting countries through mismanagement of economic resources and excessive and wasteful expenditure on arms purchases. Its main objective is to alter or overthrow the present social and political order.¹

In the 1970s and early 1980s, the Middle East and North Africa appeared to be an economic and social success story. Oil revenues soared and social conditions improved rapidly. In the 1990s, however, the region appears to be sliding towards economic and social failure. Per capita income is falling and social conditions are deteriorating quickly. The Middle East and North Africa now make up the only major region of the world which is unable to feed its rapidly growing population. This has ominous political implications.²

One of the greatest structural economic problems that the oil-producing countries of the Middle East and North Africa have faced since the early 1970s is their overwhelming dependence on oil-export revenues, accounting for 85 to 90 percent of total revenues. They evidently have not managed the transition from oil-based economies into more diversified ones, supplementing oil exports with other sources of income. As oil revenues decline, the governments seem to be running into ever more serious economic difficulties with rising foreign and internal debts and with steadily more severe social strains and potentially ominous political repercussions.

The rise in Islamic fundamentalism in the Middle East and North Africa in the mid-1980s coincided with the fall in oil prices and, therefore, oil revenues. However, Islamic fundamentalism has its roots in mounting conflicts of income distribution, exacerbated by rising social tensions. Oil may have reduced the conflict potential when revenues were rising and subsequently enhanced it when revenues started to fall. This is, perhaps, the major link between oil and Islamic fundamentalism. To this may be added the strong indirect effect of falling oil revenues in oil-exporting countries on the economies of countries such as Jordan, Lebanon, Yemen and Egypt as a result of reduced remittances. Even in 1995, with low oil prices, remittances were about US\$ 90 per capita in

* Mamdouh G. Salameh is an international oil economist, a consultant to The World Bank in Washington and a technical expert of the U.N. Industrial Development Organization in Vienna. He is also a member of the International Institute for Strategic Studies in London.

¹ See footnotes at end of text.

Egypt. This represented about 40 percent of exports or 10 percent of the gross domestic product (GDP) according to the World Bank.³

The question that begs an answer is what impact would an Islamic fundamentalist takeover in the Middle Eastern and North African oil-producing countries have on global oil supplies, the price of oil and the global arms industry, should the Islamic fundamentalist governments decide to reduce their oil depletion rates according to Islamic economic principles?

Islamic Economic Principles

A cardinal principle in Islamic economic thinking is the prohibition of interest (usury). The purpose is to encourage the sharing of risk and profit and to prevent the rise of any rentier class. Participation with risk and profit sharing is the Islamic substitute for the use of interest. Another primary economic principle is the prohibition of waste and idleness. It concerns wasteful consumption, wasteful production and the idleness of productive sources including capital.

Sharing wealth and social justice are two other primary economic principles of Islam. Finally, the responsibility of the state for supervising and controlling the economy is the fifth principle in Islamic economic thinking. Private property and profit have a central position in Islamic economic thinking. The Islamic concept of ownership is pertinent in this respect. Natural resources like oil and gas can be in private ownership but the economic rent must be shared by all members of the community. The Islamic view is that natural resources are a "gift from God" and, therefore, belong to both present and future generations. Hence, exhaustible resources should not be misused by the present generation. The revenues from their exploitation should be invested in other durable sources of income.⁴

However, the two principles which are most relevant to oil depletion policy are the rejection of interest and the prohibition of waste.

Oil Depletion in an Islamic Economic Perspective

Because oil represents the major national asset in the oil-producing countries of the Middle East and North Africa, oil policy is likely to be strongly influenced by Islamic fundamentalist's access to power in these countries. The salient issues are depletion rates and oil revenues. Policy issues on these matters have important economic and political repercussions in the countries concerned and for their relations with the outside world.

The choice of depletion rates for oil is the key policy parameter in any oil-producing country. The choice has to consider the current and future need for revenues.

Because Islam rejects the concept of interest, it is indifferent to the time preference of income. Hence concerns for revenue continuity and future income requirements argue in favor of keeping more oil in the ground than otherwise would have been the case.

Under an Islamic fundamentalist government, Islamic economic principles may become increasingly more important in the Muslim oil-exporting countries. The major issue is the relevance of the Islamic rejection of interest for the time preference of income and oil revenues in particular. This concerns the depletion rates of oil and gas. Another major issue is that the use of oil revenues should respect the prohibition of waste and idleness. To the extent that an

Islamic government prefers to use a negative discount rate to offset the private sector's focus on immediate profits and to take population growth into account, it has strong reasons for leaving oil in the ground. Even with an outlook for constant oil prices, for an Islamic government there might be an economic sense in leaving part of the oil revenues for the future. Contrary to perfectly competitive markets, the oil market is highly sensitive to acts or perceived acts of one of the major oil producers, especially in the matter of oil depletion policy. From a private investor's point of view, this would be a strictly economic consideration. For a government, the consideration is both economic and political.

Generalizations are difficult, however, because the economic situations vary profoundly among Muslim oil-exporting countries. Some countries like Saudi Arabia, Kuwait, Libya and the UAE have large oil reserves and small populations, while others such as Algeria, Egypt and Iran have large populations and relatively small oil reserves.

The Islamist opposition to the Shah of Iran for years criticized his government's oil policy for squandering resources by pumping oil out too quickly and not taking the revenue needs of future generations into account. A further criticism was that oil policy benefited the new technocratic class based in the public sector. Finally, there was a particularly strong criticism that the oil policy benefited the oil-consuming countries of the West, particularly the United States, by pumping oil out quickly and keeping prices low and also splashing out vast amounts of oil revenues on wasteful military expenditure. Similar criticisms are now being voiced by the Islamic fundamentalists in Saudi Arabia and Kuwait.⁵

From an Islamic point of view, an oil-exporting country can apply the rate of marginal utility in depletion policy if it is too small to influence the oil market. It can also do so if the revenues can be successfully invested in new sources of income at home – that is, domestically through industrial investment. Foreign investment makes the oil-exporting country an international rentier. This infringes upon Islamic economic principles.⁶ The exception would be investment on a joint venture basis, sharing risk and profit. However, if the country is sufficiently important to influence the oil market, or oil revenues can't be successfully reinvested domestically in new sources of income, depletion policy should aim to keep oil in the ground. Otherwise, depleting oil to invest abroad represents wasteful production.

According to Islamic economic thinking, oil producers who, through their size, could influence the oil market and the price of oil, have a legitimate right to defend their price interests. Because changes in depletion policy can influence the price of oil in one or the other direction, such action is compatible with Islamic economic principles. The same holds for cooperation among oil producers to defend common interests. Hence cooperation in OPEC is not contrary to Islamic economic principles, especially if it can lead to stability and predictability in the oil market for the benefit of all parties involved.

Oil Revenues in Islamic Economic Thinking

Oil depletion according to revenue targets takes marginal utility explicitly into account. It implies keeping oil in the ground once the ability to reasonably absorb oil revenues has been reached. A minimum rate of return on investment puts

a limit on the need for revenue and consequently oil production. Furthermore, the rate of depletion becomes inversely linked to the price of oil because the volume required to meet the revenue target declines with a rising oil price and rises with a falling one.⁷

Adjusting oil depletion to demographic growth is likewise compatible with Islamic economic principles since it takes future generations' needs into account and seeks to avoid waste.

The requirement is to use the revenues for the transformation of a finite and depletable comparative advantage into a more lasting comparative advantage in international economic relations. Hence, revenue, depletion and productive investment should be linked.⁷

The Oil Cost of Military Expenditure

According to Islamic economic principles, it is wasteful to pump oil out to finance wasteful expenditure. When military expenditure reaches the magnitude that it has reached in the Middle East and North Africa since the early 1970s, it is probably the best single indicator of the wasteful use of public funds.

Over the period 1974-1996, the combined oil exports of the seven leading oil exporters of the region – that is, Algeria, Iran, Iraq, Kuwait, Libya, Saudi Arabia and the UAE – were 140 billion barrels (bb). The total export value of crude oil and refined products, measured in constant 1992 U.S. dollars, was about \$ 3664 billion.⁸ The total government expenditure was about \$ 3318 bn. Military expenditure over the period 1974-96, still measured in constant 1992 U.S. dollars, has been estimated at \$ 1100 bn.⁹ As data on military expenditure are based on less open sources, it is not known what percentage of the military expenditure is included in the overall figures for government expenditure, or whether it should be added. For the seven countries combined, seen over the period 1974-96, military expenditure seems to have taken 30 percent of the oil revenues (see Table 1).

Table 1
Crude Oil Exports, Government Expenditure and Military Expenditure, 1974-96

Country	Oil Exports (Bbn)	Export Value (Bn 1992 U.S. \$)	Govt. Expend. (Bn 1992 U.S. \$)	Military Expend. (Bn 1992 U.S. \$)	Military Expend./Oil Value (Percent)
Algeria	10	246	207	26	11
Iran	22	556	1161	274	49
Iraq	10	304	457	150	49
Kuwait	13	336	155	72	21
Libya	12	340	260	50	15
Saudi Arabia	57	1502	940	490	33
UAE	16	380	138	38	10
Total	140	3664	3318	1100	30

Sources: OPEC Annual Statistical Bulletin, 1994-1996; BP Statistical Review of World Energy, June 1997; International Institute for Strategic Studies' *Military Balance*, 1993-97; The World Bank, *World Tables*, 1992-96.

Without the burden of military expenditure, these oil exporters could alternatively have increased investment in labor-intensive industries, agriculture and public services. This would have improved the welfare of the people. Alternatively, without the wasteful burden of military expenditure, a much improved financial situation would have permitted the

(continued on page 24)

Islamic Fundamentalist Thinking (continued from page 23)

seven major Middle Eastern and North African oil exporters to keep more oil in the ground, hence they would have been more able to constrain supplies to defend oil prices. Indeed, without the extra oil exported above the volumes required to finance civilian needs, the oil market in the 1970s and 1980s could have taken a completely different turn.

For the seven countries, total oil output less that needed to finance military expenditure would have been 98 billion barrels over the period 1974-1996, as opposed to actual oil exports of 140 bb. The saving of 42 bb amounts to an average production of 5.23 million barrels per day (mbd) over the entire period of 22 years. This is virtually equivalent to the combined production of both Mexico and Canada. In this perspective, the huge and wasteful military expenditure of the leading Middle Eastern and North African oil exporters doubly serves outside interests. It directly returns money to arms exporters in the major consuming countries, hence neutralizing part of the oil bill and keeps their armaments industries afloat in the post-Cold War era.

Indeed, one would argue that without the need to sell oil to finance huge military expenditures, it is doubtful whether oil prices would have collapsed in 1986. In the actual course of events, massive and rising military spending by Iran and Iraq preceded and accompanied the oil price collapse of 1986. In the late 1980s and early 1990s, oil prices could have stayed high if Iran, Iraq and Saudi Arabia had kept more oil in the ground instead of pumping it out to finance military spending. Most likely, higher real oil prices would have more than offset reduced export volumes. With less military spending, Iraq's financial situation could have been far better and the attack on Kuwait in 1990 probably would not have taken place.

The first lesson is that the high level of military expenditures in the Middle Eastern and North African countries is detrimental to the economic and social welfare of the population whether seen from an Islamic fundamentalist or a conventional Western perspective. The second lesson is that the major oil-importing countries and their armaments industries have an interest in maintaining rivalry and hostility among the Middle Eastern and North African oil exporters to prevent an agreement on oil quotas and prices. The problem with the Western oil-consuming countries is that in relation to these countries, oil and arms interests tend to drive them to compromise their long-term interests for short-term gains. Against this backdrop, there could be a potential risk of confrontation between the West and future fundamentalist regimes in the Middle East and North Africa over oil policy.

In conclusion, a thorough application of Islamic economic principles with regard to oil depletion rates and the use of oil revenues could have an enormously positive impact on the economies of the Middle Eastern and North African oil exporters by stopping the squandering of oil reserves on wasteful military expenditure and also by taking into account the health of the oilfields and the revenue needs of future generations. This will also impact global oil supplies, the price of oil and the global industry.

However, I hasten to add that any democratically-elected government in the Middle East and North Africa could apply similar depletion policies whether they are labeled Islamic or not to protect the nation's assets and pursue an oil policy

favorable to the welfare of its people and future economic development of the country.

Footnotes

¹ Mamdouh G. Salameh, "The Price of Oil and the Future of the Saudi Monarchy". IAEE's *Newsletter*, Spring 1996, p-12.

² Oystein Noreng, "Oil & Islam: Social & Economic Issues" (Chichester, England: John Wiley & Sons, 1997, pp. 1-3.

³ The World Bank, *World Tables*, 1995 & 1996.

⁴ Oystein Noreng, "Oil & Islam". pp. 104- 110.

⁵ Sheikh Ahmed Zaki Yamani, "Containment is too Risky", *Petroleum Review*, May 1997, p. 211.

⁶ Oystein Noreng, "Oil & Islam" p. 310.

⁷ *Ibid.*, p. 310.

⁸ Data from OPEC Statistical Bulletins, 1994-1996 and also *BP Statistical Review of World Energy*, June 1997.

⁹ The International Institute for Strategic Studies' (IISS's) *Military Balance*, 1993-1997.

Letters to the Editor

In M. G. Salameh's article (*Crude Oil Prices on an Upward Trend?*, Summer, 1997 issue) Table 2 gives me as source for the "cost of maintaining capacity" for Iraq, Libya and Iran: respectively \$160, \$300 and \$200 per daily barrel. No reference. In my *Genie Out of the Bottle* (1995), page 264, one can read my actual estimates: \$180, Not Available and \$1475. So his respective errors are: 12 percent, infinity and 640 percent. He does not explain how he separates newly created capacity into the part which is offset by decline and the part which is not offset. If he did so, he could go on to explain why he thinks unit investment to expand exceeds unit investment to maintain by a factor of 6 or of 33 or of 40.

Morris A. Adelman
MIT

Salameh responds:

The figures I quoted in Table 2 of my article for the "Cost of maintaining capacity" for Iraq, Libya and Iran: respectively \$160, \$300 and \$200 per daily barrel of output (\$/db) are rough and ready estimates gleaned from a variety of sources. These include various issues of *Middle East Economic Survey (MEES)* and *Petroleum Intelligence Weekly (PIW)*, but especially Gault and Hartshore in *MEES* (17/8/92) and Dr. Henry Azzam's (Chief Economist of the National Commercial Bank of Saudi Arabia) in *MEES* (1/2/93) and *Energy Compass* (29/1/93); also estimates of fully-built-up costs of capacity expansion by the Center for Global Energy Studies (CGES) in London and also Professor Adelman, MIT, prior to the publication of his book *Genie Out of the Bottle* (1995), hence, the variation from his actual estimates of \$180, not available and \$1475.

The estimated average cost of maintaining capacity in the OPEC countries is \$229 per daily barrel of output compared to Iraq's \$160, Libya's \$300 and Iran's \$200. On the other hand, the average estimated cost of expanding capacity over the period 1996-2000 for OPEC is \$7462 per peak daily barrel (\$pdb). Thus the average unit investment to expand capacity exceeds the average unit investment to maintain capacity by a factor of 33. This compares with a factor of 33 for Libya, 40 for Iran, 6 for Iraq and 27 for Saudi Arabia.

Estimating the cost per peak daily barrel of new capacity

is, of course, easier said than done, because of the confusion that abounds in the literature about whether "gross" or "net" capacity increases are being discussed. When an entirely new oil field is being considered, the capacity increase resulting from exploitation of the field is both "gross" and "net" - there is no distinction between the two. However, when the production capacity of an existing oil field is to be boosted, then one needs to differentiate between the investment need simply to maintain capacity at current levels and the spending needed to boost capacity. Producing oil fields decline as a matter of course, which implies that a distinction needs to be drawn between gross capacity increases and net increases, i.e., after taking into account the natural rate of decline of the oil fields. The associated capital costs per peak daily barrel are also separated into two categories - those needed to maintain capacity and those needed to add to capacity.

In order to calculate the incremental yield (or capacity added to offset reservoir declines), we must determine the gross capacity increase in each year, which consists of two parts. The first component is any increase in total output, which is easily observed. The second component is the additional capacity that must be installed to offset reservoir decline. That decline is primarily the result of the steady drop in bottom-hole pressures as reservoirs are depleted which can only be inferred - it can't be directly observed or measured. This component of the capacity addition, even though very important, must be estimated using an assumed value for the reservoir decline rate since empirical data on decline rates are rare. The assumed decline rates are 5 percent for major producers in the Gulf.

My estimates for the cost of maintaining and expanding capacity in Iraq, Libya and Iran have taken into account the average rate of decline of the oil fields and have also made a differentiation between investment needed simply to maintain capacity at current levels and the spending needed to boost capacity, hence the excess of unit investment to expand over the unit investment to maintain capacity by a factor of 6, 33 and 40 for Iraq, Libya and Iran respectively.

Mamdouh G. Salameh
Oil Market Consultancy Service

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The Potential for Use of Modern Asset Pricing Methods for Upstream Petroleum Project Evaluation

Guest Editor David Laughton (University of Alberta)

Written by a coalition of scholars and active industry consultants, this edition of the Journal describes the latest developments in modern asset pricing (MAP) for use in upstream petroleum project evaluation. MAP was initially developed for application in derivative securities markets, where it is now widely used. The importance of this was recognized by the award of the 1997 Nobel Prize in Economics. When applied to project evaluation, MAP offers an alternative that mitigates many of the problems that organizations face when they depend on traditional discounted cash-flow (DCF) methods for financial analysis.

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1998 - The Restructuring Process Unfolds

By Fereidoon P. Sioshansi*

A hundred years from now, 1998 will be remembered as the year when it all began. Starting with California, by far the most populous state in the Union, down to Rhode Island, the smallest of the lot, industry restructuring is beginning to unfold around the United States. By the time the new millennium comes around, it will be the norm, not the exception, as other states follow suit. And as was the case with telecommunications (which closely resembles the electric power industry in a number of ways), competition will bring significant savings to some while massive, unnecessary confusion to others.

Competition is choice and having a choice is what Americans love, be it in renting a car or buying a soft drink. But will electricity prove to be a difficult and boring thing to shop for? Will enough people know how to do it or care enough to exercise their options? Will anybody switch suppliers given the admittedly small savings for the average consumer, the perception of risk, and the hassle factor involved? In the last issue of the *EEnergy Informer*, we asked "Who Will Switch Suppliers For A Measly 2-5% Savings?", referring to the typical savings expected in California. At the time of this writing, we don't have a clue, state regulators (in California) don't know either, and those who do are not talking. An \$89 million public education and information campaign in California has so far generated mostly yawns. Some 23,000 calls were received at a toll free number by mid-December from bewildered customers, most of whom only wanted to know how much their electric bills would drop?

But the 200 retailers and over 35 aggregators who have so far flocked to California from everywhere do not seem to be discouraged. They have been busy trying to sign up customers starting in November, and will be able to switch them over starting January 1, 1998. The incumbents are not sitting idle either. They have been reminding customers that they took good care of them all these years, encouraging them to hang around with them.

Most small customers are likely to do nothing, in which case they will remain with the incumbents who will buy electricity from the power exchange at prevailing prices and pass it on to them. This default provision is not a bad one for all but the most savvy and sophisticated of customers. As was pointed out in another *EEnergy Informer* article ("Will Competing Retailers Be Able To Beat The PX's Price?" October '97), it will be hard to beat the power exchange's price unless you are considered special or among a select group of customers in which case you may be offered a special deal (see below).

How Can Montana Power Offer Such a Good Deal?

California Manufacturers Association (CMA) is not your average lobbying group. Its 1000 plus members include well known giants such as Intel and Chevron who collectively run electricity bills on the order of \$300 million annually.

*Fereidoon P. Sioshansi edits and publishes the *EEnergy Informer*, a monthly newsletter focused on the North American electric power industry. This is an edited version of the article which appeared in the January 1998 issue.

During the California's drawn-out political debate on how to restructure the electric power industry, CMA showed its muscle on numerous occasions. Now, it has pulled off another major coup for its members: the option to sign with an eager power marketer who is willing to offer standard two-year contracts at 8 percent below the power exchanges (PX) prevailing prices.

After checking out several other bidders including the state's two big utilities, PG&E. Corp and Edison International, CMA announced in early November that it has selected to go with Montana Power Trading & Marketing Co., the marketing subsidiary of Montana Power. Montana Power? What are they doing in California? And how can they beat the PX's price by 8 percent?

The former question is easier to answer than the latter. Montana Power, like many other power marketers wants a foot in the California's market to learn first-hand, to gain some exposure, and to test the market. Without the clout and the advertising budget of the likes of Enron and Southern Co. how can a small company get in the door? By offering a steal of a price. And that appears to be what Montana Power has pulled off with its incredible offer. Frank Rotondi, President of Montana Power put it bluntly when he said "It's an excellent point of entry into the market."

CMA members are not obliged to buy, but they have the right to do so - and it would seem stupid for them to decline the opportunity. Montana Power also offers longer term contracts with a variety of risk-managed options. William Campbell, President of CMA was delighted taking special pleasure in pointing out that Montana's offer was selected over less attractive offers by the two California-based utilities. In an interview with *The Wall Street Journal* (3 November 1997), he was quoted as saying, "I think if they (PG&E and Edison) want to survive in this new market, they're going to have to be as aggressive. I think this (i.e., the Montana deal) is going to spur them on." Maybe yes, and maybe no.

But how can Montana Power offer such a good deal while the local utilities with all their might and muscle can't? We put this question to a savvy power marketer who is in a position to know. His answer: "I don't have a clue how they can pull this off." His guess was that Montana Power may very well lose money on this deal. Perhaps it is a loss-leader, using the marketing industry jargon. Gaining market share in a crowded market is not an easy task. Perhaps PG&E and Edison were smart not to underbid Montana Power's fantastic offer.

Publications

Journal of Energy & Natural Resources Law, (Quarterly Journal). Price: £192. Contact: Order Department, Kluwer Law International, Distribution Centre, PO Box 322, 3300 AH Dordrecht, The Netherlands. Phone: 31-78-654-6454. Fax: 31-78-654-6474.

Economic Policy and Climate Change, Paul Koutstaal (1997). 192 pages. Price: \$80.00. Contact: Katy Wight, Edward Elgar Publishing, Inc., 6 Market Street, Northampton, MA 01060. Phone: 413-584-5551. Fax: 413-584-9933. E-mail: kwight@elgar.com

The Future Energy Utility Company. Price: \$560.00. Contact: FT Energy Asia Pacific, 159 Telok Ayer Street, Singapore 068614. Phone: 65-323-6373. Fax: 65-323-5262. E-mail: ftenergy@pearson-pro.com.sg

1998 World LNG Directory. Contact: Zeus Development Corporation, 2424 Wilcrest, Suite 240, Houston, TX 77042.

Phone: 713-952-9500, ext. 706. Fax: 713-952-9526. E-mail: wcasso@lngexpress.com

The Climate Change Treaty: How is Kyoto Changing the Legislative Debate in 1998? Price: \$29.00. Contact: EESI Publishing, 122 C Street, NW, #700, Washington, DC 20001. Phone: 202-628-6500. Fax: 202-628-1825.

History and Overview of Solar Heat Technologies (1997). Price: \$37.50. Contact: MIT Press, 5 Cambridge Center, Cambridge, MA 02142-1493. Phone: 617-356-0343. Fax: 617-625-6660. E-mail: mitpress-orders@mit.edu

Energy Statistics Yearbook (1995). 486pp. Price: \$100.00. Contact: United Nations Publications, Sales and Marketing Section, Room DC2-0853, Dept. D041, New York, NY 10017. Phone: 212-963-8302. Fax: 212-963-3489. E-mail: publications@un.org

Environment & Energy Wrap-up Report: 105th Congress, First Session. Price: \$39.00. Contact: EESI Publishing, 122 C Street, NW, #700, Washington, DC 20001. Phone: 202-628-6500. Fax: 202-628-1825.

Electric Utility Planning and Regulation. Price: \$27.00. Contact: American Council for an Energy-Efficient Economy, 1001 Connecticut Avenue, NW, Suite 801, Washington, DC 20036. Phone: 202-429-0063. Fax: 202-429-0193. E-mail: ace3pubs@ix.netcom.com

Natural Gas Potential in Canada. Price: \$147.50. Contact: Canadian Gas Potential Committee, PO Box 20032, Bow Valley Square, Calgary, Alberta, T2P 4H3, Canada.

Resource and Energy Economics. Price: \$417.00 / NLG 725. Contact: <http://www.elsevier.com/locate/reseneeco> for further details on ordering.

Energy Economics. Price: \$526.00 / NLG 915. Contact: <http://www.elsevier.com/locate/eneco> for further details on ordering.

Calendar

23-24 February 1998, CERI's 1998 North American Natural Gas Conference and Calgary GasExpo '98. Calgary Convention Centre, Calgary, Alberta, Canada. Contact: CERI, Suite 150, 3512-33 Street, NW, Calgary, AB, Canada T2L 2A6. Phone 403-282-1231. Fax: 403-289-2344. E-mail: ceri@ceri.ca

4-6 March 1998, Centre for Global Energy Studies, Second Latin American Energy Conference. Inter-Continental Hotel, Miami, Florida, USA. Gas, Power and Regulation in Latin America from State monopoly to private investment. Contact: Phone: 44-171-704-6161. Fax: 44-171-704-8440

5 March, 1998, World Energy Efficiency Day. Austria. Contact: O.O. Energiesparverband, Landstrasse 45, A-4020 Linz, Austria. Phone: 43-732-6584-4380. Fax: 43-732-6584-4383. E-mail: esvl@esv.or.at

11-12 March, 1998, The South American Natural Gas Summit. Hotel Inter-Continental, Rio de Janeiro. Contact: Alex Daniel, The Conference Desk, First Conferences, 5th Floor, 85 Clerkenwell Road, London EC1R 5AR, England. Phone: 44-171-404-7722. Fax: 44-171-404-7733. E-mail: confdesk@firstconf.com

15-17 March, 1998, Middle East Petroleum & Gas Conference. Le Meridien Dubai. Contact: Conference Connection Inc., PO Box 1736, Singapore 911758. Phone: 65-356-0960. Fax: 65-356-0962. E-mail: cconnect@pacific.net.sg

17-18 March, 1998, European Gas '98. Conrad International, Brussels. Contact: Flame Conference Administrator, ICBI, 8th Floor, 29 Bressenden Place, London SW1E 5DR, UK. Phone: 44-171-915-5103.

18-19 March, 1999, Middle East Jetfuels Conference. Le Meridien Dubai. Contact: Conference Connection Inc., PO Box 1736, Singapore 911758. Phone: 65-356-0960. Fax: 65-356-0962. E-mail: cconnect@pacific.net.sg

19-20 March, 1998, Successfully Developing Private Energy in Brazil. Wyndham Miami Biscayne Bay, Miami, Florida. Contact: Center for Business Intelligence, 500 West Cummings Park, Ste. 5100, Woburn, MA 01801. Phone: 781-929-2438. Fax: 781-939-2490. E-mail: registrar@cbinet.com

14-17 April 1998, 4th Annual North American Power Market Conference & Trade Fair & 7th Annual North American Natural Gas Market Conference & Trade Fair. Toronto, Canada. Contact: Enerdata, Ltd., Suite 304, 100 Allstate Pkwy., Markham, Ontario L3R 6H3, Canada. Phone: 905-470-0117. Fax: 905-479-2515.

19-22 April 1998, After Kyoto: Implications for Energy Demand and Policy Choice and Central Asian Economic Outlook: Priorities and Opportunities. Boulder, Colorado. Contact: Dr. Dorothea H. El Mallakh, Director, International Research Center for Energy & Economic Development, 909 14th Street, Suite 201, Boulder, CO 80302. Phone: 303-492-7667. Fax: 303-442-5042.

24-24 April 1998, Third Annual Gas & Electricity Trading Summit. Doubletree Hotel, Houston, Texas. Contact: Global Change Associates. Phone: 914-949-6798. Fax: 914-948-5301. E-mail: 76111.424@compuserve.com

27-28 April 1998, Centre for Global Energy Studies, CGES Eighth Annual Conference. Inter-Continental Hotel, London, England. Oil and Gas Investment in Asia: The Engine of Growth. Contact: Phone: 44-171-704-6161. Fax: 44-171-704-8440

29-30 April 1998, 1998 Utility Strategic Marketing Conference. Orlando, Florida, USA. Contact: June Appel. Phone: 610-667-2160. Fax: 610-353-8897. E-mail: appelj@earthlink.com

13-16 May 1998, 21st IAEE International Conference. Quebec City, Canada. Contact: IAEE Headquarters, 28790 Chagrin Blvd., Ste. 350, Cleveland, OH 44122. Phone: 216-464-5365. Fax: 216-464-2737. E-Mail: iaee@iaee.org URL: www.iaee.org

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Conference Proceedings

19th IAEE International Conference Budapest, Hungary, May 27-30, 1996

The Proceedings from the 19th International Conference of the IAEE held in Budapest, Hungary, are now available from IAEE Headquarters. Entitled *Global Energy Transitions, with Emphasis on the Last Five Years of the Century*, 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: Order Department, IAEE Headquarters, 28790 Chagrin Blvd., Suite 350 Cleveland, OH 44122, USA

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Total enclosed \$ _____ Check must be in U.S. dollars and drawn on a U.S. bank, payable to IAEE.

Calendar (continued from page 27)

18-19 May 1998, Energy '98: Future Look: The Energy Map of Latin America 1998-2005. La Jolla, CA. Contact: Institute of the Americas, 10111 North Torrey Pines Rd., La Jolla, CA 92037. Phone: 619-453-5560. Fax: 619-453-2165.

8-11 June 1998, PQA '98 North America: Power Quality in a Competitive Advantage. Phoenix, AZ. Contact: Megan Boyd, EPRI, 3412 Hillview Avenue, Palo Alto, CA 94304. Phone: 650-855-7979. Fax: 650-855-2166. E-mail: mboyd@epri.com

8-11 June 1998, 9th Global Warming International Conference & Expo. Hong Kong University of Science & Technology. Contact: Dr. Sinyan Shen, Chair, International Program Committee, Global Warming International Center, PO Box 5275, Woodridge, IL 60517-0275. Phone: 630-910-1551. Fax: 630-910-1561.

14-18 June 1998, National Energy Conference CNE'98: Energy for Tomorrow - Reconciliation of Efficiency and Competitiveness with the Sustainable Development. Neptun, Romania. Contact: Mrs. Ella Ratu, CNE'98 General Secretariat, 8 Energeticienilor Blvd., 79619 Bucharest 3, Romania. Phone: 401-321-4465. Fax: 401-321-1010. E-mail: srai@mail.gsci.vsat.ro

17-19 June 1998, EPRI's 1998 Innovative Approaches to Electricity Pricing Conference: Pricing in the Competitive Business Environment. Washington, DC, USA. Contact: Ms. Lori Adams, EPRI, 3412 Hillview Avenue, Palo Alto, CA 94304-1395. Phone: 415-855-8763. Fax: 415-855-2041.

9-10 September 1998, Energy Markets: What's New? Berlin, Germany. Contact: Georg Erdmann, Conference Chairman, Technical University TA8, D-10587 Berlin, Germany. Fax: 49-30-314-269-08.

13-18 September 1998, 17th Congress of the World Energy Council. Houston, Texas. Contact: United States Energy Association, 1620 Eye Street, N.W., Suite 1000, Washington, DC 20006. Phone: 202-331-0415. Fax: 202-331-0418. (<http://www.wec98congress.org>)

4-8 October 1998, BioEnergy '98 Conference: Expanding Bioenergy Partnerships. Madison, Wisconsin, USA. Contact: Fred Kuzel, Council of Great Lakes Governors, 35 E. Wacker Dr., Ste. 1850, Chicago, IL 60601. Phone: 312-407-0177. E-mail: fkuzel@cglg.org

18-21 October 1998, USAEE/IAEE 19th North American Conference. "Technology's Critical Role in Energy & Environmental Markets." Albuquerque, New Mexico, USA. Contact: USAEE/IAEE Headquarters, 28790 Chagrin Blvd., Ste. 350, Cleveland, OH 44122. Phone: 216-464-2785. Fax: 216-464-2768. E-Mail: iaee@iaee.org URL: www.iaee.org

19 October 1998, SNS Energy Day 1998: Taxation of Energy in an Increasingly Interdependent World. Stockholm, Sweden. Contact: Susanne Rothschild-Lundin, SNS Energy, PO Box 5629, 114 86 Stockholm Sweden. Phone: 46-8-453-99-50. Fax: 46-8-20-50-41.

27-29 October 1998, Power Mart 1998: Conference & Exhibition. Houston Astrohalla, Houston, TX. Contact: Pasha Publications, 13111 Northwest Fwy., Ste. 520, Houston, TX 77040. Fax: 713-460-9150.

9-11 November 1998, PQA '98 Southern Hemisphere: Power Quality in a Competitive Environment. Cape Town, South Africa. Contact: Marsha Grossman, EPRI, 3412 Hillview Avenue, Palo Alto, CA 94304. Phone: 650-855-2899. Fax: 650-855-8576. E-mail: mgrossma@epri.com

19-21 November 1998, 7th International Energy Conference and Exhibition - ENERGEX '98, Manama, Bahrain. Contact: Dr. W.E. Alnaser, Conference Secretariat, Dean, Scientific Research, University of Bahrain, PO Box 32038, Bahrain. Phone: 973-688381. Fax: 973-688396. E-mail: EA607@isa.cc.uob.bh

9-12 June 1999, 22nd IAEE International Conference. Rome, Italy. Contact: IAEE Headquarters, 28790 Chagrin Blvd., Ste. 350, Cleveland, OH 44122. Phone: 216-464-5365. Fax: 216-464-2737. E-Mail: iaee@iaee.org URL: www.iaee.org

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Contributing Editors: *Paul McArdle* (North America), Economist, US Department of Energy, Office of Policy, Planning and Analysis, PE-50, Washington, DC 20585, USA. Tel: 202-586-4445; Fax 202-586-4447. *Tony Scanlan* (Eastern Europe), 37 Woodville Gardens, London W5 2LL, UK. Tel 44-81 997 3707; Fax 44-81 566 7674. *Marshall Thomas* (Industry) 3 Ortley Avenue, Lavallette, NJ 08735, USA Tel 908-793-1122; Fax: 908-793-3103.

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