IAEE INTERNATIONAL ASSOCIATION FOR ENERGY ECONOMICS

IAEE Newsletter

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First Quarter 2003

President's Message

Greetings to all friends and colleagues! I wish everyone the best for this New Year. I am pleased and proud to be serving as your president, at a time when IAEE can do so much to contribute knowledge and information to the world of energy. For, of course, these are challenging times. Energy has always mirrored larger world events and issues, and once again we find ourselves facing the myriad of complex and familiar questions of supply security and how best to foster producer and consumer dialogue.

It was in challenging times like these that IAEE was formed. For those of us who have grown in our careers and professions as IAEE evolved, we have a particular duty and responsibility to inform our younger colleagues from our experiences. For those of you who are new members, and who come to IAEE with youth and vigor, you have a particular duty and responsibility to become more involved in our discipline, improve our knowledge base, offer fresh ideas and approaches, and help us ensure that all of our public audiences are as well educated on energy matters as they can possibly be.

I have three goals for myself during my turn as president. I hope you will share these goals with me and join in the effort.

1. To continue to make IAEE as visible and useful as we can be throughout this year and beyond.

Your Council members have worked hard to establish new avenues for IAEE outreach in education, through our student scholars, members, and Council representatives, and the public domain, in particular through the Internet. Our conferences have always been our most important forums for discussion, debate, and communication. Our upcoming conference in Prague June 4-7 – in the Czech Republic, where so much change has taken place – offers a wonderful platform to the world. Following Prague, we have yet another, and new, venue for IAEE in Mexico City, October 19-21. Mexico will host the North American meeting, organized by the U.S., Canada and Mexican affiliates. This will cement, after the Vancouver conference last fall, a long time goal of having the North American conference truly embrace all dimensions of energy on that continent. In the years ahead, we look forward to IAEE conferences in Tehran, April 30-May 2, 2004, and Taipei, April 19-23, 2005.

IAEE council representatives traveled to Tehran and Taipei last November and December to help the local organizers begin to build their programs. For myself, I had the opportunity to experience the warmth and hospitality all of you will enjoy in Taiwan in 2005. In this issue of our newsletter you can share, vicariously, in our tour of Taipei and our participation in the Chinese (Taipei) Association for Energy Economics annual conference.

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Editor's Notes

Leonard Coburn provides an historical look at the concept of Energy Security in the United States. He begins in the 1950s when reliance on oil imports presented no immediate threat and comes up to the present, noting that the term *Energy Security* first appeared in the Carter second energy policy report and that it was not until 1981 that there was a separate chapter on *Energy Security* in Administration policies.

Pablo Mulás and Gerardo Bazan review the Mexican energy picture noting its mixed growth in the last few years as the electricity sector has shown steady growth while the oil and gas sectors have been up and down. They summarize the 1992 Mexican energy reforms, comment on the 1999 reform proposals and discuss President Fox's reform attempts.

André Plourde argues that the Canada-U.S. energy relationship is especially important to Canada since the United States currently provides the only commercially viable export market for that country's energy production. From that vantage point, he examines issues and challenges facing this relationship, and explores possible consequences of Mexico becoming a full participant in the North American energy marketplace.

Paul Tempest discusses the World Economic Forum's project to develop a *National Competitiveness Balance Sheet*

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President's Message *(continued from page 1)*

2. To continue to encourage the concepts of producer-consumer dialogue and information transparency that were part of our founding principles.

We can't meet the challenges of the world today and tomorrow unless we continue to foster and enrich the critical dialogue that makes global energy markets work. This dialogue comprises companies and customers, producing countries and those who import from them, and networks within each arena. Many of us engage in research and distribution of data and other information that decision makers rely on. The work we all do and present at our conferences and publish through *The Energy Journal* and newsletter, as well as in other industry and academic journals, gets wide distribution and reflects the state of the discipline. It's up to us to be the best that we can be.

3. To continue to encourage expansion of the IAEE network worldwide.

One of the rewards of being active and involved in our organization is the chance to work with colleagues around the world who are building new affiliates, reinvigorating established ones, and using IAEE to help advance the energy knowledge base in their countries. Of all the things we can do as professionals, through IAEE, this is perhaps most critical. Again, our conferences can serve as the main arteries for this activity. But we have new assets to deploy in support of our affiliates through the new dynamism of the IAEE Web site and our student activities, as well as our established assets of *The Energy Journal* and our newsletter. Looking ahead, we have possibilities for affiliates based in Hong Kong and Central and South America. We are looking for ways to enhance our support of existing affiliates, and the best possible way is for all of us as members to participate, whenever we can, in our own national affiliates and chapters.

These are not small goals, but I have safety in numbers! IAEE is stronger than we have ever been, both financially and in membership, and well-positioned for the demands and opportunities that lie ahead. I look forward to serving you and our organization.

Michelle Foss

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

for each nation-state as well as *The Arab World Competitiveness Report* covering the 22 Arab League member governments. He notes the difficulties involved, though he feels the exercise has been very valuable in shedding new light on the mechanics of economic growth and the differing relative strengths of regions and individual states.

Tor Arnt Johnsen describes the Norwegian and Nordic electricity markets and discusses how a dominant hydropower generator may apply market power to its benefit. He discusses redistribution of output over the day and season and notes that while there are no clear signs of market power in Norwegian market today, increased concentration, should it occur, could lead to higher prices in the future.

Hoesung Lee acknowledges that Korea is one of the larger emitters of greenhouse gases in the world. He then describes the policy actions Korea is taking or expects to take to improve energy and materials efficiency in the various sectors of its economy thereby reducing GHGs. However, he notes that these actions are old energy policy repackaged and labeled as climate change policy. Unfortunately new initiatives are few.

Rong-I Wu reviews energy development in Taiwan and then looks at economic development in Taiwan and its impact on Taiwanese energy development. He notes that Taiwanese economic development is influenced by globalization, the knowledge economy, industrial transition and sustainable development. Finally, he looks at the future prospects for energy development in Taiwan within the framework of energy systems transitions worldwide.

Gholamhossein Hassantash traces estimates of Iraqi oil reserves and raises some questions regarding the current figures. Is there less there than generally thought?

DLW

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PRAGUE IAEE CONFERENCE STUDENT SCHOLARSHIPS AVAILABLE

IAEE is offering a limited number of student scholarships to the 26th IAEE International Conference. Any student applying to receive scholarship funds should:

1) Submit a letter stating that you are a full-time student and are not employed full-time. The letter should briefly describe your energy interests and tell what you hope to accomplish by attending the conference. The letter should also provide the name and contact information for your main faculty supervisor or your department chair, and should include a copy of your student identification card.
2) Submit a brief letter from a faculty member, preferably your main faculty supervisor, indicating your research interests, the nature of your academic program, and your academic progress. The faculty member should state whether he or she recommends that you be awarded the scholarship funds.

IAEE scholarship funds will be used to cover the conference registration fees for the Prague IAEE International Conference. All travel (air/ground) and hotel accommodations, meal costs (in addition to conference-provided meals), etc., will be the responsibility of each individual recipient of scholarship funds.

Completed applications should be submitted to IAEE Headquarters office no later than May 6, 2003 for consideration. Please mail to: David L. Williams, Executive Director, IAEE, 28790 Chagrin Blvd., Suite 350, Cleveland, OH 44122.

Students who do not wish to apply for scholarship funds may also attend the conference at the reduced student registration fee. Please respond to item #1 above to qualify for this special reduced registration rate. Please note that IAEE reserves the right to verify student status in accepting reduced registration fees.

If you have any further questions regarding IAEE's scholarship program, please do not hesitate to contact David Williams, IAEE Executive Director, at 216-464-2785 or via e-mail at: iaee@iaee.org

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

New Challenges for Energy Decision Makers

26th IAEE International Conference – June 4-7, 2003
Prague, Czech Republic – Dorint Don Giovanni Hotel
Hosted by the Czech Association for Energy Economics

If you're concerned about the future of the energy industry and profession, this is one meeting you surely don't want to miss. The 24th IAEE International Conference will detail current developments within the energy industry so that you come away with a better sense of energy supply, demand, security and policy. Some of the major conference themes and topics are as follows:

Prospects for Global Energy Markets
Sustainable Development in Energy Context
Ethics in Energy Companies
Law and Energy Economics
Europe and the U.S.: Rethinking Energy Security
Energy Market Design: Experiences and Issues
Renewable Energy: Enhancing Long Term Security
Oil & Gas: Frontier Issues
Efficiency and Regulation of Electricity and Gas Distribution Companies

Volatile fuel prices, market restructuring, globalization, privatization and regulatory reform are having significant impacts on energy markets throughout the world. Most major energy industries are restructuring through mergers, acquisitions, unbundling and rebundling of energy and other services. This conference will provide a forum for discussion of the constantly changing structure of the energy industries.

At this time, confirmed speakers include the following:

Arnold B. Baker, Sandia National Laboratories
Lars Bergmann, Stockholm School of Economics
John Brodman, U.S. Department of Energy
Alfred John Boulos, Boulos International
Mary-Ellen Boyle, Clark University
J. Christensen, RISO National Lab., Denmark
Robert Eagan, Sandia National Laboratories
Robert Ebel, Center for Strategic & Int'l Studies
Jean-Pierre Favennec, IFP-ENSPM
Massimo Filippini, University of Lugano
Marie Fagan, Int'l Human Resources Devel. Corp.
Herman Franssen, Petroleum Economics Ltd.
Michael Grubb, Imperial College, London
Einar Hope, Norwegian Sch. of Econ. & Bus. Admin.
Tooraj Jamasb, University of Cambridge
Andrei Konoplyanik, Energy Charter Secretariat
Hoesung Lee, Council on Energy & Environment, Korea
Sang-Gon Lee, Korea Energy Economics Institute
Johannes Maters, European Commission, DG TREN
Charles McPherson, World Bank Group
John Mogford, BP, Plc.
Poul Erik Morthorst, RISO National Laboratory
Mohan Munasinghe, Munasinghe Inst for Development
Shirley Neff, Energy & Natural Res. Comm, US Senate
David Newbery, University of Cambridge
Willy Olsen, Statoil
Anthony Owen, University of NSW, Australia
Miroslav Pise, EON
Robert Rios-Herran, Legal Advisor
Yoshihiro Sakamoto, Institute of Energy Economics, Japan
Jiri Schwarz, Liberal Institute, Czech Republic
Matthew R. Simmons, Simmons & Company Int'l
Vito Stagliano, Calpine
Nils von Hinten-Reed, CapAnalysis (Europe)
Frank Wolak, Stanford University

Keynote luncheon and dinner presentations will be given by Joseph A. Stanislaw, President, Cambridge Energy Research Associates; Miroslav Pise, Mgr., EON Bohemia Office and Jeremy Leggett, Chief Executive, Solar Century.

We are very pleased to announce that over 260 abstracts have been received for presentation consideration. To the best of our knowledge this is the strongest response for abstracts in IAEE's history. Given this fact, we have extended the conference an extra half day on Saturday, 7 June. We are very pleased with this program extension which will allow for more speakers to present their papers. We have 35 concurrent sessions lined-up along with 5 separate poster sessions planned to address timely topics that effect all of us specializing in the field of energy economics.

Prague is a beautiful destination to meet and very affordable. Single nights at the Dorint Don Giovanni Hotel are EURO 151. Contact Denisa Havlik at the Dorint Hotel (denisa.havlik@dorinthotels.cz) or fax +420-2-6703-6704 to make reservations. Conference registration fees are $570.00 for IAEE members and $670.00 for non-members.

For further information on this conference, please fill out the form below and return to IAEE Headquarters.

New Challenges for Energy Decision Makers
26th IAEE International Conference

Please send further information on the subject checked below regarding the June 4-7, 2003 IAEE Conference.

_____ Registration Information _____ Sponsorship Information ____ Accommodation Information

NAME: _____
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COUNTRY: _____ Email: _____ Phone: _____

IAEE Conference Headquarters, 28790 Chagrin Blvd., Suite 350, Cleveland, OH 44122 USA
Phone: 216-464-5365 Fax: 216-464-2785 Email: iaee@iaee.org
Visit the conference on-line at: http://www.iaee.org/en/conferences

Energy Security: Is the Past Prologue?

*By Leonard L. Coburn**

My objective here is to provide an historical look at the concept of Energy Security; why it became a focus of our energy policy and what we have said about it during the past decades.

Energy Security in the modern era probably starts with the decision by Winston Churchill before the start of World War I to change the fuel of the British navy from coal to oil. Coal was a domestic fuel, while at that time the UK did not produce oil. This led to a search for a stable supply of oil and led to the British government's intervention in Iran in order to develop its oil supplies to ensure a stable supply of oil for the British navy. (See Yergin, The Prize)

U.S. reliance on imports increased in the 1950s and early 1960s, but primarily from Canada and Venezuela. It was only by the end of the 1960s that the U.S. was importing significant quantities of oil from the Middle East and North Africa.

Reliance on oil imports in the 1950s-1960s presented no immediate threat to the U.S. (Or the remainder of the industrialized countries), because the oil was controlled and owned by the international oil companies – Seven Sisters.

The increasing import dependence of industrial states might not have become a vulnerability if the control of oil remained as it was in 1953.

What changed? Political and military domination by French-Anglo-American governments and companies waned; formation of OPEC in 1960 to counter major oil company control over pricing and production policies; development of independent oil companies undercut domination of the Seven Sisters.

1955

The increase of oil imports beyond the current percentage – 10 percent of domestic production – had an impact on the "domestic fuels situation" as being "seriously impaired", although the eventual language of a report on the situation was watered down to say that "the domestic fuels situation could be so impaired as to endanger the orderly industrial growth which assures the military and civilian supplies and reserves that are necessary to national defense. There would be an inadequate incentive for exploration and the discovery of new sources of supply."

Moreover, the national security debate focused on depletion of U.S. resources versus using lower cost imported oil. There was even the suggestion that low-cost foreign oil should be purchased for storage in exhausted wells.

The Eisenhower approach that emerged led away from free markets and towards regulation and also towards assuring the availability of supplies by guaranteeing the profitability of continued domestic exploration. It is reflected in the Trade Agreements Extension Act of June 1955 giving the President the power to adjust imports to a level "that will not threaten to impair the national security."

A Voluntary Oil Import Control policy was created in 1955 that differentiated crude oil imports between those from the Middle East/North Africa and those from Canada and Venezuela – restricting the former, but not the latter, since they were considered part of the response to our national defense.

In 1957 – after a finding that "crude oil is being imported into the U.S. in such quantities as to threaten to impair the national security," – the Administration cautioned that excessive reliance on imported oil may put the nation in a long-term vulnerable position. "Imported supplies could be cut off in an emergency and might well be diminished by events beyond our control. This vulnerability could easily result in a much higher cost, or even in the unavailability, of oil to consumers." The conclusion was to maintain a reasonable balance between domestic and foreign supplies, which was imported oil at 12 percent of domestic production.

In 1959, the Voluntary Oil Import Control program evolved to a Mandatory Oil Import Program due to the collapse of the voluntary program. How was the Mandatory Program justified? It was not justified on the argument that national security would argue for increased imports, leaving domestic reserves and production to be used in times of national emergencies. It was not justified on limiting price effects. Its justification was protectionist based rather national security based – providing an incentive for enhanced domestic exploration and production. Or as some termed it – the "stockpiling of domestic reserves." National Security was based more on protecting and ensuring a profitable domestic oil industry. Eisenhower's free trade tendencies were not carried out in the oil policy area. The national security argument was muddled.

1960s View of National Security: Response to a Military Need

U.S. production would be essential to a military response; U.S. production would be essential in the event of a cut-off of Middle East supplies; U.S. refining would be necessary to meet world requirements – imported oil increases the strategic vulnerability of domestic refinery because coastal refineries would have a competitive advantage over inland refiners, those without access to lower cost imported oil.

The Mandatory Oil Import Program was continued, despite significant misgivings.

If we look back over the 1950s and 1960s, the national security debate as it was framed (the term energy security did not really emerge in the debate), was one of preserving domestic U.S. oil supplies, relying on U.S. surge capacity to offset any potential national emergencies, reliance on industry stocks, rationing, and reliance on western hemisphere sources, Canada and Venezuela, to offset disruptions from the Middle East. While the Middle East was to some extent a focus of the debate, it was a focal point to the extent that Europe and Japan were becoming vulnerable to the Middle East, while the U.S. still had its own more secure flexibility. Limiting imports to the U.S. took on physical, restrictive policy – our concerns on developing alternatives, implementing conservation and demand restraints, and ensuring diverse foreign supplies, were merely glimmers of the future, not firm policy. A long-term, coordinated policy addressing energy, versus individual fuels, had not emerged. The embargoes of the 1970s changed everything in our approach to national/energy security.

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* Leonard L. Coburn is Director, NIS, Russian and Middle Eastern Affairs, U.S. Department of Energy. This is an edited version of his presentation to the 22nd IAEE/USAEE North American Conference, October 6-8, 2002, Vancouver, BC. Canada.

1970s – Rise of Government Control of Production in the Middle East and Elsewhere.

The old policies of continuity of supply through adjustments by dominant companies have given way to coordination by a more powerful, government controlled organization – OPEC. The energy security focus of the 1970s onward deals with several issues:

- Supply disruption – how to deal with a short-term disruption in the flow of oil,
- Supply diversity – increasing reliability through fuel choices, and through sources of oil,
- New emphasis on other aspects of energy policy – conservation, efficiency, long-term alternatives

1973

The oil embargo of 1973 focused our attention on our vulnerability stemming from dependence upon oil imports. Recall that in 1960, imports accounted for 15 percent of domestic consumption; in 1973, they accounted for 35 percent. Crude oil exploration peaked in 1956, domestic crude oil production leveled off in 1970 and then declined. Spare domestic capacity essentially disappeared by the embargo of October 1973 (a smaller embargo in 1967 associated with Israeli-Arab war had no impact on the domestic oil market). Project Independence was created not with the goal of creating "energy self-sufficiency", but with the goal of creating an energy policy with some oil imports, "up to a point of acceptable political and economic vulnerability." Project Independence focused on an analysis of various alternatives that included import reduction dependence through offsetting increases in domestic supply, reductions in demand through energy conservation, and developing alternative sources of energy and new technologies for fossil fuels. Part of the analysis also examined building emergency supplies, and developing standby demand curtailment and allocation programs. The importance of Project Independence, despite its many shortcoming, was the first truly integrated study of the nation's energy goals and options.

From the release of Project Independence to the beginning of the Carter Administration, the focus continued on oil imports and how to lessen oil import dependency. Unfortunately, little was accomplished to address national security concerns, except for two important developments. One was the creation of the International Energy Agency (through the International Energy Program) and its oil allocation plan, and the other was the creation of the strategic petroleum reserve. Unbeknown to energy policy formation, two cornerstones of future energy security were put in place, although little emphasis was given to either during this period.

Carter's first National Energy Plan of April 1977 had three overriding objectives:

- reduce dependence on foreign oil and vulnerability to supply interruptions,
- in the medium term, keep imports sufficiently low to weather the period when world oil production approaches its capacity limitation; and
- in the long term, to have renewable and essentially inexhaustible sources of energy for sustained economic growth.

Energy security was not discussed as a concept on which energy policy was developed, but it was clear that the focus had shifted away from the supply side to the demand side with policies aimed at energy conservation, energy efficiency, and the development of renewable alternatives. Looking back at one of the basic premises – the ultimate limit on oil resources– the 1977 NEP indicated that both U.S. and world oil resources would be insufficient to satisfy all the increases in demand expected to occur in the U.S. and elsewhere throughout the 1980s.

"The energy crisis that now faces America results from the divergence between its historically increasing demand and its decreasing supplies of oil and natural gas. To meet this crisis, America must make a new kind of energy transition – from a period of abundant, cheap oil and gas to period when these resources will be in short supply." (NEP)

The NEP recognized that "Import dependence produces economic and political vulnerability." It also stated the world's oil supply will no longer be able to satisfy growing American demand, even if we were willing at accept the consequences of increasing dependence on imports. The NEP did acknowledge that the U.S. must reduce its vulnerability to potentially devastating supply interruptions. Unrestrained growth in oil imports had national security implications. "Continued growth of imports would erode the nation's economic security, promote dissension with allies, and jeopardize America's world leadership." Energy independence is not the answer. The more sensible goal is "relative invulnerability" through reduction of imports to a manageable level, primarily through effective conservation and increased use of other domestic resources such as coal. "A large Strategic Petroleum Reserve, diversification of foreign sources of oil, and contingency plans should help deter interruptions of foreign oil supply and protect the economy should an interruption occur."

In the Carter Administration's second NEP issued on May 1979, the report says that a focus on the short term energy crisis is too simplistic. After describing the factors leading to the present dangers posed to the "nation's political and economic security", factors that stemmed from the U.S. rapid and massive shift to consumption of foreign oil. The origin of this vulnerability is traced to U.S. dependence on cheap energy, the finite nature of oil supplies, and dependence on a few oil producers leading to unpleasant economic shocks. The consequent quadrupling in the cost of oil raised the cost of everything in the U.S. and was a direct and indirect source of U.S. inflation. Finally, the report uses the expression "energy security" in the context that "energy security problems facing the U.S. could worsen" – again alluding to the underlying supply and demand pressures facing the U.S. and major consuming countries. The NEP II proposed three objectives:

- As an immediate objective, the Nation must reduce its dependence on foreign oil and its vulnerability to supply disruptions. The focus here is on pricing of oil and gas at their true replacement cost (deregulating the price of oil and gas); reducing barriers to new production, and other energy projects, filling the SPR, diversifying world oil supplies, and other ways to cushion the impact of a disruption.
- In the mid-term, the Nation must seek to (1) keep imports

sufficiently low to protect U.S. security and to extend the period before world oil demand reaches the limits of production capacity and (2) develop the capability to use new higher-priced ("backstop") technologies as world oil prices rise.

- The Nation's long-term objective is to have renewable and essentially inexhaustive sources of energy to sustain a healthy economy.

The NEP II discusses "The Security Threat" in detail indicating that the growth in imports to almost 50 percent of consumption poses real dangers to U.S. political security. The threats comes from interrupted supplies from volatile and potentially unstable areas in the Middle East and North Africa. The steps to limit vulnerability were SPR and IEA oil sharing. There is the recognition that even if the U.S. were relatively self-sufficient in energy, "it would remain strategically vulnerable to supply disruptions because of its political, economic and military interdependence with Japan and Western Europe, both of which remain heavily dependent on imported oil." The NEP stated, perhaps for the first time in quite stark terms, "that it must have a coherent energy strategy to protect its security." The NEP, in summarizing its near-term, mid-term, and long-term strategies, states, "Energy security is just one more form of the economic security to which every citizen is entitled."

1980s

The change in Administrations in 1980 ushered in a different approach to energy policy – reliance to a greater degree on market principles – "Increased reliance on market decisions offers a continuing national referendum which is a far better means of charting the Nation's energy path than stubborn reliance on government dictates or on a combination of subsidies and regulations." (NEPP, July 1981) The NEPP indicated that despite some recognition that market pricing would elicit increased domestic supplies, the new Administration stated boldly that "the regulatory emphasis was overwhelming (import controls, domestic price controls, entitlement program) and experience suggests that national energy policy should now break cleanly and candidly with that approach."

While the return to market pricing reduced oil imports, there was a recognition that "achieving a low level of U.S. oil imports *at any cost* is not a major criterion for the Nation's energy security and economic health." The U.S. was part of a world oil market and cooperation with our partners was essential. "Part of the effort to ensure energy security consists of cooperation with American partners and a sound economic evaluation of our respective circumstances and the requirements of free world security." Increased stockpiles and eliminating controls and other impediments to private sector responses were important components of the energy security policy.

For the first the time in the 1981 report, the NEPP had a separate chapter titled "Energy Security." Again, the mix of public and private efforts was emphasized. The federal role in stockpile development was recognized. The goal was 750 million barrels in the SPR by 1989. The role of stockpiles was recognized as both a mitigation for short-term price effects and as a deterrent to some supply interruptions. The second element of the energy security policy was international cooperation through the IEA. The third element was emergency preparedness, not through price controls, but through reliance on market pricing; rapid growth in federal stockpiles and elimination of factors that created disincentives for private stockpiling; using the federal stockpiles in the event of emergencies; fuel switching capabilities for the private sector; creating surge capacity for domestic producers; and international cooperation.

The NEPP of October 1983, continued the policy espoused in 1981, but in greater detail. The goal of "an adequate supply of energy at reasonable costs," was the articulated policy. The policy pursued market forces as the principle mechanism for determining "adequate supply", but also recognized "The international dimensions of energy security and emergency preparedness are fundamental aspects of the definition of adequate supply for ourselves."

The NEPP's chosen strategies were to minimize federal control and involvement in energy markets while maintaining public health and safety and environmental quality, and to promote a balanced and mixed energy resource system.

Three areas of energy programs and actions were deemed particularly important: energy conservation, research and development, and energy security. The energy security element again focused on emergency preparedness and international cooperation. On the domestic side, the continued expansion of the SPR, emergency response planning, and testing of the U.S.'s ability to respond to energy emergencies were emphasized. "Domestic energy security is enhanced by a range of other federal energy programs, including oil price deregulation; federal reform efforts in natural gas pricing and nuclear licencing; leasing programs for federal lands and the Outer Continental Shelf; enhanced energy trade; and expanded research and development; including cooperative international research efforts." The international component of energy security relied on "diversifying the sources of foreign oil supply and avoiding undue dependence on unreliable sources of energy." There was an indication that "energy trade" was likely to take on increasing importance. International cooperation through the IEA remained an important component of energy security. Unfortunately, there was also the fixation on increasing natural gas supplies to Europe from the Soviet Union. Part of the strategy was to find "secure and economic alternatives to increased Western reliance on insecure and prospectively uneconomic Soviet supplies."

NEPP 1985

The goal remains "adequate supply of energy available at reasonable cost." Strategies from 1983 have not changed. Three broad conceptual objectives: energy stability, energy security, and energy strength.

- Energy stability: "a situation in which problems of energy availability and price do not destabilize the U.S. economy and our way of life." It promotes steady economic growth. It includes a consistent regulatory policy. It is the flexibility of our free-market system and its long-run ability to cope with changing circumstances that bring stability.
- Energy Security: means that adequate supplies of energy at reasonable cost are physically available to U.S. consumers, from both domestic and foreign sources. It means that the Nation is less vulnerable to disruptions in energy supply and it is better prepared to handle them should they occur.

Mentioned are – SPR, adequate defense, coordination with allies, facilitating production of U.S. energy resources.
- Energy Strength: Over longer term, energy security leads to energy strength. Reliance on domestic resources – coal, gas and nuclear power – can lead to long-term strength.

Energy Security, 1987

This report represents a shift within the Reagan Administration focusing on "Energy Security" in the backdrop of the lower oil prices and increasing oil imports. The mere title of the report reflects a renewed emphasis on the concept of energy security. The goal of energy policy is restated as, "adequate energy security at reasonable cost to the Nation." The President established the following goals:

- Increase domestic stockpiles to be used in event of a supply disruption
- Maintain a strong domestic oil industry
- Expand availability of domestic oil and gas resources
- Continue conservation and progress toward diversification of energy resources
- Promote among our allies the importance of increasing their stockpiles.

The report focuses on assessing "energy security risks" – with no one indicator providing an adequate measure of energy security. The indicators used included:

- oil prices;
- OPEC and Persian Gulf share of free-word production;
- excess production capacity;
- level of free-world exploration;
- U.S. production, consumption, and imports;
- exploration and development activities;
- fuel substitution capability;
- level of government and private stocks; and
- political or military threats in the Middle East of oil-producing regions.

The international strategies proposed by the Energy Security report include:

- Increased size and improve coordination of IEA strategic oil stockpiles;
- Reduced government intervention and removal of barriers to trade;
- Development of a balanced economic, and diversified energy supply system in response to market incentives; and
- Promotion of international collaboration on R&D.

Clinton Administration Policy: Reliance on the Three E's.

The National Energy Strategy (NES) was published in February 1991. The focus was on:

- Economic growth – more competitive economy, increased energy economic efficiency
- Environment – better environment
- Increased energy security

In the section on oil, the goal stated was to reduce U.S. vulnerability to oil supply disruptions by expanding U.S. and worldwide oil production capacity and strategic stocks:

- Ensure proper balance between energy security and environmental protection. The ideas for doing this included:
  - Advanced oil recovery
  - Exploration and development of a limited portion of the coastal plane of ANWR and OCS under strict environmental safeguards.
  - Stimulate oil and gas development and excess production capacity outside of the Persian Gulf, including the Western Hemisphere, Eastern Europe, Asia (Russia is part of this focus).
  - Expand the U.S. strategic oil reserves and encourage similar action our allies.
- Great reliance on natural gas
- Maintain coal's competitiveness.
- Enhanced R&D for energy security.
  - Increase the efficiency of surface transportation
  - Increase the efficiency of air transportation
  - Spur development of new transportation fuels
  - Improve energy efficiency in buildings and industry
  - Promote innovation in electric technologies

In July 1995, the Clinton Administration published Sustainable Energy Strategy: Clean and Secure Energy for a Competitive Economy

Sustainable Development guides energy policy and motivates three strategic goals:

- Maximize energy productivity to strengthen the economy
- Prevent pollution
- Keep America secure – reduce vulnerability to global energy market shocks.

The report focused on a mixture of reliance on markets and government policies

The Energy Security focus was on oil from ***potentially unstable sources*** of oil.

- While market changes suggest the U.S. is less vulnerable to economic damage of oil supply disruptions than 20 years ago, the increasing concentration of global oil from potentially unstable regions imply that unstable global energy markets may still compromise our economic and national security goals.
- Strengthen Energy Security policy by reaffirming U.S. policy for responding to oil supply disruptions
  - International coordination through the IEA
  - Reliance on the SPR
  - Enhance global stockpiling
  - Develop information to enhance transparency and functioning of markets

April 1998 – Comprehensive National Energy Strategy (CNES)

Five goals were articulated in this study:

- Improve the efficiency of the energy system
- Ensure against energy disruptions
  - Reduce vulnerability of the U.S. economy to oil supply disruptions – excessive reliance on Persian Gulf creates potential for oil importers to be vulnerable to supply disruptions and volatility

    - Stabilize domestic production
    - Maintain readiness of SPR
    - Diversify import sources
    - Reduce consumption
    - Ensure energy system reliability, flexibility and emergency capability
- Promote energy production and use in ways that respect health and environmental values
- Expand future energy choices
- Cooperate internationally on global issues

NEP May 2001: Goal: Reliable, Affordable, and Environmentally Sound Energy for America's Future.

Components of NEP:

- The Policy is a long-term, comprehensive strategy. Our energy crisis has been years in the making, and will take years to put fully behind us.
- The Policy will advance new, environmentally friendly technologies to increase energy supplies and encourage cleaner, more efficient energy use.
- The Policy seeks to raise the living standards of the American people, recognizing that to do so our country must fully integrate its energy, environmental, and economic policies.

Five goals:

- Modernize conservation
  Increase energy efficiency by applying new technology
- Modernize our energy infrastructure
  Focus on reducing regulatory barriers to infrastructure enhancements
- Increase energy supplies
  Adding supply for diverse sources – domestic oil, gas, coal, hydro power, and nuclear
- Accelerate the protection and improvement of the environment, and develop a long-term energy policy, including reliance on clean technologies
- Increase our nation's energy security.
  Lessen impact of energy price volatility and supply uncertainty; energy security must be priority of U.S. trade and foreign policy; restore credibility with overseas suppliers; build strong relationships with energy producers in Western Hemisphere;

"U.S. national energy security depends on sufficient energy supplies to support U.S. and global economic growth."

- Measures to enhance U.S. energy security must begin at home: use our own capability to produce, process and transport the energy resources we need in an efficient and environmentally sustainable manner.
- U.S. energy and economic security are directly linked not only to our domestic and international energy supplies, but to those of our trading partners as well.
- Energy security also depends on an efficient domestic and international infrastructure to support all segments of the energy supply chain.
- Expand the sources and types of global energy supplies
- Increasing the efficiency of energy consumption,
- Enhancing the transparency and efficient operation of energy markets
- Strengthening our capacity to respond to disruptions
- Strengthen our trade alliances
- Deepen our dialogue with major oil producers
- Greater oil production in the Western Hemisphere, Africa, Caspian, Russia, and Asia
- Increased energy efficiency and use of clean energy technologies
- Continue work with IEA
- Work with large importers to augment their oil reserves

National Energy Security Post 9/11 – USEA

"Energy security is assured when the nation can deliver energy economically, reliably, environmentally soundly and safely, and in quantities sufficient to support our growing economy and defense needs."

Core Principles:

- Diversity of fuel sources – diversity of fuel supplies, including domestic production
- Economic efficiency through competitive markets
- Accelerated innovation and R&D
- Contingency planning and emergency preparedness
- Balance energy security, economic and environmental objectives

Energy Security evolved from a somewhat minor aspect of energy policy to the primary focus. It will remain the core of energy policy as long as the elements outlined in energy security concerns predominate – dependence upon oil imports for a significant portion of U.S. energy supply.

Other organizations have focused on Energy Security. For example, at the 8th International Energy Forum (IEF) in Osaka, Japan, that took place in September 2002, there was an extensive discussion of energy security issues. For consumers, the emphasis was on "Security of Supply" while for major producers the emphasis was on "Security of Demand." One observer at the IEF said that energy security was all about the "ability to manage risk."

In the current environment, the U.S.-Russia relationship must be factored into the discussion on Energy Security. Dan Yergin of CERA framed the issue in terms of the U.S. and Russia being the two largest overall energy producers if both oil and gas were considered, with Saudi Arabia in the number three position. The commonality of interests between these countries is very strong – with Russia desiring to become a strong, stable supplier of crude to the U.S. and the U.S. seeking to diversify its sources of crude oil. The questions that come to mind are whether Russia can sustain its current surge in crude oil production? Can Russia break into the U.S. and become a significant supplier – Russia is looking to achieve a 10% market share by 2010 versus its less than 1% share today? Can the U.S. limit imports from the Middle East given the Middle East's position as having the largest oil reserves in the world (about three quarters of proven reserves)? Should the U.S. try to limit these imports? What about supplies to the world oil market and isn't that what really matters in terms of diversity of supply? With the Middle East playing a critical role in the world oil market due to its large proven reserves, what does this mean for market stability in the future? These are all important questions that will have an impact on the future discussion of Energy Security.

Mexico's Energy Scene

*By Pablo Mulás and Gerardo Bazan**

Mexico's Energy Sector in Numbers

The energy sector of Mexico has had mixed growth in the last few years as can be observed in the statistics shown in tables 1 to 5. While the electric subsector shows a steady growth, the oil and gas subsector shows both ups and downs. Nonetheless, the demand of natural gas and oil products as well as that of electricity has been satisfied, and the end users have not suffered any serious disruptions. In the first two, natural gas and oil products, imports have made the difference.

Crude oil production has increased slightly. Since oil refining products production has mainly remained constant, it was possible to somewhat increase crude oil exports. As stated by PEMEX's Director General, Mr. Raul Muñoz L., the past lack of investment in exploration activities has reduced the amount of total reserves. The same observation seems to apply to the transport infrastructure. Fortunately, recent investment to modernize refining facilities will start bearing fruit this year.

Table 1
Mexico's Primary Energy Reserves and Production

	1998			2001		
	Reserves	**Production**	**R / P**	**Reserves**	**Production**	**R / P**
Crude Oil	40.38×10^9 b	3.07×10^6 b/d	36 3	8.29×10^9b	3.13×10^6 b/d	33.5
Natural Gas	$1{,}712.5 \times 10^9$ m^3	134.1×10^6 m^3 /d	35	$1{,}418 \times 10^9$ m^3	126.3×10^6m^{3}d	30.7
Coal	663×10^6 mton	11.5×10^6 mton/a	57.6	663×10^6 mton	12.0×10^6mton/a	55.2
Hydroenergy	80 TWh/a	24.62 TWh/a	———	80 TWh/a	28.44 TWh/a	———
Geothermal	10.4 TWh/a	5.66 TWh/a	———	10.4 TWh/a	5.56 TWh/a	———
Uranium	10,600 mton	———	———	10,600 mton	———	———

Ref. Compendio de Información del Sector Energético Mexicano, Programa Universitario de Energía, Universidad Nacional Autónoma de México

Table 2
Oil Refining Products (10^3 b/d)

	1998	**2001**
Gasolines	412	434
Diesel	290	292
Fuel Oil	446	436

Ref. Memoria de Labores 1999, PEMEX
Informe Estadístico de Labores 2000, PEMEX
Informe Estadístico de Labores 2001, PEMEX

With regard to the electric sector, the important increase in generation is due mainly to the so called external power producers which correspond to power plants built with private investment. But these have a different status than the independent power producers in other electricity markets as will be briefly described below. The transformation (substation capacity) and transportation (transmission and distribution) infrastructure has increased steadily. Until now , the average annual time of service interruption has slowly decreased. It is still much higher than the desirable value, due to a weak transmission and distribution system resulting from chronic underinvestment over the last decades and not due to the lack of generation capacity.

Table 3
Hydrocarbon Pipeline Transport Infrastructure
(kilometers)

	1998	**2001**
Crude Oil	4297	4088
Natural Gas	9185	7516
Liquid Products	12578	12017
	26060	23621

Ref. Anuario Estadístico 1999, PEMEX
Anuario Estadístico 2001, PEMEX

Mexico's Reform Attempts

The 1992 Reform

The first reforms to the laws regulating electricity public service were approved by the Mexican Congress in December 1992. Prior to this, all activities related to the offering of this service were exclusive of the public sector through two public utilities, Comisión Federal de Electricidad (CFE) and Luz y Fuerza del Centro (LyFC) which are administered by the executive branch, more as government agencies than public enterprises. Some exceptions were allowed: for example self generation of electricity for internal uses of the generator. The new law allows the following participations, in addition to public utilities, in electricity generation:

- Power generation for self supply. No permit is required if capacity is below 500 kW. A single or a group of industries may install their own power plant to satisfy their own needs. Excess capacity must be made available to CFE.
- Cogeneration. Power and heat generation in an industrial process may be carried out by a permit holder different from the process plant owner. Excess capacity must be made available to CFE.
- Small power generation. Power plants of less than 30 MW may be installed anywhere and may generate electricity to be sold to CFE. If it is to be used in rural isolated areas as self supply, the capacity must not exceed 1 MW.
- External power producer (EPP). This scheme allows private investors to install power plants, but all the electricity generated must be sold to CFE under long term

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contracts. In practice, CFE defines the site and the power required, and through an open bidding process, assigns the project. Being a government owned public utility and paying for energy delivered as well as capacity availability, the risk is low for the private investor winner, as the government basically takes most of it. For all practical purposes, this is a virtual finance scheme by which CFE may have access to new generating capacity without directly incurring in the capital expense; it probably is more expensive than a direct loan or bond issue, but the arrangement apparently has other advantages for the Mexican government.

- Power generation for export and power imports. Individuals or entities may generate electricity for export. Also, they may import electricity for their own use. Both activities require a permit.

A common denominator is that only the public utilities, CFE and LyFC, can provide this service in the country. Thus, except in the EPP modality which provides the lowest cost scheme to CFE, this reform did not create any kind of competitive environment.

Table 4
Gross Electricity Generation (GWh)
(Effective Generation Capacity in MW)

	1998		2001	
Hydroelectric Units	24,616	(9,700)	28,435	(9,619)
Fossil Fuel Fired Units				
Fuel Oil / Gas Fired	86,206	(14,283)	90,395	(14,283)
Coal Fired	17,957	(2,600)	18,567	(2,600)
Fuel Oil / Coal Fired	12,692	(2,100)	14,109	(2,100)
Combined Cycle	13,184	(2,463)	20,789	(3,733)
Gas Turbines	1,087	(1,929)	5,456	(2,381)
Diesel Int. Combustion	314	(120)	467	(143)
Nuclear Power Units	9,265	(1,309)	8,726	(1,365)
Geothermal Power Units	5,657	(750)	5,567	(838)
Wind Driven Power Units	5	(2)	7	(2)
Total	**170,983**	**(35,256)**	**192,518**	**(37,064)**

Ref. Informe de Operación 1998, CFE
Informe de Operación 2001, CFE

The 1999 Reform Proposal

In 1999, President Zedillo sent a reform proposal for the electrical sector following more or less the Argentinian model. The system would be unbundled, creating competition at the generation level through wholesale and spot markets.

Only the hydroelectric, and nuclear power plants as well as the transmission network would be kept under the administration of the public sector. An independent dispatch center would administer and control the spot market. An energy regulatory agency would supervise the whole scheme with its main mandate being to protect the consumer at the end of the process. As is well known, the political opposition, including the PAN (right-leaning) political party now in power, was overwhelming. The proposal never reached the senate floor for discussion, as the federal (presidential and congress) political campaign went into high gear and the last months of the administration drifted by.

Although the main argument to promote electrical reforms to open the electrical sector to private investors was the large future investments required for expansion and the lack of public funds to do this, in many instances, the weak performance of the two utilities was also utilized. A benchmark exercise of CFE and LyFC was made (1), based on a previous publication (2) of a comparison between an Indian utility, Maharashtra State Electricity Board (MSEB), and an American utility, PacifiCorp (PC). The results (Table 6) showed that CFE fares quite well, while LyFC has more problems. The large difference of CFE with PC in the transmission and distribution losses is due, in part, to the large difference in territory covered by each (PC covers 460,800 km^2 while CFE covers 1,952,016 km^2). Transmission losses directly correlate with the distances covered by the network. Non-technical losses (thefts) also contribute in the case of CFE while for PC these are probably non-existent. On the other hand, the average annual interruption of service time duration and the voltage and frequency variations are not reported in the original publication and thus are not compared; CFE and LyFC probably have a much worse performance index in these two areas due to the lack of robustness in their transmission and distribution networks.

Table 5
Electricity Transport Infrastructure
(kilometers)

	1998	2001
Transmission (150-400kV)	33,063	36,848
Subtransmission (69-135kV)	38,226	40,796
Distribution (< 34.5kV)	516,187	554,374
	587,476	632,018

Ref. http://www.cfe.gob.mx

President Fox's Reform Attempts

In May 2001, President Fox signed a decree allowing self-suppliers and cogenerators to sell their excess electricity to CFE above the limits set by the 1992 reform. Some senators and congressmen from opposition political parties contended that this was unconstitutional and requested the Supreme Court to analyze the case and rule on this issue. Earlier this year, the Supreme Court declared President Fox's decree unconstitutional by an 8 to 3 vote and agreed with the opposition parties that presidential decrees could not change laws passed by Congress. In their presentation of motives, some of the judges that voted with the majority went so far as to question the validity of the sale of excess generation since it appears to be in contradiction with articles 27 and 28 of the Constitution. These state that electricity generation, transmission and distribution are a public service and are reserved, exclusively, to be performed by the state through its public utilities. Such an interpretation has created uncertainty about the legal status of the EPPs, which now have 2548 MWe operating and 6016 MWe under construction.

In early August, President Fox sent his reform proposal to Congress which obviously included changes to article 27 and 28 of the Constitution. His proposal was immediately contrasted to the previously presented proposals of some PRI members and of the PRD (left-leaning party). The only common feature of the three proposals is that both electrical utilities should be given more administrative independence from the central government, that is, the utilities would become closer in status to a real enterprise and less of a government agency. In the remainder of their contents, President Fox's proposal takes completely opposite positions to the PRI and PRD ones.

The PRI and PRD proposals basically call for the maintenance of the status quo and oppose any alterations in articles 27 and 28 of the Constitution. They seem to agree to maintain the 1992 changes allowing EPPs in order that private investors continue to participate in the generation of electricity and, as mentioned before, they would grant much more administrative autonomy to the public utilities from the central government than what they have now. Yet, it is not clear what they would propose to reduce the uncertainty created by the Supreme Court ruling.

Table 6
Benchmark of Some Parameters Between an Indian, An American and the Two Mexican Electrical Utilities

	MSEB	PC	CFE	LyFC
Thermal Efficiency (*) (kcal / kWh)	3,103	2,678	2,469	———
Capacity Factors (*) (%)	62.3	76.5	72.4	———
Transmision and Distribution Losses(%)	16.2	5.7	14.5	22.5
Labor Productivity (No. of. clients /worker)	100	155	190	141
Labor Productivity (Workers / MW installed)	14	1	2.5	——

* This comparison is only for coal-fired power plants
Reference (1)

President Fox's proposal, besides maintaining intact the two public utilities, calls for their increased administrative autonomy as the PRI and PRD proposals also do. But it further proposes changes in articles 27 and 28 so that the government does not have exclusive rights in the activities related to the electrical subsector and the creation of wholesale and spot markets in electricity generation.

The environment in which the discussions are taking place is quite interesting. In favor of President Fox's proposal, it is stated that public finances are meager because government tax revenues are quite small; they are only of the order of 18% of GDP. Thus the large amount of financial resources required for the accelerated infrastructure expansion (5-6% electricity demand annual growth rate) would quite seriously reduce the availability of funds for the pressing social investments the government has to make in health, education, housing, etc., to get the recently estimated 53 million Mexicans out of poverty status. Supporters of the President's proposal argue that in order to achieve both responsible energy and social goals, the electrical sector has to be opened to private investment without any legal uncertainties floating around. This argument has been widely accepted even by some in the opposition; some PRI state governors, senators and congressmen have publicly come out in favor of President Fox's proposal.

The opposition arguments run along the line that in the recent past, cases of private participation in previously public exclusive sectors as banking and the toll highway system have produced terrible failures, costing the Mexican taxpayer trillions of pesos (1 US$ is equivalent to about 10 pesos). Moreover, the opposition adds that the electrical system is a strategic sector which should not be allowed to fall into the hands of foreign decision makers as this would affect Mexico's sovereignty. Finally, they point out the many examples of serious flaws in other reformed electricity markets that make it highly probable that Mexico's attempt will fail. A few months ago, Governor Davis of the State of California, on a visit to Mexico, publicly recommended not to go the route of reform. Recently, Joseph Stiglitz, 2001 Nobel prize in economics, in a highly publicized telephone interview with one of the main Mexican newspapers, stated that electricity competitive market creation is a very difficult task and that market power and price manipulation is probable. He also stated that without an adequate regulatory framework in place, business and individuals will be confronted with a disaster. While the opposition agrees with the fact that current fiscal resources can not support the electricity expansion's required investment, they claim that a well managed publicly owned enterprise should be able to finance its own expansion, something that Stiglitz also stated as possible.

In the meantime, the multiple service contracts proposed by PEMEX to accelerate the expansion of dry natural gas exploration and production have been relegated to a second level of discussion. At present, gas sector distribution is 100% in the hands of private companies, and the transport area already has some private pipelines under construction. At some point, it is expected that the opposition will consider this new scheme unconstitutional as articles 27 and 28 also refer to oil and gas. It is likely they also will request the Supreme Court to judge their validity. Energy Secretary Martens recently declared that a reform proposal related to oil and gas activities will be sent to Congress. The PRD has made public their reform proposal for PEMEX which only calls for its administrative autonomy from the government, and the creation of a new energy planning commission. But at the moment, the spotlight is on the electrical sector reforms.

The PRI party president has declared that there will not be an official party position and that each senator and congressmen will be allowed to vote according to his convictions. At present, the lobbying activity on both sides is very intense and the common perception is that President Fox hopes to be able to get his proposal through with the support of his party, PAN, and a split PRI. As there is no timetable set for the voting procedure at present, uncertainty is even greater.

In December, a newspaper poll made among 40% of congressmen and senators indicated that most agreed that private investment is required in the electrical sector (67% congressmen and 64% senators) but 58% of the polled senators and 45% of the polled congressmen said that they would vote against the reform proposal sent by President Fox (as it involves constitutional changes, it requires 2/3 approval from both chambers). A few days later, a report was published on a meeting of the PRI senators to discuss the electrical reform, where it said that unanimous consensus was reached that there should be no constitutional changes. The next day, one of them presented on the senate floor, a new proposal similar to President Fox's, but restricting foreign investment in the generation subsector to less than 49%. At present, the Senate has postponed again the electrical reform floor discussion until February 2003.

In conclusion, the situation is one that could briefly be described by one of those popular Chinese phrases; we shall live interesting times in the near future.

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The Canada-U.S. Energy Relationship: Issues and Challenges - *A Canadian Perspective*

*By André Plourde**

By the end of the 1980s, deregulation initiatives directed at the oil and gas industry had reversed a decades-long approach to policy centered on direct government intervention in Canada's energy sector. Since then, Canadian energy policy has focused on the role of market forces in determining energy trade and development patterns. The pillars of this policy approach can be summarized as follows:

- open, competitive markets, with focused interventions when federal policy objectives are not being met;
- fair and efficient regulation;
- trade governed by the rules embodied in the North American Free Trade Agreement (NAFTA).

Such a policy framework fits in well, at least nominally, with the U.S. market-based approach to energy policy. Indeed, much of the growth in Canadian energy production (especially crude oil and natural gas) has been spurred by access to U.S. markets. Since the deregulation push of the mid-1980s, natural gas production in Canada has more than doubled, reaching 6.6 trillion cubic feet in 2001. Almost 60% of this production is exported to the United States, where it accounts for more than 98% of imports and is used to meet some 16% of domestic requirements.

During the same period, Canadian crude oil production has increased by approximately 25%, to 740 million barrels in 2001. This, despite the fact that the Western Sedimentary Basin – from which most of Canadian oil production is drawn – is gas-prone and relatively mature. Here, exports to the United States amount to some 65% of Canadian production, accounting for about 8% of U.S. crude oil consumption.

The situation is different for electricity as the structure of the relevant markets is much more regional in nature in both countries. A much smaller proportion of Canadian electricity production crosses at least one border (either provincial or international) on its way to market: about 15% against more than 80% for both crude oil and natural gas. All in all, less than 10% of Canadian electricity production is exported to the United States, where it is used to meet about 1% of end-use requirements.[1]

It goes without saying that there are regional differences to the patterns outlined above – exports are more important market destinations for Alberta's crude oil and natural gas producers than they are for Saskatchewan's, for instance. The same can be said about Québec's electricity production in comparison to Alberta's. Overall, however, export markets are of vital importance to Canadian energy producers, especially to those active in crude oil and natural gas. In a parallel fashion, Canada has become, over the last two decades, an increasingly important source of supply for energy consumers in the United States.

While this energy relationship is significant to both countries, it can be argued that it is of greater importance to Canada. The United States imports crude oil from a number of countries and sees liquefied natural gas (LNG) produced in countries like Australia and Algeria reach its shores. In addition, there are clear opportunities for expanding energy trade with Mexico. In the case of Canada, however, geography and the existing infrastructure have led to a situation where the United States is currently and for the foreseeable future the only commercially viable export market for Canadian energy production. Continued access to U.S. energy markets is thus of critical importance to the health of the Canadian energy sector. As a result, U.S. policy developments can have significant effects, not only within the United States, but also on energy-sector participants in Canada. With this in mind, what follows is a list (with no pretense of it being exhaustive) of issues that could affect Canada-U.S. energy trade in the coming years. Many of these, as one would expect, are reflections of possible consequences for Canadian producers of U.S. policy actions.

Basic Thrust of U.S. Energy Policy

The May 2001 National Energy Policy document emphasized the role of international linkages in securing energy supplies to meet U.S. requirements. While specific attention was paid to Mexico and other regions of the world (such as West Africa, Russia and other states of the former Soviet Union), very little was said about Canada-U.S. energy trade. This omission is rather surprising since Canada is *by far* the single most important foreign supplier of energy to the United States. From Canada's perspective, the omission is also worrisome since it could be interpreted as a shift in U.S. policy – a signal to U.S.-based companies to re-direct their investment dollars away from energy development and production projects in Canada in favor of other foreign destinations. However, U.S. investment will be needed if flows of energy exports from Canada are to be sustained, not to mention increased, to help meet growing energy end-use requirements in the United States. All in all, some clarification on the basic thrust of U.S. energy policy and, in particular, on the desired role of imports from Canada would appear to be in order.

Infrastructure Development

If continued export growth from Canada were deemed desirable, then there would be a need for additional investment in the expansion of the long-distance energy transmission and transportation infrastructure linking the two countries. Here, the capacity expansion projects, whether based in northern and western Canada or offshore from the east coast, would clearly benefit from the establishment of similar rules applicable to the approval, construction, and regulation processes in the different jurisdictions. This seems a propitious area for cooperation between Canada's National Energy Board (NEB) and the FERC.

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[1] See end of text for footnotes.

Prospects for Natural Gas Production

The NEB and Alberta's Energy Utilities Board, among others, forecast a decline in Alberta's conventional gas production within the next five years, which raises some questions about the feasibility of increased exports to the United States from Canada's major gas-producing area. Before firm conclusions can be drawn, it is clear that more work is needed to assess how likely and how significant such a decline could be. It does, however, highlight the role that could be played by production from the north and from Nova Scotia. It also brings the issue of coal-bed methane production to the forefront. In contrast to the situation prevailing in the United States, there is currently no coal-bed methane production in Canada. Since Alberta (and to a lesser extent Saskatchewan) possesses huge coal reserves, it may be that an expansion in this area would offer opportunities to counter any declining conventional natural gas production. Prospects for coal-bed methane production are also being assessed as the government of Alberta proceeds with the development and implementation of a water strategy for the province, which could lead to tight environmental standards applied to the disposition of water pumped out of coal-bearing formations.

Prospects for Crude Oil Production

The last ten years or so have witnessed important changes in Canada's oil production profile. Specifically, a shift to heavier crudes and to non-conventional production (bitumen and synthetic crude from oil sands) has occurred. Overall, conventional crude oil from Alberta has been falling since 1994 and any expansion in light-to-medium crude output will be generated by additional development and processing of that province's massive oil sands reserves. However, such operations are characterized by large economies of scale and are extremely capital intensive, especially in the development phase. Securing additional light crude oil production from Alberta will thus require huge inflows of investment in oil sands development projects. This raises again the issue of the basic thrust of U.S. energy policy as a signal for investment activities by U.S.-based companies.

These last two items have potentially significant consequences for Alberta's economic performance and for the state of the province's public finances. As things stand, there are now only two "have" provinces in the Canadian federation: Alberta and Ontario. Since the oil and gas industry is the main driving force of Alberta's economy and is an important revenue source for the provincial government, a significant downturn in activity in this industry would have deleterious consequences on Alberta and would also have negative effects on the Canadian economy as a whole.

Natural Gas from Alaska and Subsidies

Recent discussions and proposed legislation in the United States about restrictions on the choice of pipeline routes to transport natural gas produced in Alaska and on possible subsidies for the production of this gas have been met with dismay in Canada. For most of the 1970s and early 1980s, when Canadian energy policy was highly interventionist in nature, U.S. officials would regularly take Canada to task for subsidizing certain activities and for distorting market signals to energy producers and consumers. After many years of intervention, the government of Canada finally withdrew from the business of subsidizing energy megaprojects and from regulating upstream prices. But now we face the perplexing situation of having the U.S. government actively consider the possibility of adopting the kinds of policy initiatives to which it so strongly objected when these were part of the Canadian approach to energy policy. This frustrating state of affairs leads me to ask: what are the main objectives of U.S. energy policy? To what extent will the U.S. government allow market forces to affect producer and consumer decisions in energy markets?

Aboriginal / First Nations Issues

The possibility of oil and gas development activities in the northernmost regions of Canada and the United States has highlighted an issue of increasing relevance to energy industries in both countries, namely that of Aboriginal / First Nations rights. The Canadian government has implemented a process of direct negotiations with First Nations over land claims. The resulting settlements have typically involved the recognition of rights relating to the control by First Nations over activities taking place in areas covered by the settlements. One consequence of these actions has been to create a multiplicity of jurisdictions involved in energy project approval. Take for example the case of the proposed Mackenzie Valley natural gas pipeline. When a project of this type was first considered in the 1970s, there were two jurisdictions involved – the governments of Canada and Alberta (since the proposed pipeline was to extend into the province of Alberta). As things now stand, a dozen or so distinct jurisdictions would be involved in approving such a project – the two identified earlier, plus the government of the Northwest Territories and a number of First Nations.[2] This marks a fundamental change in the way that some proposed energy projects would be assessed and considered for approval. It results in a more costly and time-consuming process for proponents, but one that is also more inclusive and more respectful of the rights of First Nations.

The Future of LNG

The last few years have witnessed a heightened sense of optimism in the industry about the prospects of LNG emerging as a viable source of supply. Some of this optimism has been reflected in concrete actions: U.S. LNG imports, while still quite small, have grown sharply since 1999. I am at a bit of a loss to explain these developments. During the 2001-2002 academic year, some of my students undertook a financial analysis of the LNG project linked to the proposed natural gas development on Alaska's North Slope. The results were quite clear: under all reasonable (and some rather generous) configurations of underlying cost and market conditions, the Alaska LNG proposal was commercially a non-starter. To the extent that this exercise captured the key elements influencing LNG development, the results would suggest that additional work is needed to assess whether the prevailing optimism is justified. From Canada's perspective, the future of LNG gives rise to two sets of issues. First, the required infrastructure does not currently exist in Canada, and its construction would thus need significant injections of capital, which could potentially draw funds away from other energy-sector projects (oil sands development, for example). Second, were LNG to emerge as a cost-competitive source of natural gas, it could challenge Canadian-produced natural gas

in its traditional markets in the United States.

Is Large-Scale Hydro "Green/Renewable" Power?

Many U.S. states have recently introduced, or are considering introducing, a renewable portfolio standard (RPS) to their mix of electricity sources. Large-scale hydro is typically not considered eligible in meeting these RPSs. From Canada's perspective, these standards could be considered a significant barrier to electricity trade since almost all electricity exported to the United States is generated by large-scale hydro installations. The status of such standards under NAFTA is unclear, as pointed out in a recent paper.[3] The underlying concern revolves around the fact that RPSs lead to artifical product/service differentiation (since all electrons are the same) based on the generation technology, which here leads to discrimination against Canadian producers.

The Future of Electricity Restructuring

In the aftermath of the events in California and more recently in Ontario, there is a distinct "chill in the air" when it comes to electricity restructuring in Canada and the United States. While most previously announced plans for in-depth restructuring have recently been scaled back or abandoned – and certainly no new plans have been announced – the current situation is nonetheless unsustainable. New developments on the regulatory front are to be expected, and the FERC's recent proposals covering regional transmission organizations (RTOs) and standard market designs represent first steps in a renewed effort to adjust the structure of the electricity industry to reflect current economic and technological realities. These, however, are but first steps and much more will need to be done in both Canada and the United States if regionally integrated electricity markets are to emerge. To the extent that the last few years are any indication of what could be in store, this restructuring process is likely to be a politically charged issue and thus highly subject to direct political intervention.

The Fallout from Enron and California

The questionable business dealings allegedly undertaken by officials at Enron and other companies, and the perception that abuse of market power contributed to California's electricity debacle have cast the industry in an unfavorable light with elected officials and the public at large. A likely consequence is the imposition of additional regulation on various aspects of energy industry activities. If so, how does this increased regulatory oversight fit in with energy trading relationships based on contracts negotiated by buyers and sellers? The last chapter in this has certainly not be written, but it is difficult to imagine an outcome that would see increased regulation without accompanying higher costs of doing business and dampened market signals.

Greenhouse Gas Emissions and the Kyoto Protocol

The decision by the Bush Administration not to seek ratification of the Kyoto Protocol has left Canada – with its long-standing pledge to abide by its Kyoto commitments – in a very difficult position. Almost 90% of *all* Canadian merchandise exports (not just energy) are currently destined for U.S. markets.[4] As a result, when this trading partner adopts a radically different approach to addressing a common issue, such as the ratification and implementation of the Kyoto Protocol, concerns about potential negative competitiveness effects arise in Canada with respect to all industries, and not just those focused on energy production. Granted that both state and federal authorities will enact measures aimed at curbing the growth of U.S. greenhouse gas (GHG) emissions, but it seems reasonable to assume that these cuts will be less extensive than those originally agreed upon in December 1997. This difference in approach has also contributed to the creation of a more uncertain investment climate in Canada's energy sector. From this perspective, U.S. GHG policy may in effect prove counter-productive to that country's energy security goals. As noted earlier, Alberta's oil sands will be the key source of future crude oil production from western Canada. Significant expansion of oil sands production will require massive investments in additional production facilities and infrastructure. The U.S. failure to ratify the Kyoto Protocol could well create disincentives for U.S.-based firms to invest in Canada's oil sands, thus leaving the United States even more dependent on less secure sources of crude oil supply in the future.

The Role of Mexico

Since 1994 the North American economic partnership includes a third country – Mexico. But, with the exception of crude oil exports to the United States, Mexico has – for all intents and purposes – chosen to remain on the periphery of North American energy markets. Were the Mexican government to seek to strengthen its energy ties with the other two NAFTA countries, it would have important implications for Canadian energy companies. Take the case of natural gas, for example. Mexico has significant and under-developed reserves of this energy source. If production were increased and the necessary infrastructure built, Mexico could become an exporter of natural gas to the United States in the medium and longer term. The resulting situation would be quite different than for crude oil, where increased Canadian and Mexican production can both be accommodated in the US market by backing out production from other countries. In the case of natural gas, there are currently no other significant suppliers that can be pushed out of the U.S. market. Mexican production would thus be in direct competition with natural gas exports from Canada in the U.S. marketplace. If Mexico's energy sector were opened up to foreign participation, that country could also become a destination for Canadian energy-sector investment. To date, however, the opportunities for such activities have been relatively few and Canadian companies have had a limited, and not particularly successful, involvement in Mexico's energy sector. One thing is clear: were Mexico to seek closer energy ties with its NAFTA partners, our thinking about North American energy relationships would need to shift from a focus on Canada-U.S. energy trade to a conception of truly continental energy markets.

My overall message can be stated rather succinctly. The coming decades will bring many challenges and many opportunities in the development and production of energy resources in Canada, Mexico, and the United States. Let's work together to make sure that each country puts in place a policy framework that allows us to deal with the challenges and take advantage of the opportunities for the benefit of *all* participants in North America's energy sector.

(See footnotes on page 17)

Global Cooperation for Hydrocarbon Technology

*By Paul Tempest**

Summary

New technology has, throughout the history of mankind, been a key which opens the door to economic development and growth. Technological breakthroughs and their effective application cut costs, achieve higher efficiencies and, above all, open up wide new options. Herein lies the strongest and safest route to affluence, enhanced welfare and enhanced competitiveness, the most robust protection against economic deprivation, inertia and decay, and, in the longer term, hopefully, the path to a transition to non-fossil-fuel energy and non-pollutant industry .

Precisely how individual genius has to interact with favourable economic and social circumstances to generate new and highly useful technology and how commercial and financial mechanisms can translate these breakthroughs most effectively into new machines, new industries and new markets still remains a matter of conjecture, lively debate and divided opinion. Clearly demand pressures, supply constraints and the availability of capital are significant factors.

In any analysis of the global economy or of any single national economy within the global total, it soon becomes abundantly clear that there is also a very wide range of obstacles blocking or inhibiting the transfer of new technology and that there are many vested interests and rigidities which resist the displacement of old and out-of-date tools, machines, systems and practices.

Advances in tele-communications have, in recent years, accelerated the transfer of new technology by disseminating it more widely, by illuminating and exposing inefficiencies and by facilitating international co-operation. Indeed globalized science and technology enhances political and commercial co-operation. The harnessing of scientific and technical research world-wide brings massive economies of scale and progress to many parts of the world simultaneously. At the forefront of this process is the energy sector.

As regional and global markets expand, many new issues are uncovered concerning the involvement of government, the accountability of industry and new patterns of international competition. Global standards, regional patterns and national regulation of industry all require continuous adjustment.

Yet many of the obstacles of administrative inertia, legal complexities, infrastructure bottlenecks and public ignorance could be gradually eliminated if we all had a clearer description of what globalized markets need to thrive in free competitive conditions.

In 2002, a major effort has been made by asking many of the leading international agencies such as The World Bank, the International Monetary Fund, the United Nations Development Program and the World Health Organization to identify those key elements favouring an acceleration of technology generation, of technology transfer, of economic growth and of national competitiveness within the global economy.

The World Economic Forum, Geneva, has over the past few years developed, in its Global Competitiveness Report, a massive study to apply these key elements to 75 states world-wide and to rank those states according to their current performance and prospects in each of 175 separate categories. These 175 surveys are clustered into eleven groupings:

- Aggregate Country Performance Indicators
- Macroeconomic Environment
- Technological Innovation and Diffusion
- Information and Communications Technology
- General Infrastructure
- Public Institutions – Contracts and Law
- Public Institutions – Corruption
- Domestic Competition
- Cluster Development
- Company Operations and Strategy
- Environmental Policy

Using this material which relies largely on company sources and that supplied by governments and the international agencies, a National Competitiveness Balance Sheet is constructed for each state. Notable Competitive Advantages and Disadvantages are identified and graded under three main headings:

- Growth Competitiveness Rank
- Current Competitiveness Rank
- Other Competitiveness Rank

These markings and rankings are then aggregated and an overall global ranking is established for each state.

The Global Competitiveness Report 2001-2002 has also been supplemented by two detailed specific studies covering the countries of Europe and the 22 member-countries of the Arab League.

My conclusions, having been closely involved in this process over the past year, are that this is a very valuable exercise, which has shed much new light on the mechanics of economic growth and the differing relative strengths of regions and individual states.

However, the Global Competitiveness Report is unlikely to provide a satisfactory template for governance in all parts of the world. Just as the IMF has been unable to impose its own standard criteria in many parts of Africa, Asia and Latin America, the current pursuit of an ideal formula for competitiveness through free market principles is likely to be very widely frustrated. Within Asia, for example, there are many patterns of mixed economies where governments will find their own routes to enhanced growth through developing their own technologies and absorbing technology from external sources in their own way, routes and patterns which are not at all easily captured by sets of global principles, however detailed.

The Gulf States

The Gulf states have, of course, a central pivotal part to

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play in the global economy through the provision of adequate oil and gas for the next fifty years at least – with probably a doubling of current Gulf aggregate production levels necessary to meet global demand. Even by 2030, the global economy will need 66% more energy (says the International Energy Agency) and in the key energy commodity, oil, the OPEC countries are expected to have increased their market share of global production from 39% to over 50%

In technology transfer terms, these states have a marked advantage in long-standing exposure to the international oil industry. Yet despite massive revenue from oil and gas exports, the leading Gulf producers still need to diversify their economies and to attract new foreign technology and external capital on a scale to give themselves self-generating new technology capacity and an adequate rate of economic growth to match or surpass their high population growth, employment needs and welfare expectations.

Gulf and Asia/Pacific Region Symbiosis

Already the bulk of oil and gas exports from the Gulf flows to the Asia/Pacific countries. This switch from the time when the bulk flowed to the Atlantic Basin is not likely to be reversed. The Asia/Pacific share is rising steadily.

We can be sure that this growing interdependence between the Gulf states and the leading Asia/Pacific states will be expressed in close bilateral trading and political relationships, such as those already established on a firm footing by China, Japan, Korea and India.

Background

Through the summer of 2002 I have been working on the 400-page report of the World Economic Forum (WEF) , *The Arab World Competitiveness Report,* covering the 22 member states of the Arab League and drawing on substantial inputs from all Arab governments, the Arab League, OAPEC and many other pan-Arab organisations.

My own assignment was simply to examine in detail the competitiveness of the Hydrocarbon Sector – almost entirely Oil and Natural Gas – and to come to a set of Conclusions and Probabilities for the Medium (to 2010) and Longer term (to 2050).

The Arab World Competitiveness Report has now been published as a follow-up to the WEF *Global Competitiveness Report 2001-2002* published earlier in the year. This latter study ranks 75 leading economies according to their current and potential growth, the stability of their infrastructure, their degree of globalization and their ability to attract and self- generate new technology.

Not a single Gulf state features in the *Global Competitiveness Report* which in my view is regrettable as this omission and the omission of the Central Asian states represent a substantial distortion of the global view represented. The *Arab World Competitiveness Report* goes some way to remedy this omission, but, of course, there is still no analysis of the standing and ranking of one major Gulf state, namely Iran.

A Significant Caveat

The more I think about these matters, the more doubtful I become about whether the criteria used by the World Economic Forum and the World Trade Organization are necessarily the right ones for the Gulf states or, for that matter, for India, China and Asia in general.

At first sight, it appears rather naïve to identify the free market characteristics of the most affluent industrial states and then to expect all the rest of the world to emulate that pattern, and to be ranked accordingly (in 175 separate categories), come what may. It is rather surprising that many small affluent industrial states, some very small, come out at the top of the WEF list as shown below:

World Economic Forum Global Compeitiveness Report 2001-2002

Overall Competitiveness Index Ranking

1. Finland	17. Germany
2. United States	20. France
3. Canada	
4. Singapore	21. Japan
5. Australia	23. Korea
6. Norway	
7. Taiwan	39. China
8. Netherlands	57. India
9. Sweden	
10. New Zealand	63. Russia
11. Ireland	
12. United Kingdom	

My conclusion is that while the WEF report is rigorous in discerning the great variety of economic mechanisms world-wide, its surveys and rankings are more concerned with political attitudes and conformity to a broad North American/European model than to the economics and to the reality of where the major advances in new technology are being generated and developed.

Most observers would agree that, while the United States retains the top position as technology generator, South China is now laying claim to the global lead in manufacturing and international trade. These fundamentals are rather obscured in the mass of detail in the WEF reports and rankings.

Clearly, it is very difficult to aggregate all this disparate material into one table of results in any meaningful way. We would also have to examine the statistical reporting in detail to determine whether this was objective and appropriate or whether it relied on a judgmental view of a limited number of economists and other experts, many without experience on the ground. And we would need to review the weights ascribed by the WEF to the various components.

The results seem to imply, for example, that Finland (No.1) makes a stronger contribution to new global technology than Japan (21st), Korea (23rd), China (39th), India 57th, or Russia (63rd). This, of course, would be nonsense. All that we can learn from this WEF analysis and ranking is that tiny Finland may fit the "ideal" globalization model more closely than any other state.

Where, we might ask, has been the predominant region of the world for the last decade or so in terms of the largest share of global economic growth and the largest share in new international trade. The answer, of course, is Asia led strongly by China and India.

If, by contrast, we were to evaluate all the new technology developed in China and India in the last decade under conditions of strong economic growth and stable political governance and if we were to go on to calculate a

total or index for China, Japan and India, each would probably be at a level well in excess of nine of the top ten states listed in the overall growth competitiveness index of the World Economic Forum.

China, for example may not have developed all its new technology by subscribing to free market principles and, without doubt, it has its own ways and techniques for stimulating infrastructure development. In the decades ahead, we may well find that the Chinese development model and the pan-Asia model first pioneered by Japan and Korea and the experience of India and other Asia Tiger economies may be more attuned to the needs of the rest of Asia, where they may be, therefore, more comprehensible and probably more effective.

Consider India with its vibrant new technology centered in Bangalore, Mumbai, Dehra Dun and a dozen other major cities, the second largest economy in population terms in the world and a key leader in world trade, clearly far more important for the future than the likes of Finland.

Conclusion

It seems to me, therefore, that China, India, Japan and much of the rest of the Asia-Pacific area are already developing strongly, each along their own lines. Their already high and growing dependence on energy supply imported from the Gulf may quickly express itself in bilateral trading patterns and commitments of a geo-political nature which will substantially challenge the assumptions of global free trade in Gulf oil and natural gas and the concept of homogenous global product and petrochemical markets as so vigorously espoused at present in North America and Western Europe.

Of the vital importance of the Gulf states to the global economy over the next fifty years, there is no question. It will be in the primary interest of both East and West, of both the industrialized and the developing world, that the Gulf area remains a stable and secure source of global energy supply.

A Note on Globalization

Successful economic development is defined in the Executive Summary of the *WEF Global Competitiveness Report* as follows:

> "Successful economic development is a process of successive upgrading, in which businesses and their supporting environments co-evolve, to foster increasingly sophisticated ways of producing and competing."

High levels of investment and the acquisition of new technology are seen as the key to this process:

> "As economies move from low- to middle-income status, global competitiveness becomes Investment-Driven, as economic growth is increasingly achieved by harnessing global technologies to local production."
>
> "Foreign direct investment, joint ventures, and outsourcing arrangements help to integrate the national economy into international production systems, thereby facilitating the improvement of technologies and the inflows of foreign capital and technologies that support economic growth."

A Note on Oil Market Fundamentals

I would like to remind you of four of the fundamentals of the oil market today and of their consequences in any examination of future prospects for global economic growth and consequences for global energy demand.

Population Growth

UN estimates indicate a global population rising strongly with very severe employment strains over at least the next thirty years, as the recent "bulge" of high birth-rates (hopefully) works itself out. The move from country to town is expected to continue with 80% of the global population living in towns by 2050.

Energy Demand Growth

A predicted real economic growth rate of 3.5% p.a. to 2050 (less than the growth rate over the last 50 years) would indicate, on current growth/energy elasticities, a tripling of global energy demand by 2050.

Increasing efficiency of energy use might cut this growth to a doubling by 2050, but is unlikely to achieve much more. Pessimistic scenario builders point to dislocation by terrorism, regional struggles and environmental problems on a global scale but even they, in their darkest moments, concede that energy demand will continue to grow, even if irregularly and more slowly.

Energy Supply

It is widely accepted, given the characteristics of the capital stock and long-term character of energy investment, that the bulk of incremental energy will have to come from oil and natural gas, at least over the next thirty years. Also, that the bulk of that incremental oil and natural gas will have to come from the Gulf States, who already control over 60% of proven global reserves of oil and 35% of natural gas.

International Trade in Oil

In the international trade in oil, the Gulf states have current dominance of the oil market, being the source of about 50% of global crude oil exports. Whereas one-third of their production used to go East and two-thirds West, the ratios are now reversed with two-thirds going East. This is a structural change in the market of major significance. It is not likely to be reversed and indeed the large share going East will probably continue to rise.

The Canada-U.S. Energy Relationship *(continued from page 14)*

Footnotes

[1] The information contained in the last three paragraphs is based on data available in publications and websites maintained by the U.S. Department of Energy's Energy Information Administration and Statistics Canada.

[2] This situation would be even worse but for efforts by Aboriginal groups to cooperate with another, thus reducing the number of distinct interveners.

[3] Gary Horlick, Christiane Schuchhardt, Howard Mann (2002) "NAFTA Provisions and the Electricity Sector", background paper prepared for the Commission for Environmental Cooperation of North America, Montréal, June.

[4] This proportion is up from about 76% in 1991, according to the U.S. Department of Commerce's Office of Trade and Economic Analysis.

Increased Concentration in the Norwegian Electricity Market: Is the Market Sufficiently Open, or Can a Dominant Norwegian Power Company Raise Prices?

*By Tor Arnt Johnsen **

Many restructured electricity markets have experienced market power problems. Market power has not played an important role in the Norwegian market. International comparisons show that Norway has low prices. If market power has been applied, it has not led to large price increases for long periods. However, market concentration has increased over recent years, and privatization of major electricity producers may be part of future development. In order to continue to have a well-functioning and efficient power market, it is important to maintain a concentration level that stimulates competition.

Introduction

Since 1991, when the Norwegian electricity market was liberalized, mergers and acquisitions have led to a reduction in the number of generators. Statkraft, the large state-owned generator is one of the companies that has grown through various acquisitions. In Norway, the Competition Authority has to approve mergers and acquisitions and until 2001 they allowed this structural change to continue. However, when Statkraft in 2001 bought 45.5 percent of the shares in Agder Energi, the Competition Authority did not approve the transaction. The Ministry of Labor and Government Administration has the final word in such cases. Finally, the Ministry gave Statkraft permission, with conditions, to buy the shares of Agder Energy. The conditions were that Statkraft sell its shares in E-CO (Oslo Energy) and HEAS (Hedmark Energy). In addition, Statkraft has to sell 1 TWh of capacity. However, if the transmission capacity into South-Norway is increased by 200 MW before a given time, this last condition (1 TWh sale) may be dropped. However, Statkraft continues to expand and recently acquired 100 percent of the shares in Trondheim Energiverk, another large generation firm. The Competition Authority has stopped this case as well.

These cases have triggered discussion about market power issues within the Nordic and in particular Norwegian electricity market. In this article, we describe these markets, and we discuss how a dominant hydropower generator may apply market power in the Norwegian power market.

The rest of the article is organized as follows: In the next section, we give a brief description of the physical production and transmission system in the Nordic area, and we give some background information about the liberalization that was undertaken in 1991. Next, we describe the current structure and concentration at the supply side of the Norwegian market. Thereafter, we discuss market power in a Norwegian context. We focus on a hydropower production system with transmission connections to neighboring countries with thermal power production systems. In particular, we focus on the potential for using market power within seasonal and daily time horizons. Finally, we draw some conclusions.

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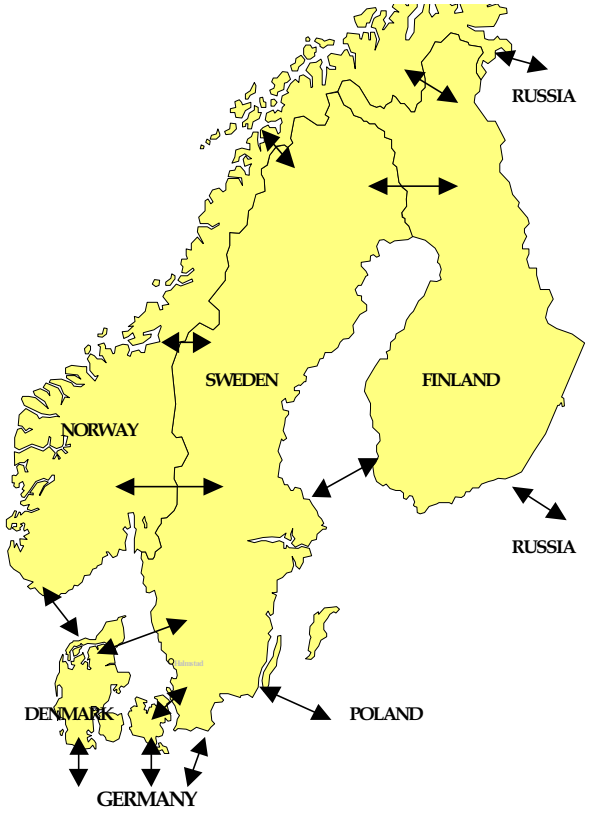
Background

The Nordic Power System

Annual power consumption in Norway is 125 TWh, while total Nordic consumption is about 380 TWh. Thus, we are talking about a market of the same magnitude as the British or German power markets. Figure 1 shows the geographical area and transmission connections between the Nordic countries and between the Nordic area and other European countries.

Figure 1
The Nordic Electricity System



There are a large number of transmission lines and sea cables between Nordic countries and between Nordic countries and non-Nordic countries, see Table 1.

Table 1
Transmission Capacities, MW

From: To:	Norway	Sweden	Denmark	Finland	Non-Nordic Countries
Norway		3170	1040	70	50[a]
Sweden	2990		1840	1700	1200[b]
Denmark	1040	1840			1400[c]
Finland	100				0
Non-Nordic Countries	50	1200	1800	1500[d]	

[a] To Russia, [b] To Germany and Poland, [c] To Germany, [d] From Russia
Source: Haug and Johnsen (2002).

Transmission capacities depend on the actual network configuration, and capacities are not always the same in both directions. Table 1 gives upper estimates of available capacities.

There are large differences with respect to generation technologies across the Nordic countries, see Table 2.

Table 2
National Power Generation in 2001. TWh

	Hydro	Nuclear	Other Thermal[a]	Wind
Norway	121		1	
Sweden	78	69	10	
Denmark			32	4
Finland	13	22	36	

[a] Condensing, district heating and industrial back-pressure stations fueled by coal, gas, oil and biomass.
Source: Nordel (2002)

More than 99 percent of Norwegian generation is hydropower. In Sweden, almost 50 percent of generation came from hydro in 2001, while nuclear power accounted for about 40 percent and the rest was conventional thermal. Swedish hydropower has a larger fraction of run of river generation and relatively less reservoir capacity than in Norway. Coal based thermal power dominates in Denmark. Heavy subsidies to wind power projects in Denmark have led to an increasing share of wind power. In 2001, wind covered more than 10 percent of generation. Finland has hydro, nuclear and conventional thermal power. In Finland hydro accounts for only 20 percent of generation, 30 percent is nuclear, while the rest is conventional thermal power.

Restructuring Status

The Norwegian power market was restructured in 1991. Unbundling of generation and network services and mandatory separation of the accounts for generation, transmission, distribution and sales activities were introduced. Generation and sales are competitive, while transmission and distribution are regulated natural monopolies. Transmission and distribution are from 1997 due to income regulation with the income revised every fifth year. The regulatory authority is the Norwegian Water Resources and Energy Directorate (NVE).

Power is traded in voluntary day-ahead, futures and forward markets. Based on predicted generation, consumption and network availability, the system operator, Statnett SF, defines the geographical zones into which the day-ahead market is divided. Normally, two or three Norwegian zones are declared ahead of each season. Bilateral trade between parties located in different zones has to be bid as sale in the generating zone and purchase in the consumption zone. Zones expected to last for less than three days are normally not defined. Short term transmission congestion and short run discrepancies between demand and supply are treated in a real-time market operated by the system operator.

Finland (1995), Sweden (1996) and Denmark (1999/ 2000) have followed in Norway's footsteps and liberalized their national electricity markets. Sweden and Finland do not apply price-zones when there are bottlenecks within the national grids. These two national markets are separate zones at Nord Pool, and the national system operators relieve intrazonal congestion by sales and purchases in the real-time (balancing) market. The word "counter-trade" is used when the system operator buys and sells in order to eliminate national bottlenecks. Denmark consists of two parts, East- and West-Denmark, that are not electrically connected. Thus, there are two Danish price-zones. The two Danish system operators apply counter-trade if there is transmission congestion within any of these two zones.

The Nordic power exchange, Nord Pool, is the most important marketplace. Nord Pool's day-ahead market consists of 24 hourly markets. Market participants prepare and submit bids for the coming day before noon the day before, or 12 to 36 hours prior to the actual hour. Available information is the number and configuration of price areas and the transmission capacities between the price areas determined by the Nordic transmission system operators.

Structure at the Supply Side

Table 3 shows the largest Norwegian hydropower producers and their market shares based on expected generation in a year with normal hydrological conditions.

Table 3
Market Shares in Norway and the Two Most Common Norwegian Price-zones.
Percent Calculated From Generation (TWh) in a Year With Normal Precitipation

	Norway	South-Norway	Mid- and North-Norway
Statkraft and partners[a]	41	38	50
E-CO[b]	8	10	
Norsk Hydro	7	10	
Agder Energi	6	9	
Lyse	5	7	
Trondheim Energiverk	3		11
Nord-Trøndelag	2		9
Trønder Energi	1		5
Salten	1		4
Other	24	26	21
Herfindahl-Hirchman Index	0.19	0.18	0.28

[a] Partners are companies where Statkraft owns more than 49 percent or more of the shares. BKK (49.9 percent), HEAS (49) and Skagerak (66.6) are included.
[b] Statkraft owns 20 percent of the shares in E-CO
Note: Statkraft owns 35 percent of the shares in the Swedish company Sydkraft, which owns 26.5 percent of the shares in Hafslund. E-CO owns 30 percent of the shares in Buskerud.
Source: Norwegian Competition Authority (2002).

Statkraft is a large state-owned producer with power plants in many different parts of the country. At the national level, Statkraft, including companies where Statkraft owns 49 percent of the shares or more, have a market share of 41 percent. In addition, Statkraft owns, directly or indirectly through a third company, smaller parts of seven other Norwegian producers. Most frequently, Norway has two price-zones, South-Norway and Mid- and North-Norway. Statkraft and partners have a market share of 38 percent in South-Norway, while Statkraft's market share in Mid- and North-Norway is 50 percent. The Herfindahl-Hirchman Index (HHI) is 0.19 at the national level, 0.18 in South-Norway and 0.28 in Mid- and North-Norway.

If we add Agder Energi and Trondheim Energiverk to Statkraft and partners, Statkraft's shares of the market become 50, 47 and 61 percent in Norway, South- Norway and Mid- and North-Norway, respectively. The accompanying HHI will change to 0.27 at the national level and to 0.25 and 0.39 for the two regions. Consequently, the two acquisitions, if they are completed, will increase market concentration

substantially.

In a Nordic context, Statkraft and partners have a market share of 12 percent. It increases to 15 percent if we add Agder Energi and Trondheim Energiverk. Vattenfall, the large Swedish producer, and the Finnish company, Fortum, are the largest Nordic producers with market shares of 21 and 15 percent.

Market Power Within a Hydropower System

Norwegian power generation is purely hydroelectric. Normally a power plant consists of a water reservoir, the power station with one or more turbines and one or more pipelines that connect the reservoir and the power station. Water is collected from snow melting mainly in June, July and August and from rainfalls throughout the year, most intensive in September and October. The load is highest in the winter, November to April. The national reservoir capacity is 81 TWh or about 75 percent of annual consumption. Consequently, storage of water and the disposal of the water resources over time become seriously important decision variables for power producers.

If producers know that by acting strategically they are able to affect the market price in a profitable way, they will try to increase the price level. Traditionally, it is normally assumed that the strategic behavior is to withhold output in order to reduce supply and increase the price. However, if a hydro producer withholds generation, he will end up with more water in the reservoir. Over time this may lead to spill and lost production possibilities. In addition, overflow and spill of water may be observed, and producers that spill water run the risk of being detected by the authorities. For a thermal power generator, the difference between the market price and marginal cost for the last produced units may be zero or very low. Therefore, the loss from withholding production may be very low for a thermal producer. For a hydropower producer spill implies lost production and since spilled water has no opportunity value the loss per unit may be large.

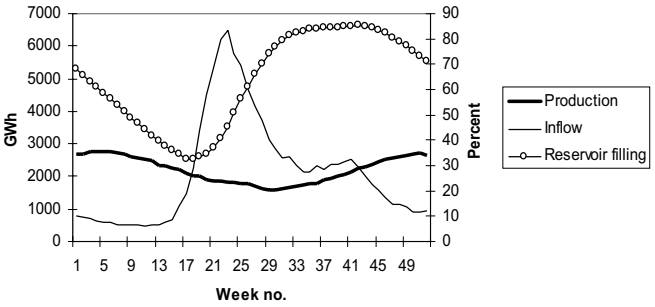
While the withholding of hydropower generation and spill of water definitely are profitable for producers that are large enough, we do not consider such strategies in this article. A large number of academic articles and papers discuss withholding strategies at length, and the outcomes of such strategies are well known. Therefore, we focus on applications of market power in hydro systems under an assumption of no spill of water.

Seasonal Aspects

Figure 2 shows the typical seasonal pattern of power production and water inflow in Norway over the course of a year. During the winter, production is larger than inflow and water is withdrawn from reservoirs. Normally, the amount of water in the reservoirs decreases until week 18. At this time snow melting accelerates and reaches a maximum around week 24. Inflow stays higher than production until week 42, when there are lower temperatures in the mountains and the precipitation turns out to be mostly snow. Between week 42 and week 18 the next year, production mainly relies on the water stored throughout the summer.

There are large variations in inflow in the short-run, and from year to year. The annual production potential may vary at least +/- 25 percent compared to the production in a year with normal precipitation. The hydrological situation – water storage and snow volumes – are very important for the price formation, see Johnsen (1998). The most important cost component related to hydropower generation is the opportunity value of water, or the discounted expected market price in the future. Future market prices will depend on the expected inflow and the water available in the reservoirs. The decision on how much to produce today and how much to store, is made under uncertainty.

Figure 2
Production and Inflow (left axis) and Reservoir Filling (right axis) for the Norwegian Hydropower System.
Weekly Averages Based on the Period 1991-2000



Source: Nord Pool ASA and Statistics Norway.

During summer, producers will compare the market prices with expected prices for the coming winter and be more willing to store water if the actual prices are lower than discounted expected prices for the winter. However, since reservoirs have a maximum capacity there is a probability of overflow by the end of the summer. As this probability increases, the profitability of storage is reduced, and the link between summer and winter prices becomes weaker.

In the winter season, we expect producers to compare the current price and the discounted expected future prices. If the probability of empty reservoirs and high prices by the end of the winter increases, producers reduce their use of water and store more for the future. Consequently, current prices rise.

A dominant producer may find it profitable to deviate from the competitive behavior sketched above. By producing more at the beginning of the summer and winter seasons he will reduce the probability of overflow in the autumn and increase the probability of low reservoir filling by the end of the winter. Whether such a strategy is profitable or not depends on a large number of assumptions. The dominant producer's market share, price elasticities and other producers' response are important variables.

However, the uncertainty about future conditions is large and hydrological conditions change continuously. Ex post, producer strategies may look inoptimal, while they actually were optimal ex ante. Because of the large uncertainty, it is also hard to distinguish between strategic behavior due to imperfect competition and rational price-taking behavior.

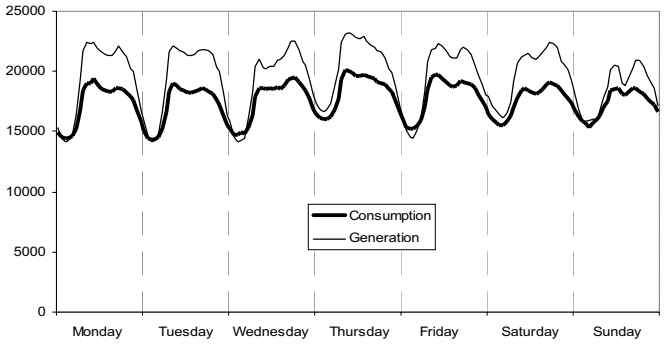
Hourly Considerations

While strategic movement of water and production within seasons has to take into account the inflow uncertainty, short-term production decisions within the day can be made without considering hydrological uncertainty. However, market conditions change drastically over the course of a day.

Figure 3 shows consumption and generation in Norway hour by hour throughout week 51 – 2001. Generation rises

more than 50 percent from night to day and varies more than consumption does. During this particular week, there were only a small number of hours with import. Night generation was close to the actual consumption, while there was heavy export during daytime.

Figure 3
Norwegian Electricity Consumption and Generation
Week 51 – 2001. MWh/h

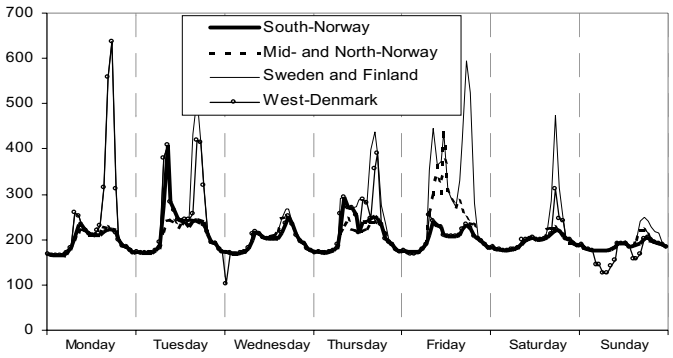


Source: Nord Pool ASA

Norway's neighboring countries have electricity systems dominated by thermal power, see Table 2. Thermal power is less flexible than hydropower, and it is costly to regulate output up and down in the short-term. Consequently, thermal power producers prefer stable output, and they are often willing to continue to produce during night in order to avoid stopping. Similarly, they need high prices during the day to make it profitable to start up new units for production during daytime only.

The large variation in consumption over the day and the thermal power cost structure result in larger price volatility in thermal systems than in hydropower systems. Day-ahead prices for week 51 – 2001 are illustrated in Figure 4.

Figure 4
Nord Pool's Day-ahead Prices
Week 51- 2001. NOK/MWh*

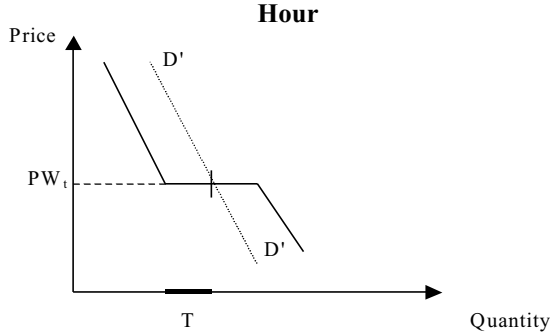


*1 US$ is approximately 8 NOK
Source: Nord Pool ASA

As expected, prices in Norway are more stable than prices in neighboring countries. Every day there are peak periods with lower prices in Norway than in the other countries. Price differences mean that the available transmission capacity is fully utilized. In periods with lower prices in Norway than in other areas, there is export at full capacity, and Norway is a separate market. In periods without price differences, the transmission capacity is not used and there is an integrated Nordic market. As indicated above, Norwegian prices are lower than foreign prices only in hours where the Norwegian prices, consumption and generation are at their highest levels.

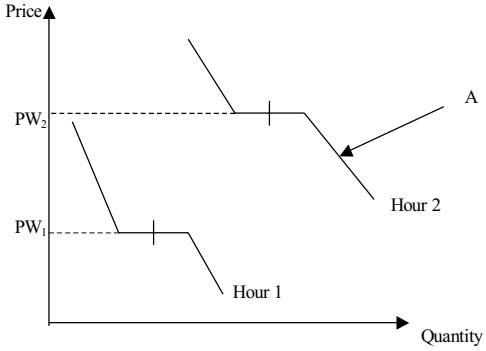
We can illustrate the market situation given by Figures 3 and 4 within a simple graphical example. For a moment, we assume prices in neighboring areas to be fixed. This assumption allows us to draw the demand curve directed against Norway's incumbent generators as in Figure 5.

Figure 5
The Demand for Electricity in Norway in a Particular Hour



Norwegian electricity demand is given by the dotted curve D'-D'. At prices above the foreign price (export/import price, PW_t), demand directed towards Norwegian producers is shifted leftwards by a quantity equal to the import capacity (T). If price is lower than the foreign price (PW_t) demand is shifted rightwards with the export capacity (T). Each of the 24 hours throughout a day may be described with a figure similar to Figure 5. The only difference is the level of PW_t and the level of Norwegian demand. A typical pattern for two different hours may be as indicated in Figure 6.

Figure 6
Demand in Two Hours



Hour 1 is a night hour with low international prices and low demand in Norway. Hour 2 is an hour with high demand and high international prices.

The power supply from Norwegian generators determines the local price levels and power exchange with neighboring regions. We do not know the level or curvature of the marginal cost curve. However, even without knowledge about marginal costs it is easy to see that power producers have a common interest in not being export-constrained in hours with high demand and high prices in neighboring areas. Increased generation when export capacity is filled up, has, when the price elasticity is small, dramatic consequences for the price.

If, for instance, the perfectly competitive solution is market clearing in the point A in Figure 6, producers have a

strong incentive to reduce generation in hour 2. Reduced generation in hour 2 will increase price for a large generation volume. The quantity of water that is saved can be produced in another hour in which there is no transmission congestion. Without transmission congestion, the increased production is absorbed in a complete Nordic (or even European) market, and the price decrease will be modest.

A Numerical Example

In order to discuss strategic behavior within this hourly model, we will apply a simple numerical example. We consider strategic movement of water between two hours of the same day. We compare a competitive benchmark with a situation where a large generator (leader) with a market share of 50 percent, moves output from the hour with high demand, high price and export constraint (hour 1) to an hour with low demand, low price and an integrated Nordic market (hour 2). A competitive fringe consisting of a large number of smaller producers constitutes the rest of the market. The total generation capacity is 23000 MW, and the leader and fringe have a capacity of 11500 MW each.

With a competitive solution, Norwegian demand is 18000 MW in hour 1 and the competitive price is 200 NOK/MWh. There is export at full capacity (3600 MW) and Norwegian generation is 21600 MW. The leader and fringe produce 10800 MW each. The Swedish price in hour 1 is 300 NOK/MWh. In hour 2, the Norwegian and Swedish prices are equal – 150 NOK/MWh. Generation equals consumption and is 14000 MW and there is no foreign trade. The leader and fringe produce 7000 MW each. The competitive solution and resulting producer incomes are indicated in the left panel of Table 4.

The right panel of Table 4 gives the market outcome when we allow the leader to act strategically. He finds it profitable to reduce generation in hour 1, and he reduces output until the bottleneck between Norway and Sweden disappears. We assume the price elasticity within Norway to be constant and equal to –0.05. With this elasticity, Norwegian consumption falls with 361 MW as the price in hour 1 increases from 200 to 300 NOK/MWh. However, the leader needs to reduce his output by a larger quantity in hour 1, because the strong price increase motivates the fringe to generate as much as possible. Thus, the fringe increases output from 10800 MW to maximum output, which is 11500. Therefore, the leader has to reduce output by 1061 MW in hour 1. Both the leader and fringe benefit heavily form this behavior. Compared with the competitive solution, their incomes in hour 1 rise by 760.000 and 1.290.000 NOK, respectively.

Since the leader reduces output in hour 1, he has to increase output in hour 2, and the price in hour 2 decreases. The price reduction and the increase in the fringe's generation in hour 2 lead to lower output from the fringe in hour 2. The net increase in generation in hour 2 equals the consumption reduction in hour 1, which was 361 MW. Since there are no transmission constraints in hour 2, this quantity is absorbed in the complete Nordic market. We assume the price elasticity to be the same as in hour 1, -0.05. Given an initial Nordic consumption in hour 2 of 35000 MW, the price in hour 2 falls from 150 to 122 NOK/MWh. Compared to the competitive solution, both the leader and fringe receive lower incomes in hour 2, -65.000 and –280.000 NOK. However, the net change in income from hour 1 and 2 is 700.000 NOK (+23 percent) for the leader and 1.000.000 NOK (+30 percent) for the fringe. The detailed figures for the competitive and leader/fringe market solutions are shown in Table 4.

It is worth noting that some of the increased generation in hour 2 is exported. In aggregate, the quantity supplied in the Norwegian market is reduced. This behavior is, therefore, comparable with "dumping".

The calculations in Table 4 may be done for other values of critical parameters. Price elasticity, price level in Sweden, Norwegian demand level and the market share of the dominating firm are important variables. With respect to price elasticity it has two opposite impacts. First, larger price elasticity will increase the consumption reduction in hour 1,

Table 4
Impacts on Market Prices and Producer Income

		Competitive Solution			Large Producer Withholds		
Variable	**Unit**	**Norway**	**Large**	**Fringe Producer**	**Norway**	**Large**	**Fringe Producer**
Generation capacity	MW	23000	11500	11500	23000	11500	11500
Hour 1: An hour with export at full capacity and higher price in Sweden than in Norway							
Generation	MW	21600	10800	10800	21239	9739	11500
Consumption	MW	18000			17639		
Price in Norway	NOK/MWh	200	200	200	300	300	300
Price in Sweden	NOK/MWh	300	300	300	300	300	300
Sales income	NOK		2,160,000	2,160,000		2,921.627	3,450,000
Change in sales income	NOK					761,627	1,290,000
Hour 2 : An hour without transmission congestion and equal prices in the Nordic area							
Generation	MW	14000	7000	7000	14361	8061	6300
Consumption	MW	14000			14144		
Price in Norway	NOK/MWh	150	150	150	122	122	122
Price in Sweden	NOK/MWh	150	150	150	122	122	122
Sales income	NOK		1,050,000	1,050,000		984,699	769,559
Change in sales income	NOK					-65,301	-280,441
Aggregate change in incomes:							
Sales income hour 1+2	NOK		3,210,000	3,210,000		3,906,326	4,219,559
Net income change	NOK					696,326	1,009,559

and the leader has to reduce output more in order to receive the Swedish price. Second, increased generation in hour 2 will lead to a smaller price reduction if the price elasticity is large. This will reduce the losses in hour 2.

With respect to other values for the differences between the Norwegian and Swedish price in hour 1, Norwegian demand and the market share, there will be combinations that make it unprofitable to act as a leader. Other combinations make it profitable to apply the leader strategy. Throughout the 8760 hourly markets of a year there will clearly be many opportunities for a dominant producer to increase price and income through a strategic behavior as sketched here.

We have not focused on the welfare implications in our example. Traditional deadweight losses will be relatively small since price elasticity is low. Since the overall price level is affected, long-term decisions are affected as well. In addition, many authors question the deadweight loss as a good indicator of the welfare impacts of market power abuse. Unproductive profit seeking and X-inefficiency are keywords in that debate, see Posner (1975).

Concluding Remarks

While there are no clear signs of market power in the Norwegian market today, increased concentration may lead to higher prices in the future. Dominant generators may apply market power in various ways. In this article, we have discussed redistribution of output over the day or season. Limited transmission capacity and differences in the generation technology mix across the Nordic countries, make it possible for a dominant Norwegian hydropower producer to affect Norwegian power prices in a profitable way. Market power reduces efficiency, and market participants do not trust in the market any longer. Therefore, it is important to limit the number of new mergers and acquisitions in this market and thereby avoid increased concentration.

References

Contact the author for references.

2004 IAEE International Conference Planning Meeting, 8 December 2002, Tehran, Iran, Hosted by the Iranian Association for Energy Economics (IRAEE)

Pictured from left to right: Jan Myslivec, Czech IAEE Affiliate, David Williams, IAEE, Majid Abbaspor, IRAEE President, Tony Owen, Australia Affiliate & 2004 IAEE President-Elect, Arild Nystad, IAEE VP for Conferences & IAEE Past President, Reza Farmand, IRAEE Board Member, Mohammad Mazraati, IRAEE/IAEE Member, Seyed Alavi, IRAEE Board Member and 04 IAEE General Conference Chair, Mohammad Reza Omidkhah, IRAEE Board Member and Gholam Hosein Hassantash, IRAEE Vice President

IAEE leaders were present at the 7th IIES International conference in Tehran December 8-10, 2002. The conference is also hosted by the Iranian Association for Energy Economics (IRAEE) and proved to be a most opportune time to meet with Affiliate leaders to discuss progress in planning of the 2004 IAEE International Conference to be held in Tehran, Iran – **April 30 – May 3, 2004.**

The IIES Conference entitled "The Impact of Globalization on Middle East Oil and Gas Industry" highlighted current research and developments affecting the Middle East as it supplies petroleum/gas worldwide. The conference was chaired by IAEE member Dr. Seyed Alavi and convened with noteworthy speakers including:

Dr. Fereidun Fesharaki, President, FACTS, USA
Mr. David Fitzsimmons, Group Vice President, BP, UK
Mr. Olav Fjell, President & CEO, Statoil, Norway
Mr. Masahisa Naitoh, Vice Chairman, Itochu, Japan
HE Bijan Zanganeh, Minister of Petroleum, I.R. Iran

IAEE representatives attending this meeting and discussing the developments of the 2004 IAEE International conference consisted of Dr. Arild Nystad-Norway (IAEE Past President & Vice President for Conferences), Dr. Anthony "Tony" Owen-Australia (IAEE 2004 President-Elect & Past Conference Chairman), Mr. Jan Myslivec- Czech Republic (2003 IAEE General Conference Chairman & Council Member), and David Williams-USA (Executive Director, IAEE).

IAEE saw first hand how active and devoted the Iranian Association for Energy Economics is to planning a most successful International conference on behalf of the association in 2004. Seen above is a picture of those in attendance at the Affiliate/IAEE planning meeting for the conference. Topics discussed included conference content, (e.g., representation of a well balanced program), special technical and social tours, conference venue and attracting an international IAEE audience to Tehran.

IAEE witnessed the ease of travel to/from Iran as well as how welcome the Iranians make everyone feel. The IRAEE is pledged to provide a superior conference and we encourage all IAEE members to mark their calendar for this meeting. IRAEE members will attend the Prague conference to promote the meeting and solicit for program support. If you are interested in participating in the program committee please send an email to David Williams at iaee@iaee.org indicating your energy expertise and intended contribution to the 2004 program committee for consideration.

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Challenge and Opportunity for a Sustainable Future of Korea

*Hoesung Lee**

Korea[1] is one of the big emitters of greenhouse gases in the world. Currently, its total CO_2 emissions is 9th largest (U.S. DOE, 2000). Its per capita emission is 2.6 carbon ton and 25th in the world. According to recent OECD reports on environmental indicators, Korea recorded the highest increase in per capita CO_2 emissions during the last two decades. And the GHG emission per GDP is increasing. Currently, it stands at 0.49 carbon ton per million won, increased from 0.46 ten years ago. The World Summit on Sustainable Development asked the world community to initiate policy actions that would reduce ecological stress and thereby enhance the opportunity for sustainable development. Korea, being a newly industrializing country, is at a front facing this challenge and opportunity.

The Korean government declared at the 5th Conference of Parties that the widest possible participation of parties is necessary in order to limit global emissions of greenhouse gases, and this would be possible only if taking such action would not hurt continuous economic growth (Republic of Korea, 1999). It supported an approach to set targets in terms of emissions growth, given a desired rate of economic growth. It further stated that Korea would participate, on a voluntary and non-binding basis, in a regime of limiting greenhouse gases formulated along those lines.

Given the scientific evidence of global warming[2] and the increasing worldwide pressure for policy responses addressing climate change, the views by the Korean government, or any government in a similar situation, seem rather weak and confused. This should be understandable because Korea is saddled between developing country reality and status as an OECD member.

Policy Actions to Reduce GHGs

Policy actions in Korea are aimed at improving energy and materials efficiency in various sectors of the economy and stimulating fuel substitution in the energy system. The Korean government established an "Inter-agency Committee to Combat Climate Change" in the Prime Minister's Office in 1998 to develop a "National Action Plan to Mitigate Climate Change". The government's official position on the Climate Change treaty negotiations was based on the recommendation made by this committee in 1998. It agreed that Korea would consider mandatory commitment for the 2018-2022 period, and for the interim period would consider establishing a non-binding voluntary target and accomplishing it.

The Inter-agency Committee has drawn up a comprehensive response strategy to climate change, with inputs from various Ministries and research institutions. It covers policy actions designed to reduce future emissions of carbon dioxides from a various sources including industry, transportation, residential and commercial sectors, electricity generation, agriculture, and waste management sectors.

Industrial Sector

The Voluntary Agreement system has been established since 1998. The agreement stipulates voluntary targets in excess of 8% for carbon dioxides reduction or energy efficiency increases for the 5-year period. Participating firms would receive from public funds subsidized financing for the necessary investment for achieving targets.

Subsidized financing is also available to promote the dissemination of energy efficient equipment. The financing covers both the initial cost of purchase and the ensuing running cost. To lower the entry barrier facing high energy efficient equipment, the entire purchase cost of equipment receives subsidized financing. The government also created publicly funded risk capital, specially earmarked to provide financing to venture firms developing high energy efficient equipment. Technology R&D for energy efficiency improvement would receive public funding also.

In addition, some sectors are subject to mandatory use of energy efficient equipment. All government buildings, since 1999, must use energy efficient equipment. The government also issued "Energy Conservation Construction Design Standards for Multi-unit Residential Structures" in 1999 under which apartment buildings with more than 50 housing units must use energy efficient equipment. The government plans to increase the number of certified equipment for high energy efficiency, and streamline the qualifying process. At the same time, it plans to toughen energy efficiency standards for a number of home appliances. And there are many government-sponsored technology seminars and awareness campaigns to promote energy efficient technologies.

Transportation Sector

Policy actions include measures to promote fuel efficient vehicles—light weight sub compact, research support for increasing fuel efficiency, and development of alternative fuels vehicles—and improve overall efficiency through development of environmentally friendly transportation and distribution infrastructure.

Purchasers of light passenger vehicles (engine size less than 1000cc) pay lower taxes on vehicle ownership, less on auto insurance, and receive discounts on highway toll and parking. The government plans to tighten automobile fuel efficiency standards to stimulate technology development for energy efficient transportation. It provides R&D funds to private automobile makers and research institutions for technology to improve fuel efficiency and develop low/zero emission vehicles. The government also provides funds for deployment of CNG buses—both the bus purchase and the installation of CNG distribution networks.

To improve the system efficiency of the national transportation infrastructure, the government enacted the "Transportation System Rationalization Law" in early 1999, and a year later adopted a "National Transportation System Plan, 2000-2019" and established a "Transportation Policy Council" chaired by the Prime Minister. These policy initiatives are to find better investment priorities for transportation infrastructure, determine appropriate transport load distribution, and improve connectivity within the nation-wide transportation system.

Residential and Commercial Sector

Policy actions include measures to improve energy

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* Hoesung Lee is former Co-Chair of IPCC Working Group III, President of Council on Energy and Environment Korea, and a former President of IAEE.

[1] In this paper, Korea refers to the Republic of Korea, commonly known as South Korea.

[2] Most authoritative source of information on climate science is contained in *Climate Change 1995* (IPCC, 1996).

efficiency in buildings and dissemination of district heating and small co-generation. Regulation and standards are critical factors in determining energy efficiency in commercial buildings and residential structures. Through tightening of the "Construction Design Standards for Energy Conservation in Buildings", the government expanded the mandated adoption of energy efficient equipment. The government provides R&D funds for energy conservation technology development. It plans a labeling system for building energy efficiency. Two ministries, Energy and Construction, work closely to expand the district heating system to new housing development projects.

Electricity Generation

In addition to increases in nuclear and LNG powered electricity generation, the government also plans to increase renewables-based electricity generation. These will be mostly for remote area power service through wind power or photovoltaics. R&D for alternative energy technology has been conducted in accordance with the National Ten-year Plan for Energy Technology Development, established in 1997. Its goal is to supply 2% of total required energy through alternative energy technology by 2006.

Impact of Policy Actions

The combined effect of these policy actions is estimated to reduce CO_2 emissions by 27% relative to BAU in 2020. This reduction reflects energy saving (23%) and fuel substitution (4%). Total amount of reduction, according to government assessment, is judged to be on the high side due to possible double counting (Republic of Korea, 2000). More important is the cost of this reduction in CO_2 emissions. How costly it would be to achieve energy saving and fuel substitution—the cost of policy actions—is not presented in the government study. We cannot know if the array of policy actions and measures would be cost effective.

There are several research results that show the impacts on the economy of a domestic carbon tax designed to achieve hypothetical domestic target CO_2 emissions, or the impact of the Kyoto Protocol on the domestic economy. These studies suffer the usual shortcomings of the top-down macro economic methodology: structural adjustment inherently responding to policy measures is not well analyzed.

Comprehensive bottom-up engineering studies on climate change policy and its relations to the Korean economy are rare. However, one recent study by a University of Delaware research team is worth noting (John Byrne, 2001). Its focus is on energy efficiency improvements and is aimed at evaluating cost effective potential energy savings and CO_2 emissions reductions. The uniqueness of this study is a construction of an energy efficiency database, reflecting Korea's energy end-use characteristics on the basis of, among others, comprehensive technology assessments conducted by the U.S. Department of Energy and its five national laboratories. From the pool of available technologies, only cost-effective efficiency technologies were selected and run through a scenario of energy efficiency improvement. Cost effective criteria differ for each consuming sector. Selection in the industrial sectors was based on energy savings greater than 10% and a payback period of less than 7 years. The residential and commercial buildings technologies were based on a cost of conserved energy of less than 5 cents/kWh. In the case of the transportation sector, a payback period of less than 5 years was required.

The study found that if all identified cost-effective energy saving technologies were implemented, the resulting reduction in CO_2 emissions in 2020 would reach 29%. Compared to the government study, the CO_2 reduction potential in this independent study is much higher, and this potential is based only on cost effective energy saving options, without considering fuel substitution options. The magnitude of 29% energy saving by 2020 would translate to no new nuclear power plants beyond those already under construction, and as a result release capital amounting to US$ 25 billion from would-be nuclear investment.

Conclusions

Policy actions adopted as response to climate change problems in Korea are mostly, in fact, old energy policy that has existed for last two decades. It is now merely packaged and labeled as climate change policy. The existing energy policy is aimed at bolstering industrial activity that has been the backbone of the export-driven economic development of the country. The price of energy to industry is set at lowest of all consumers, and the energy conservation subsidy was given most generously to energy-intensive industries that would have improved energy efficiency on their own without the subsidy, given the competitive pressure they face in the domestic and world market. The subsidy merely replaces private funds and does not induce additional investment for efficiency improvement. These policies are inappropriate as measures addressing climate change problems.

New initiatives are very few. This passive response reflects the low level of understanding of the problems and low priority in decision making. Consumer surveys found that only 2% of the general public recognize global climate change as a problem the Korean government must address. The concern for local environmental degradation overwhelms the concern for global environmental issues among both policymakers and the consumers. This dichotomy misses the larger picture.

The energy sector in Korea has been modernized by two external shocks arising from oil supply and price instability. New fuels were introduced in response to the shocks and the result has been positive throughout the economy. Global climate change problems and policy responses—future external shock—have a potential to revolutionize the energy system in Korea. The new system that will be based on climate friendly technologies will provide a platform for sustainable development for Korea. The challenge is to recognize the availability of cost effective technology options that the country can utilize immediately and improve further through technology development. In this way, Korea can realize a future of sustainable development.

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Prospects of Energy Development in Taiwan Under a Changing Economic Structure

*By Rong-I Wu**

Energy is essential to the operation of the modern economy. Economic growth is closely tied to the production, transportation and use of energy. In general, higher economic growth is associated with higher energy consumption. Because the exploration, development, production and use of energy emit pollutants into the environment, concern for protecting the environment grows with economic development. In addition, many of the conventional fossil energy resources are limited in supply and can be depleted in the foreseeable future. Thus, sustainable development has become a worldwide vision for growth. Applied to energy development, it is sustainable energy development.

In this article, I will review the trends of recent energy and economic developments in Taiwan, and offer my views on the prospects of future energy development from the perspective of sustainable development.

Energy Developments in Taiwan: Trends and Issues

In 2001, total domestic energy consumption in Taiwan amounted to 94.8 million kiloliters of oil equivalent. The largest share of total energy use is in the form of electricity, about 48%. Oil and oil products' share is second with about 39%. The rest are coal and coal products (11%), and natural gas and LNG (3%). In terms of economic sectors, the industrial sector has the largest share with over half of the total (or 57%). It is followed by transportation (15%), residential (12%), businesses (6%), others (6%), and non-energy use (2%). With electricity use, the industrial sector also has the largest share (56%), while the residential sector is second with 20%. Business and other sectors account for 11% each. The transportation sector is the smallest with only about 2%.

From 1981 through 2001, total energy use grew at an average annual rate of 6.9%, while total electricity use grew at 7.8%. Among economic sectors, the business sector has the highest annual growth rate of 11.7% for both total energy and electricity. Residential and other uses of electricity are also the faster-growing sectors, with 8.3% and 9.5% respectively.

In 2001, oil and oil products accounted for over half of Taiwan's energy supply (51%). Coal is second with 32%. The other sources of energy supply are, in order of percent contribution, nuclear (8%), LNG (6%), hydropower (2%) and natural gas (1%). Over the last 20 years, coal grew fastest with 10% annual rate, followed by nuclear at 6.3%. Since 1991, LNG grew fastest at almost a 12% annual rate.

Recent energy developments in Taiwan can be characterized by liberalization, diversification, energy conservation and efficiency, environmental protection/sustainable development, and promotion of renewable energy.

Liberalization. Taiwan has liberalized, or is in the process of liberalizing, her oil, electricity, and natural gas industries. Liberalization of retail, wholesale, refining, and imports of gasoline and other oil products have been largely achieved. Taiwan has opened up the electricity generation market to allow self-generation and an independent power producers. The Electricity Law is being revised to allow additional integrated electrical suppliers, open access to the transmission grid, and establishment of independent system operator. In natural gas, the wholesale price mechanism is being improved, and a second LNG receiving station is being constructed in the northern part of Taiwan. These industries are opened to foreign direct investments. The issues are:

- How to achieve the government's oil reserve target (30 days),
- How to address the problems of illegal market operators, market disruption, and tax evasion,
- Consumer protection ,
- Complete the revision of, and implement, the Electricity Law,
- Remove the barriers to further development in the natural gas industry.

Diversification. Taiwan is highly dependent on imported energy resources. In 2001, about 97% of her energy supply was imported. Oil comes mainly from the Mid-East. Coal is mainly from Australia and China. The principal LNG suppliers are Indonesia and Malaysia. To reduce the dependence on oil, the government encouraged industries to use coal in place of oil. LNG import was also opened up. Efforts were made to diversify energy resource supplying regions and nations. Over the last 20 years, dependency on oil has fallen from 68% to 50%. Correspondingly, dependence on Mid-East oil declined to 50% from 68%. Diversification issues are as follows:

- Additional facilities and infrastructure to receive imports of coal and LNG need to be constructed,
- Energy transmission and transport facilities and infrastructures need to be strengthened,
- Promote and develop new and renewable energy resources,
- How to achieve the 2020 target ratios of installed electric generation capacity set by the "National Energy Conference": coal 35-37%, oil 4-5%, natural gas 27-29%, hydro 9-11%, nuclear 19-20%, new energy resources 1-3%. (For comparison, the corresponding 2001 ratios are, respectively, coal 25%, oil 13%, gas 16%, hydro 13%, nuclear 16%, and combined heat and power 17%.)

Energy Conservation and Efficiency. Taiwan has strived to promote energy conservation and improve the efficiency of energy production and use through establishment of energy conservation and efficiency policies, promulgating regulations on efficiency, providing incentives, research and development, energy services, and education and information. Conservation and efficiency targets were established for all sectors, including industrial, transportation, business, residential, electric power, and government. In addition, energy-conserving and high-efficiency technologies are being developed. Issues on this aspect are:

- Due to lack of funds, small to medium enterprises are not inclined to install energy-conserving equipment,
- The energy pricing system is unable to provide the appro-

* Rong-I Wu is President, Taiwan Institute of Economic Research in Taipei, Taiwan. This paper is adapted from a presentation made on November 1, 2002 at the annual meeting of the Chinese Association of Energy Economics in Taipei, Taiwan.

priate price signals to energy consumers because it does not reflect the cost differences due to time and regional variations,

- To date, energy conservation practices are concentrated on the industrial sector. There is need to promote energy conservation in the residential and business sectors., especially with respect to high efficiency appliances and air conditioners.

Environmental Protection and Sustainable Development. As Taiwan has attained a relatively high level of economic development, there is a high degree of public concern about environmental issues. Two factors are likely to further heighten the environmental protection and sustainable development perspective: the greenhouse gas emission reduction targets arrived with the Kyoto Protocol under the United Nations' Framework Convention on Climate Change in December 1997; and the "Law on the Prevention and Remediation of Air Pollution" enacted in June 2002.

Under the Kyoto Protocol, the industrialized countries, as a group, agreed to reduce emissions of greenhouse gases by 5.2% from the 1990 level in the 2008 -2012 period. Individually, Switzerland, Austria, Central and Eastern European countries, and the European Union agreed to reduce by 8%; U.S.A., 7%; Canada, Hungary, Japan, and Poland, 6%. New Zealand, Soviet Union, and Ukraine, will maintain their respective 1990 emission levels. Norway can increase by 1%; Australia, by 8%; Iceland, by 10%. Taiwan is not a signatory to the UNCCC and thus has no specific reduction target. However, as a member of the Earth village, emission reductions are being developed. Cement, petroleum refining, chemical, artificial fiber, and steel industries have developed voluntary reduction targets. In addition, electric generation and transportation are likely to be highly affected.

The Law on the Prevention and Remediation of Air Pollution sets forth rules for trading emission allowances. For example, Article 9 defines that new or modified fixed sources can only obtain emission allowances through (a) the differences between their lawfully reserved allowances for the fixed sources and their actual use; (b) allowances auctioned off by the authorities from their reserves; and (c) allowances obtained through improvement in transportation equipment and their operation, scrapping of old vehicles, and other methods in relation to moving sources; and other allowances approved by the Central Authority.

The issues in this area include:

- Assist the industries in achieving their voluntary emission reduction targets.
- Implement emission allowance trading.

Promotion and Development of Renewable Energy. Since 1998, Taiwan has enhanced the development and utilization of renewable energy resources. The planning target is for renewable energy resources to account for over 3% of total energy supply (4.5% including conventional large scale hydro) and over 15% of electric generation capacity (including large-scale hydro). Subsidies are being provided for some renewable energy installations. For example, NT$1,000 to 3,000 per square foot are provided for the installation of solar water heating systems. For wind and photovoltaic generating facilities, subsidies are being provided for up to 50% of total installation costs. In addition, Taiwan has formulated related plans and statutes such as "Report on the Study of New and Clean Energy Resources", "Articles for the Development of Renewable Energy Resources (Draft)", "Plan for the Development of Renewable Energy Resources." Some of the issues are listed below:

- The majority of the externality costs of energy resources is not yet internalized,
- The law on land use needs to be modified to allow development of renewable energy resources,
- Make explicit the procedures for filing applications for constructing renewable generating facilities, including whether land use and construction permits are needed, and which filing documents are needed,
- Enact the rules for interconnection and for sales and purchases of electricity generated and of reserve power for use during scheduled and unscheduled down time.

Economic Development in Taiwan and Its Impacts on Energy Development

Recent economic development in Taiwan is characterized by globalization, knowledge economy, industrial transition, and sustainable development.

Globalization. Under globalization, the production and/or the provision of products and services are not constrained by national or regional boundaries. The degree of international division of labor is high. "Produce at wherever the cost is lowest and market to wherever the profit is highest." International financial markets are highly interrelated and capital and funds move freely across national borders. There are increased opportunities for personal and regional choice of products and services.

Knowledge Economy. In a knowledge economy, the most important factor inputs are the possession, creation, and application of knowledge, and innovation. The market is dynamic and globally competitive. Enterprises are highly mobile and are organized as a worldwide network, not a hierarchy or bureaucracy. Industrial production is highly flexible, rather than mass production. Technology is driven by digitalization, not by mechanization. Research and development is essential to a firm's success and is largely provided by innovative firms, not by existing firms. Competitive advantage derives mainly from innovation, quality, and timeliness of market entry, not by economies of scale and lower costs. Firms characteristically team and collaborate with others in research and development, instead of going it alone.

Industrial Transition. Taiwan's economy has been led by exports. In recent years, due to significant international and domestic economic developments, such as international economic fluctuations, Taiwan's entry into the World Trade Organization, and fast growth of the Chinese economy, the industrial structure of Taiwan is in a period of transition. For example, the focus of industrial development has shifted from the traditional industries of food and other necessities and basic industries to high-technology industries with high skill intensity. The former two industries include food, textile, clothing, paper, chemical materials and products, petroleum, plastic, and metals. High skill-intensity industries include computers, fiber optics, and biotechnology. Further, planning for the "National Energy Conference" calls for the percentage contribution to manufacturing output from skill-intensive industries to be 55%, with basic industries 25%,

and traditional industries 20%. For comparison, in 1996, the corresponding percentage shares respectively were 34%, 40% and 26%. Also, services, together with the skill-intensive industries, will grow in importance. Another notable trend is that, due to shifting comparative advantages, traditional industries are moving out of Taiwan. As a result, many of the traditional enterprise zones are being converted into science-based industrial parks.

Sustainable Development. "Sustainable development is development that meets the needs of the present generation as long as resources are renewed or, in other words, that does not compromise the development of future generations."[1] Needs, limitations and equality are the three elements in sustainable development. The basic needs of human beings must be met. However, in satisfying present and future human needs, technological conditions and social organizations such as population, the environment, and resources would impose certain restrictions on the environment. Equality means trans-generational equity, as well as equality among different groups and regions in the present generation. In some ways, these three elements are at the same time conflicting and complementary with one another. For example, huge increases in basic needs would cause damage to the environment, slowing down economic growth. On the other hand, insufficient demand will not necessary be good for the environment. As an example, because of poverty, many underdeveloped countries intensively develop and extract their natural resources, damaging their environment and ecology.

Impacts on Energy Development. With globalization, bottlenecks on energy supply would cause an economy to miss opportunities for profitable trade. Foreign direct investment in domestic energy businesses will become a fact of life. Domestic energy enterprises can also participate in foreign energy ventures. With her knowledge economy and the transition in industrial structure, Taiwan's electricity industry needs to provide more reserve generating capacity to meet the need for higher-quality electricity for the growing high-tech industries. Further, some energy conservation or load management measures, such as interruptible power, would become inappropriate. Nevertheless, developing and utilizing new and clean energy resources, such as renewable energy, is a positive way to address the limitations inherent in sustainable development. Another point is that one long-term strategy to simultaneously achieve the objectives of economic development, energy security, and environmental protection is to invest in research and development in energy technology so as to achieve breakthroughs in both technology and costs.

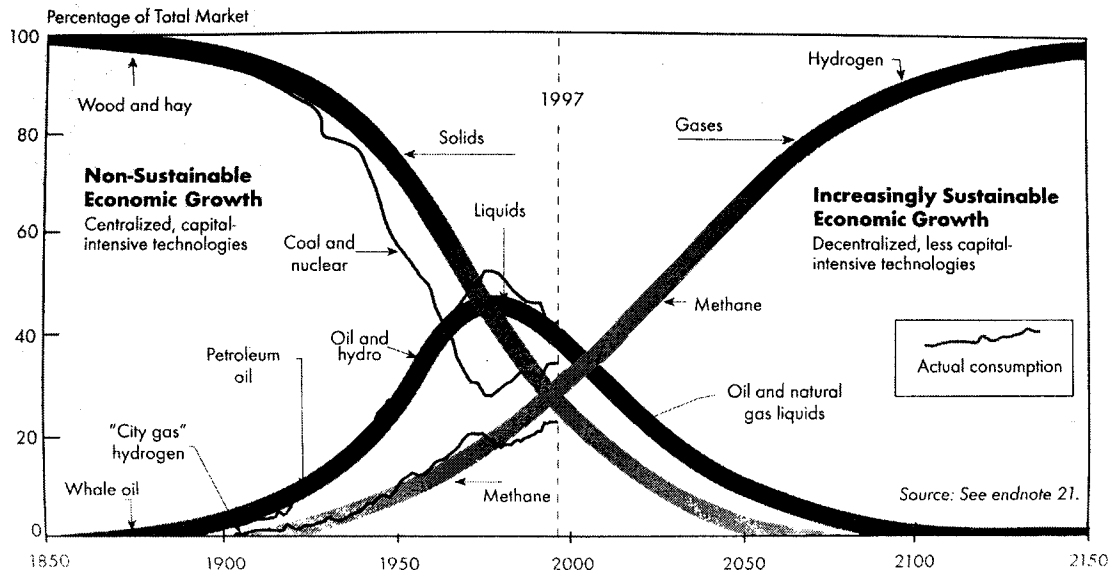
[1] See footnotes at end of text.

Future Prospect of Energy Development in Taiwan

In looking toward the future of sustainable energy development in Taiwan, the focus is on two non-traditional aspects. One is a view of the long-term transition of the global energy system and its future in the hydrogen economy. The other is a brief discussion on Nano-technology and its potential application in energy development.

Global Energy System Transition. The relative shares of three categories of energy resources–solid, liquid, and gaseous fuels–over three centuries from 1850 to 2150 are shown in Figure 1. The share of solid fuel started with 100 percent. Initially, it declined gradually. In the mid- 1900s, the pace quickened. Over the long term, it traces out to be a reverse "S" curve. The share of liquid fuels, the second category, started with zero and grew until it accounted for about 40-45% in the late 20th century. Then it started to decline. By 2100, it will have a relatively small share. Over the long haul, it forms a bell-shaped curve. In contrast, gaseous fuels started even later than liquid fuels. Its share grew slowly but consistently and forms an elongated "S"

Figure 1
Global Energy Systems Transition, 1850-2150



Source: Jiqiang Zhang, "The Prospect of Hydrogen Economy - A Strategic Decision for Every Nation" Undated presentation

curve. In terms of actual fuels, solid fuels include wood, hay, coal, and nuclear (uranium). Liquid fuels include whale oil, petroleum, hydro, and liquid natural gas. Gaseous fuels include city gas, methane, natural gas, and hydrogen. In this view of the world, the single most important fuel of the future is hydrogen. It is based on the important assumption that technological breakthrough in the production and use of hydrogen will occur in the next decade or two. Figure 1 shows that in the early years, or in the left end of the chart, the world economy was highly dependent on solid fuels. It represents non-sustainable development. In contrast, after 2000, the world economy has become more dependent on gaseous fuels. Especially after 2100, or in the right end of the chart, it is highly dependent on hydrogen. It is a hydrogen economy and represents sustainable development.

Hydrogen Economy. In the hydrogen economy, hydrogen is the primary energy used in electricity generation, transportation, industrial, business, and residential sectors. Use of hydrogen reduces reliance on imported oil, coal, and LNG, thereby enhancing national security. Hydrogen is a renewable energy resource and can reduce the impacts on the environment, contributing to clean air and clean water. Hydrogen can be produced using primary energy sources such as solar power, wind, biomass, and fossil fuels, and clean energy technology, such as photo-conversion, generation, electrolysis and re-forming. Existing technology for gas storage and transportation can be improved for use in storing and transporting hydrogen. Use pipeline or liquid form for large quantities and long-distance transportation. For small quantity and short-distance transportation, use compressed gas. For short -distance transportation, use metal hydrides.

For large quantity and the long-term, use underground storage. For small quantity and the short term, use compressed air storage. For small quantity use metal hydrides or carbon Nano- tube.[2]

Nano-technology. A Nano meter equals 10^{-9} meter or one thousandth of a micro- meter. Nano-technology is the study of very small things, measured in Nano-meters. It combines physics, chemistry, and material sciences and can help us understand, handle and change the composition of materials and substance, create new materials, develop new products and applications. It can have tremendous impacts on industrial development. Examples of potential energy applications of Nano-technology include:

- Use of the carbon Nano-tube for storing hydrogen. It will have high storage capacity, and can be used in fuel cells and hydrogen cars,
- Introduce Nano particles into heat conducting agents such as water or coolant to form Nano-fluids. It will raise the heat conducting coefficient, and increase efficiency,
- Use as high-efficiency lighting sources or solar cells,
- Use Nano-materials to improve upon permanent magnets and raise the efficiency of motors,
- Use Nano-crystals for the agent in light for eliminating poisonous gases,
- Use Nano-coatings to improve the quality of heat-insulating materials,
- Use the Nano-characteristics of negative and positive charges to improve the efficiency of rechargeable batteries.

Concluding Remarks

Recent energy developments in Taiwan are characterized by liberalization, diversification, energy conservation and high efficiency, environmental protection and sustainable development, and promotion of renewable energy development. At the same time, the Taiwanese economy is in transition under the influence of globalization, the knowledge economy, changing industrial structures, and concern for sustained development. As a result, traditional industries are moving away from Taiwan, and skill-intensive industries are growing in importance. Looking to the future, it is absolutely essential for Taiwan to invest in research and development in technology and innovation and their applications in order to create job opportunities and sustainable economic development. In terms of sustained energy development, it is hypothesized that the hydrogen economy is a likely future and that Nano-technology will have both energy and economic applications.

Footnotes

[1] The World Commission on Environment and Development, *Our Common Future,* Oxford University Press: Oxford, 1987.

[2] See the source cited with Figure 1.

Mythologizing Iraq's Oil

*By Gholamhossein Hassantash**

Based on a foregone conclusion that the present regime in Iraq will soon be ousted, some corners have been busy mythologizing about the oil reserves of Iraq. This is quite reminiscent of a similar move about the oil and gas resources of the Central Asian region, following the disintegration of the Soviet Union.

Then, the U.S. Administration, and some others, needed a pretext to consolidate their influence in the newly created independent States, while the White Bear was licking its wounds.

The subject had to be attractive enough to ensure a quick presence of the Western investors in the region. The issue of oil and gas resources was a suitable one. The mere presence of wealthy oil companies would pave the way for others to follow suit.

Astonishing stories were created in support of that policy. Some of the States started being called new Kuwaits and the like.

The gold rush of a different scale was underway! Soon quite a few Western oil company were busy exploring the area for, supposedly, gigantic oil and gas reserves. As the dust settled, gradually everyone realized that the reality was quite another thing. There were oil and gas all right, but very much less than expected.

Those mythologizing publicities, nevertheless, served their purpose. The Western oil companies, particularly the American ones, managed to exploit them to their own ends. Following a relatively long period of stagnation in their bulky activities, those oil companies utilized the break to sign production-sharing contracts in the already mythologized resources. And even before doing anything on the ground, they managed to increase the value of their shares in the market, making huge profits.

Now seemingly the same scenario is being rewritten for Iraq. No doubt Iraq possesses considerable hydrocarbon resources, especially crude oil, and it is not at all intended here to undermine that. However, there has to be a line drawn between reality and legend.

Iraq joined the oil producing States in 1927. Based on the annual statistics made available by OPEC, Iraq reportedly owned 65 billion barrels of crude oil during 1983–1985 period. But it must not be forgotten that following the third oil shock and the ensuing rivalry amongst OPEC members over their market shares during 1985 to 1986, the criterion adopted for everyone's quota was the quantity of their respective reserves. That is when, Iraq's reserves were suddenly reported to have reached 100 billion barrels! Interestingly enough, this figure kept being repeated until 1995 when it, once again suddenly, changed to 112 billion barrels! Strangely enough, during the entire period when Iraq's reserves were reported to have nearly doubled the country was either totally entangled in war or was being penalized through the UN Security Council Sanctions! Naturally, the possibilities of any significant exploration being carried out were hardly there for Iraq.

The registered statistics for Iraqi oil production, available quite regularly ever since OPEC was established (1960), indicate that the country has used up at least 23 billion barrels of its reserves. If the volumes used during the period of 1927-1960 are also taken into account, then the total figure could well be 25 billion barrels.

The highest registered level of production of oil in Iraq is of that of 1997 when it was just about 3.5 million barrels a day. In that particular year, taking advantage of the absence of Iranian crude (because of the revolution), Iraq managed to increase its production, but could not continue producing at that level for long. Apart from that exceptional year, Iraq's maximum registered production level has not surpassed 2.6 million barrels a day.

The oil produced by Iraq in the past 20 years (after attacking Iran) has been at the cost of exerting much pressure on its oil wells, which have obviously been harmful. Hence, to produce any valid estimation of the remaining recoverable oil reserves of the country requires time to carry out a close examination of the actual situation of its reservoirs. Other than that, all claims and counter-claims have no scientific value and are only at the service of certain politico-economic ends and, therefore, not credible.

Perhaps, it is for the same reason that oil constitutes the most urgent part of the agenda in the negotiations of the American officials with the Iraqi regime's opposition. Their joint effort is concentrated on finding oil-informed refugees from inside Iraq so as to get access to up-to-date and precise information on their oil industry's status.

There are already billions of dollars worth of oil contracts Iraq has signed with French and Russian companies, the execution of which are pending the return of normalcy to Iraq's relation with a U.S. influenced Security Council.

Is it a pure coincidence that just a while ago some members of the opposition group had openly said that they would not necessarily remain committed to those existing contracts? In case they take over, in the reassessment of those signed agreements, will there be room for competition, particularly for American oil companies?

Apparently, the mythologizing efforts have some other short and mid-term purposes too. Under the prevailing tense circumstances, the launching of an American led military offensive on Iraq will actually drive the oil price soaring. The policy of depicting a legendry prospect for Iraq's oil future (after Saddam falls), is aimed at offsetting that price course.

Such publicities have other benefits also. Competition on investment, particularly for the Persian Gulf oil industries, will be stiffer in favor of the investors. Additionally such war of nerves can be manipulated to gain political points. Saudi Arabia can come under pressure with the image of a new potential oil rival at its boarder.

The irony being that the Iraqi officials play the same tune, naturally for a different, but, unknown reason. The future will tell.

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* This is an edited version of an article written by Gholamhossein Hassantash and appearing in the August-September 2002 issue of *Energy Economics*, published by the Iranian Association for Energy Economics.We are indebted to the publication's editor, Ebrahim Ghazvini, for its use.

IAEE Plans 2005 International Conference in Taipei, Taiwan

Pictured from left to right: Edward Soong, Director of the Secretary Office of the Board, Chinese Petroleum Corporation; David Williams, IAEE Headquarters; Michelle Michot Foss, IAEE 2003 President; C.T. Kuo, Chairman, Chinese Petroleum Corporation and Arthur Hsiang-Yun Kung, Director, R&D & Corporate Planning Division, Chinese Petroleum Corporation.

IAEE President Michelle Foss and Executive Director David Williams travelled to Taipei, Taiwan last November to visit with the Chinese Association for Energy Economics (CAEE) and begin planning the 2005 IAEE Taipei International Conference. The conference will be held from **19-23 April 2005** in Taipei.

Dr. Michelle Foss was one of the keynote speakers during CAEE's annual fall conference. She delivered an address on *Worldwide Gas and Power Developments: Key Issues* and was joined by Dr. Rong-I Wu addressing the issue of *Prospects of Energy Development in Taiwan Under Changing Economic Structure*. During the CAEE Affiliate meeting annual elections were held and Dr. Liang-jyi Fang was elected CAEE Chairman (currently he is the Secretary General of the Energy Commission), Mr. Shih-ming Chuang has been elected CAEE Secretary.

The CAEE is fully committed to planning a first rate IAEE Conference in Taipei. There are many wonderful hotels and off-site venues to hold our meeting and special events. CAEE has established a special working committee to begin mapping out a successful program, contracting with the appropriate vendors and developing off-site events that will highlight their city and culture. IAEE Leadership learned a new phrase while in Taipei: "don't worry about the budget." This was reflected by several CAEE officers. Both the Chinese Petroleum Corporation and the Taiwan Power Company have pledged significant funds to ensure the financial success of the conference to IAEE.

During IAEE's visit we met with Chairman Kuo (seen at left) from the Chinese Petroleum Corporation, Chairman Lin from Taiwan Power Company and Chairman Chen from CAPCO as well as Senior Fellows from the Energy Commission, Ministry of Economic Affairs and the Chung-Hau Institution for Economic Research. All parties with which we met are highly supportive of the IAEE Taipei 2005 International Conference and pledge to make this one of IAEE's largest and most financially successful conferences ever.

Mark your calendars and plan to attend this important conference.

For further information contact:

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(p) 886-2-87258259
(e) 902144@cpc.com.tw

Mr. David Williams
Executive Director
IAEE
28790 Chagrin Blvd., Suite 350
Cleveland, OH 44122 USA
(p) 216-464-5365
(e) iaee@iaee.org

Conference Proceedings
22nd USAEE/IAEE North American Conference
Vancouver, Canada, October 6 to 8, 2002

The Proceedings from the 22nd North American Conference of the USAEE/IAEE are available from IAEE Headquarters. Entitled Energy Markets in Turmoil: Making Sense of it All, the price is $85 for members and $105 for nonmembers (includes postage). Payment must be made in U.S. dollars with checks drawn on U.S. banks. Please complete the form below and mail together with your credit card information or check to: Order Department, IAEE Headquarters, 28790 Chagrin Blvd., Suite 350 Cleveland, OH 44122, USA.

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General Chairs: Adam Sieminski, José Gonzalez Santalo, André Plourde
Program Chair: Pablo Mulás
Arrangements Chair: David Williams

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To explore the forces driving and opposing the creation of regional North American energy markets

Plenary Session Themes

Gas & Power Sector in North America
Oil & Natural Gas in Mexico
Energy Trade & Transport
Energy Security & Reliability
Environment & Energy
Role of State Owned Public Utilities

Possible Concurrent Session Topics

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Anyone interested in organizing a session should propose topics, motivations, and possible speakers to:
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Input-Output models

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Abstract Submission Deadline: January 31, 2004

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Abstracts should be between 300-600 words. All abstracts should clearly address the themes of the conference listed in the invitation. The deadline for submission of abstracts: January 31, 2004. All papers accepted and returned in time will be included in the conference proceedings. At least one author from an accepted paper must pay the registration fee and attend the conference to present the paper.

Abstracts, papers and inquiries should be submitted to the SAEE conference secretariat:
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More information about the conference and the registration formalities will be available under www.cepe.ethz.ch in 2003.

Owen Named President-Elect

Anthony (Tony) Owen was elected President-elect in the Association's recent election balloting. Owen is Professor in the School of Economics at The University of New South Wales, Australia and Director of the Energy Research Development and Information Center there. He received his BA in economics from the University of Leichester and his MA and PhD from the University of Kent. He has done energy related consulting in Australia, China, Denmark, Indonesia, Norway, the Philippines and the UK. He was a founder of the Australian Affiliate and Chair of the 23rd International Conference held in Sydney in 2000. He will serve in 2003 under President Michelle Michot Foss and move to the Presidency in 2004.

Also elected in the balloting were Carlo Andrea Bollino and André Plourde.

Bollino, who will serve as Vice President of Development and International Affairs, is Professor of Economics at the University of Perugia, Italy. He is also Professor of Econometrics at the Luiss Guido Carli University in Rome and Energy Counselor to the Minister of Industry, Rome. He received his undergraduate degree from Bocconi University in Milan and his MSc and PhD from the University of Pennsylvania. He is a former Advisor to the Minister of Treasury and Chief Economist of ENI. He was a member of the Organizing Committee of the 1999 Rome International Conference.

Plourde, who will serve as Vice President and Treasurer, is Associate Professor and EPCOR Professor of Energy Policy at the University of Alberta, Canada. He is also Associate Director of the Canadian Building Energy End-Use Data and Analysis Center, School of Business at the University of Alberta. He received his BA and MA from the University of New Brunswick and his PhD from the University of British Columbia. Plourde is also president of the Canadian Affiliate of IAEE and has served as Vice President Conferences of the USAEE as well as in a number of other capacities in that Association. He was Program Chairman of the 1998 International Conference in Quebec.

The final vote tally was:

President

Alex Kemp	116
Tony Owen	133

VP for Development & International Affairs

Carlo Bollino	152
Jan Myslivec	98

VP and Treasurer

Wumi Iledare	102
Andre Plourde	144

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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 Policy Issues	Renewable Energy Issues
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- **Newsletter:** The IAEE Newsletter, published four times a year, contains articles dealing with applied energy economics throughout the world. The Newsletter also contains announcements of coming events, such as conferences and workshops; gives detail of IAEE international affiliate activities; and provides special reports and information of international interest.
- **Directory:** The Annual Membership Directory lists members around the world, their affiliation, areas of specialization, address and telephone/fax numbers. A most valuable networking resource.
- **Conferences:** IAEE Conferences attract delegates who represent some of the most influential government, corporate and academic energy decision-making institutions. Conference programs address critical issues of vital concern and importance to governments and industry and provide a forum where policy issues can be presented, considered and discussed at both formal sessions and informal social functions. Major conferences held each year include the North American Conference and the International Conference. IAEE members attend a reduced rates.
- **Proceedings:** IAEE Conferences generate valuable proceedings which are available to members at reduced rates.

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- -

_____**Yes**, I wish to become a member of the International Association for Energy Economics. My check for $65.00 is enclosed to cover regular individual membership for twelve months from the end of the month in which my payment is received. I understand that I will receive all of the above publications and announcements to all IAEE sponsored meetings.

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IAEE Members Published in *The Economics of Energy*

Several members of IAEE had papers selected for publication in a comprehensive two-volume collection of energy economics research conducted in the past 70 years. These members include: M.A. Adelman, S.C. Bhattacharyya, R. L. Gordon, H.G. Huntington, M. Munasinghe, D.M. Newbery, W.D. Nordhaus, E.T. Penrose, P. Stevens and G.C. Watkins. Relevant information for ordering the book:

The Economics of Energy, Paul Stevens, Editor (2000). 1,216 Pages. Price: $425.00. Contact: Edward Elgar Publishing. URL: www.e-elgar.co.uk

Publications

World Energy Outlook 2002. Price: $150 Paper/$120 PDF. Contact: International Energy Agency, BP 586, 75726 Paris Cedex 15, France. Tel: 33-1-4057-6690. Fax: 33-1-4057-6775. Email: books@iea.org

Dealing With Climate Change. Price. $100 Paper/$80 PDF. Contact: International Energy Agency, BP 586, 75726 Paris Cedex 15, France. Tel: 33-1-4057-6690. Fax: 33-1-4057-6775. Email: books@iea.org

Policies and Measures in IEA Member Countries Beyond Kyoto. Price: $75 Paper/$60 PDF. Contact: International Energy Agency, BP 586, 75726 Paris Cedex 15, France. Tel: 33-1-4057-6690. Fax: 33-1-4057-6775. Email: books@iea.org

Energy Dynamics and Climate Stabilisation CO2 Emissions from Fuel Combustion 1971-2000. Price: $150 Paper/$120 PDF. Contact: International Energy Agency, BP 586, 75726 Paris Cedex 15, France. Tel: 33-1-4057-6690. Fax: 33-1-4057-6775. Email: books@iea.org

Yearbook of International Co-Operation on Environment and Development 2002/2003. 336 Pages. Price: #60.00 (Sterling). Contact: Earthscan Publications Ltd, 120 Pentonville Road, London N1 9JN, United Kingdom. Tel: 44-20-7278-0433. Fax: 44-20-7278-1142. Email: earthinfo@earthscan.co.uk URL: www.earthscan.co.uk

Natural Gas in Asia – The Challenges of Growth in China, India, Japan and Korea, Ian Wybrew-Bond and Jonathan Stern, Editors. 336 Pages. Price: $60.00. Contact: Mrs. Margaret Ko, Oxford Institute for Energy Studies, 57 Woodstock Road, Oxford OX2 6FA, United Kingdom. Tel: 44-1865-311377. Fax: 44-1865-310527. Email: publications@oxfordenergy.org

Global Oil and the Nation State, Bernard Mommer. 255 Pages. Price: $45.00. Contact: Mrs. Margaret Ko, Oxford Institute for Energy Studies, 57 Woodstock Road, Oxford OX2 6FA, United Kingdom. Tel: 44-1865-311377. Fax: 44-1865-310527. Email: publications@oxfordenergy.org

Technical Progress and Profits – Process Improvements in Petroleum Refining, John Enos. 336 Pages. Price: $60.00. Contact: Mrs. Margaret Ko, Oxford Institute for Energy Studies, 57 Woodstock Road, Oxford OX2 6FA, United Kingdom. Tel: 44-1865-311377. Fax: 44-1865-310527. Email: publications@oxfordenergy.org

Energy Policies of IEA Countries 2002 Review. Price: $120. Contact: International Energy Agency, BP 586, 75726 Paris Cedex 15, France. Tel: 33-1-40-57-66-90. Fax: 33-1-40-57-67-75. URL: books@iea.org

Natural Gas Prospects in the Middle East Gulf to 2015. Price: #1750. Contact: Centre for Global Energy Studies, Jenni Wilson. Tel: 44-020-7309-36. URL: www.cges.co.uk/gulfgasorder.htm

Saudi Arabia to 2020. Price: #2000. Contact: Centre for Global Energy Studies, Jenni Wilson. Tel: 44-020-7309-36. URL: www.cges.co.uk/gulfgasorder.htm

Iran – Understanding Iran and its Oil and Gas Industry. Price: #2750. Contact: Centre for Global Energy Studies, Jenni Wilson. Tel: 44-020-7309-36. URL: www.cges.co.uk/gulfgasorder.htm

The Economics of Energy, Paul Stevens, Editor (2000). 1,216 Pages. Price: $425.00. Contact: Edward Elgar Publishing. URL: www.e-elgar.co.uk

Calendar

18-20 February 2003, Global Alternative Fuels Forum for Automotive Applications at Munich. Contact: Claire Pallen, Conference Director, The Energy Exchange Ltd, 25 St Georges Road, Cheltenham, Gloucestershire, GL50 3DT, UK. Phone: 0044 1242 529090. Fax: 0044 1242 570820 Email: c.pallen@theenergyexchange.co.uk URL: www.theenergyexchange.co.uk

24-25 February 2003, CBI's 5th Annual Electric Asset Valuation at Houston, TX. Contact: Conference Coordinator, Registration Dept., The Center for Business Intelligence, 500 W Cummings Park, Ste 5100, Woburn, MA, 01801, USA. Phone: 800-817-8601. Fax: 781-939-2490 Email: cbireg@cbinet.com URL: www.cbinet.com

25-26 February 2003, Power Generation Asset Management Conference at Westminster, CO. Contact: PMA, PO Box 2303, Falls Church, VA, 22042, USA. Phone: 201-784-5389. Fax: 201-767-1928 URL: www.pmaconference.com

26-27 February 2003, Remotely Operated Assets - Solving the Organisational, Human and Technical Challenges at The Ardoe House Hotel, Aberdeen, UK. Contact: Customer Services, Oil & Gas IQ, Anchor House, 15-19 Britten Street, London, SW3 3QL, UK. Phone: +44(0)20 7368 9300. Fax: +44(0)20 7368 9301 Email: enquire@iqpc-oil.com URL: www.iqpc-oil.com/GB-1946/ediary

26-27 February 2003, New Operational Philosophies for Marginal Field Developments at The Ardoe House Hotel, Aberdeen. Contact: Customer Services. Phone: +44 (0) 20 7368 9300 Email: enquiry@iqpc-oil.com URL: www.iqpc-oil.com/GB-1946/ediary

3-4 March 2003, CERI NA Natural Gas Conference & Calgary Energy Show 2003 at Calgary, Alberta, Canada. Contact: Dave Donald, Conference Division, CERI, Canada. Phone: 403-220-2375 Email: ddonald@ceri.ca URL: www.ceri.ca/confer_gas.htm

3-4 March 2003, Energy Risk Management & Risk Assessment at New York. Contact: Jeff Kaminski, Euromoney Training - Americas, 225 Park Avenue South, New York, NY, 10003, United States. Phone: 212-843-5225. Fax: 212-361-3499 Email: jkaminski@euromoneyny.com URL: http://www.euromoneytraining.com/databasedriven/coursedetail.asp?busareaid=3&CourseID=700

3-7 March 2003, Energy Essentials Week at San Francisco. Contact: John Ferrare, Partner, Enerdynamics LLC, P.O. Box 411165, San Francisco, CA, 94141-1165, USA. Phone: 415.777.1007. Fax: 415.777.2611 Email: jferrare@enerdynamics.com URL: http://www.enerdynamics.com/seminar3.html

4-6 March 2003, Electric Power 2003 - 5th Annual Conference & Exhibition at Houston, TX. Contact: Conference Coordinator, Electric Power, 1220 Blalock, Ste. 310, Houston, TX, 77055, USA. Phone: 713-463-9595. Fax: 713-463-9997 Email: info@tradefairgroup.com URL: www.electricpowerexpo.com

5-7 March 2003, World Sustainable Energy Day at Stadthalle Wels, Austria. Contact: Conference Coordinator, O.O. Energiesparverband, Landstrabe 45, A-4020 Linz, Austria. Phone: 43-732-7720-14380. Fax: 43-732-7720-14883 Email: office@esv.or.at URL: www.esv.or.at

11-12 March 2003, Russia Power at Moscow. Contact: Conference Coordinator, PennWell Corporation, PennWell House,

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Horseshoe Hill, Upshire, Essex, EN9 3SR, United Kingdom. Phone: 44-1992-656-629. Fax: 44-1992-656-704 Email: russiapower@pennwell.com

12-15 March 2003, Building Energy 2003 Conference and Trade Show at MIT Campus and the Boston Park Plaza Hotel. Contact: Northeast Sustainable Energy Association, 50 Miles street, Greenfield, Massachusetts, 01301, USA. Phone: 413-774-6051. Fax: 413-774-6053 Email: nesea@nesea.org URL: http://www.nesea.org/buildings/be/

24-26 March 2003, 7th Annual Distributed Generation & On-site Power at Warwick Hotel, Houston Texas, USA. Contact: Ken Dee, President, Global Energy Solutions, 21 Tynan Ave., East Taunton, MA, 02718, USA. Phone: 508-823-5797. Fax: 508-823-5197 Email: gesi@attbi.com URL: www.dist-gen.com

25-26 March 2003, Best Practice Sand Control at The Hyatt Regency. Contact: Customer Services. Phone: 1 973 256 0205 Email: enquiry@iqpc-oil.com URL: www.iqpc-oil.com

26-27 March 2003, US and International Sanctions in Oil & Gas at The Hyatt Regency, Houston, TX. Contact: Customer Services. Phone: 1 973 256 0205 Email: enquiry@iqpc-oil.com URL: www.iqpc-oil.com/NA-1955/ediary

26-27 March 2003, Contract Risk Management in Upstream Oil & Gas at The Ardoe House Hotel, Aberdeen. Contact: Customer Services. Phone: +44 (0) 20 7368 9300 Email: enquiry@iqpc-oil.com URL: www.iqpc-oil.com/GB-1954/ediary

March 31, 2003 - April 1, 2003, Fuel Cells 2003: Fuel Cells and the Hydrogen Infrastructure The Third Annual BCC Conference at Stamford, CT. Contact: Sharon Faust, Conference Coordinator, Business Communications Company, Inc., USA. Phone: 203-853-4266 ext 304 Email: conference@bccresearch. com URL: www.buscom.com/fuel_cells2003/registration.html

2-3 April 2003, GLOBALCON at Hynes Convention Center, Boston MA. Contact: Jared Pursell, Exhibit Manager, Association of Energy Engineers, POB 1026, Lilburn, GA, 30048, USA. Phone: 770-279-4392. Fax: 770-381-9865 Email: jared@aeecenter.org URL: http://www.aeecenter.org

7-8 April 2003, The Second Annual Green Trading Summit: Emissions, Renewables & Negawatts at New York. Contact: Peter Fusaro, Global Change Associates, 211 W 56th St #23M, New York, NY, 10019, USA. Phone: 212-333-4979. Fax: 212-399-3471 Email: info@greentradingsummit.com URL: www.greentradingsummit.com

9-11 April 2003, 12th Annual MEMS Professional Program at Golden, CO. Contact: Melody Francisco, Conference Division, USA Email: mfrancis@mines.edu

13-15 April 2003, Middle East Petroleum & Gas Conference (MPGC 2003) at Singapore. Contact: Conference Coordinator, The Conference Connection, PO Box 1736, Raffles City, Singapore, 911758, Singapore. Phone: 65-6226-5280. Fax: 65-6226-4117 Email: mpgc@cconnection.org

15-17 April 2003, Energy Market Reform: Issues and Problems at Hong Kong Baptist University. Contact: Dr. Larry Chow, Dir of Hong Kong Energy Studies Ctr, Hong Kong Baptist University, Kowloon Tong, Hong Kong. Phone: 852-3411-7187. Fax: 852-3411-5990 Email: hkesc@hkbu.edu.hk

17-19 April 2003, WindPower Asia 2003 at Beijing International Convention Center. Contact: Harry Xu, Secretary General, Chinese Wind Power Association, Suite 21K, Tower B, Yayunhaoting Plaza, No. 9, Xiaoying Road, Chaoyang District, Beijing, Beijing, 100101, China. Phone: ++86-10-64980270. Fax: ++86-10-64983999 Email: cnwpa.cnpwa.org URL: http://www.cnwpa.org

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