IA INTERNATIONAL ASSOCIATION FOR ENERGY ECONOMICS
EE

Newsletter

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President's Message

It seems that we should welcome Dr. Alan Greenspan, Chairman of the U.S. Federal Reserve System, to the ranks of energy economics experts! As many of you know, we Americans returned from our international conference in Prague to heightened attention to natural gas supply and price conditions largely because of Dr. Greenspan. Many of us in the IAEE and USAEE are contributing analysis and opinion to myriad audiences, including our members of Congress and state and local governments, and otherwise attempting as best we can to help shed light on a market imbalance that has been building for several years. As all of this has unfolded, I've found myself thinking once again about a favorite topic, and one that I've touched on as USAEE president in our newsletter *Dialogue* - energy literacy.

Dr. Greenspan is a prodigious economist, a logical thinker, and certainly a quick study of emerging economic trends and issues. The basics are straightforward - inadequate supply relative to demand drives up price; current and expected prices and related volatility and uncertainty drive out demand as customers seek substitutes or simply use less or new supplies enter the marketplace. But the market dynamics, driving forces, policy choices, and critical decisions that surround natural gas and energy in general in the U.S. and North America today are complex and beyond the reach of many citizens (even many who are, or should be, well-informed). Combine these complexities with the market disruptions of the past three years, and it makes for an unstable mixture.

U.S. citizens and businesses are not the only ones affected, of course. To our south, Mexico has struggled to formulate a workable energy policy that can satisfy the needs of an emerging market economy and accommodate significant shifts in strategy. These include greater reliance on natural gas for electric power generation, to both reduce urban air pollution associated with the poor quality fuel oils that have been in use and attempt to introduce new thinking about how power can be developed in that country. As part of its regulatory framework, Mexico, a hydrocarbon resource rich country, relies on U.S. pricing (effectively Henry Hub, our most liquid market center) for its net imports of gas. Mexico's constitution prevents competitive, private investment in natural gas exploration and production, and thus works to constrain evolution of benchmark basis prices. In Canada, growing domestic demand for natural gas, debate about long term supply and deliverability, and the need to push further into the pristine north or offshore for new reserves adds to the sense that market fundamentals have altered substantially. In response, we find that North America may become a prime market for natural gas resources located elsewhere but are "stranded" due to lack of domestic demand. These resources would arrive here mainly in the form of liquefied natural gas (LNG). Because it has been more than two decades since new LNG receiving terminals have been developed in the continental U.S., and never in Mexico or Canada, lack of public familiarity complicates the process of locating and permitting facilities for an industry that has one of the most technologically advanced safety records in the world.

We are not alone in our dilemma, of course. It happens that building workably competitive natural gas markets, much less workably competitive electric power markets that can host new generators like those that use natural gas, is not easy to do. In recent years, these problems have dominated discussions at our IAEE conferences. Many of us are actively engaged in research, consulting, or commercial activities that influence or hinge on achievement of new paradigms. We know the tensions that exist between suppliers and customers, and government and business, and that underlie any set of assumptions about particular market structures, designs, and

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Editor's Notes

Jean-Pierre Favennec notes that the Middle East possesses two-thirds of the world's liquid hydrocarbon reserves. After September 11th, the United States sought to reduce its dependence on the Middle East and to increase its imports from other sources. New equilibria are taking shape: to what extend can Africa, Russia and the Caspian replace Saudi Arabia? This is the challenge today.

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

regulatory approaches for implementation. But we rarely, if ever, question whether market actors - suppliers and customers - are reasonably well prepared and informed to act in these new marketplaces in ways that we expect they, we, will. (And, of course, even if we are prepared and informed, the number and variety of exogenous forces that interact with and impact on our choices only continues to grow.)

So, where does that leave things? Energy illiteracy puts us behind the eight ball right off. Some IAEE and USAEE members have recognized this problem and are attempting to contribute solutions. However - and here is the sales pitch - as a worldwide association of professionals interested in energy economics, we individually and collectively have a responsibility to improve our knowledge base and disseminate it in user friendly ways. Within our association, our technical and information exchanges and networking at our conferences are a prime resource for all of us engaged in these efforts, no matter where we are on the learning curve. Prague, as many of our international conferences have been, was impressive in that regard. I expect that the upcoming North American conference in Mexico, October 20-21, will be equally impressive.

Yet, I want to emphasize the concept of "user friendly." I've made the point before that if we only converse among ourselves, we limit our impact. I'd like to hear from members who may have ideas about how we can make energy economics more accessible, understandable, and user friendly. It seems to me, considering our modern energy history, and the history of our association and affiliates, that this should be our bottom line.

Dr. Greenspan, glad to have you on board!

Michelle Foss

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

Jim Watson examines the prospects for micro-generating heat and electricity in households during the next few years. He investigates the economics of installing micro-generation in the UK, based on solar photovoltaic and micro-CHP technologies and assesses what incentives there are for householders and energy companies to invest in the technologies and what barriers might prevent such investments.

John Grant reports that some see Ontario as a case of failed electricity restructuring, since small consumers' prices were frozen and privatization was halted. Others argue that what's needed is evolution, not revolution. The next twelve months will be critical for the Independent Market Operator and industry stakeholders in their effort to get the provincial govenment to recommit itself to market principles.

Paul Tempest reports on the Montreaux Energy Roundtable held June 16-18. He comments on six key points included in the discussions.

Doug Reynolds, in his new book about Alaskan natural gas, argues that the United States is heading for a perfect energy storm where three energy problems will hit at the same time. First, U.S. gas will be in short supply, second an oil crisis will hit and third coal and nuclear energy use will not expand quickly enough.

Jurgis Vilemas and Vaclovas Miskinis discuss the transition of the Lithuanian energy sector from that of one belonging to a centrally planned economy to a free market economy. They note the impact of the nineties recession as well as the impact of the legacy of central planning, namely the inefficient use of energy in all transition countries. They discuss the progress made so far the future changes planned.

In an increasingly crowded and polluted world, renewable energy technologies stand out as a beacon of hope. But, by and large, they remain expensive relative to conventional technologies. Perry Sioshansi explains how sympathetic policy makers are trying to prod them along using a combination of regulatory push and financial pull.

Peter Kobos takes a critical approach to parameterize how the one factor experience curve and recent experimentations with a two factor experience curve can be used to forecast energy technology costs. He gives an overview of these curves for wind and solar photovoltaic technologies using a dynamic simulation model.

DLW

A Note on *The Energy Journal*

The Energy Journal (EJ) Editorial Board meetings are customarily held (at the crack of dawn) during IAEE international conferences. Luminaries attending these meetings usually include several from the EJ Board.

The first item on the meeting agenda is a review of recent and forthcoming activities, a review that may well be of some interest to the laity of all IAEE members. Hence this note.

During 2002 we received about 100 papers, of which around 20 percent were accepted for publication; these figures are much the same as in recent years. Electricity is the fastest growing topic. The geographical breakdown of submissions is:

45% - North America (US, Canada, Mexico)
30% - Europe
15% - Asia-Pacific
10% - Rest of World.

Over half our papers, then, are contributed from countries outside of North America. The Journal also carries book reviews; 11 reviews were published in 2002.

The work of our referees is vital to the *Journal.* In 2002 we received close to 300 referee reports, an average of about three per paper. The referees were drawn from people located in some 50 countries. We use a 'double blind' system: the referees don't know the identity of the authors; the authors don't know the identity of the referees.

The average time for receipt of referee reports on a new submission is six to eight weeks. Accepted papers are normally published within a year of their original submission.

Three new IAEE members joined the Editorial Board in 2002: Einar Hope, (Norwegian School of Economics and Business Administration); Catherine Waddams (University of East Anglia, UK); and Catherine Wolfram (UC Berkeley, USA).

In terms of new activities, we shall be publishing four invited essays in the last issue of 2003 to commemorate the contribution of the Hans Landsberg and Sam Schurr to the field of energy economics, both of whom died in the past year. Plans are also underway to put together a special issue devoted to European electricity – assuming the required funding can be raised. If so, we are targeting publication for the end of next year.

Several people are involved in bringing the *Journal* to members, including Dave Williams (IAEE executive director), Dick Gordon (book review editor), Carol Dahl (assistant book review editor) and of course our publishers, Edward Brothers, but I would be derelict indeed were I not to make special mention of the outstanding contribution of associate editor Geoff Pearce. Geoff handles all the essential administration of the journal with exemplary efficiency and also helps in other ways - my co-editor Adonis Yatchew joins with me in this special acknowledgement.

Campbell Watkins,
Joint Editor

!!!!! MARK YOUR CALENDARS – PLAN TO ATTEND !!!!!

Integrating the Energy Markets in North America: Issues & Problems, Terms & Conditions

23rd IAEE North American Conference
Supported by the USAEE/IAEE/AMEE/CAEE
October 19 – 21, 2003 * Mexico City – Camino Real Hotel

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 23rd IAEE North American 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:

North American Energy Security and Reliability
Energy Trade and Transportation: Forward or Reverse?
Gas and Power – Convergence or Divergence?
Environment and Energy in North America
Oil and Gas in Mexico
Role of State Owned Utilities in North America

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 and/or invited speakers include the following:

Francisco Barnes, Undersecretary for Energy Policy & Technology, Mexico
Ernesto Martens, Secretary of Energy, Mexico
Juan Eibenschutz Hartman, Comision Nacional de Seguridad Nuclear y Salvaguardias
Luis Giusti, Center for Strategic and International Studies
Adrian Lajous, Petrometrica
Shirley Neff, Goldwyn International Strategies
Joseph Dukert, Energy Consultant
Guy Caruso, Energy Information Administration (tentative)
Mario Molina, Nobel Prize Winner, MIT
Michelle Michot Foss, University of Houston
Rafael Fernandez de la Garza, PEMEX
Roberto Osequeda Villasenor, PEMEX Corporativo
Daniel Resendiz Nunez, Comisión Federal de Electricidad
Bradley Patterson, Duke Energy International Mexico

Felix Kwamena, Natural Resources Canada
Michehl Gent, North American Electric Reliability Council
Dionisio Perez-Jacome, Comisión Reguladora de Energia, Mexico
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Jean Marie Bourdaire, World Energy Council
Luis Ramirez C., PEMEX Exploration & Production
Roberto Osegueda, PEMEX
Jose Luis Aburto, Petrelec Consultants
Marcos Ramirez S. PEMEX Gas y Petroquimica Basica
Mitchelle P. Rothman, Navigant Consulting, Canada
Juan Bueno Torio, PEMEX Refinacion

Mexico City is a city filled with history and a great place to begin or end a pre/post vacation. Single nights at the beautiful Camino Real Hotel are $110.00 per night. Contact the Camino Real Hotel at 5255-5263-8889, to make your reservations. Conference registration fees are US$570.00 for USAEE/IAEE/AMEE/CAEE members and US$ 670.00 for non-members.

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

Integrating the Energy Markets in North America: Issues & Problems, Terms & Conditions

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Petroleum Geopolitics at the Beginning of the 21st Century

*By Jean-Pierre Favennec**

Introduction

The Middle East possesses two-thirds of the world's liquid hydrocarbon reserves. This concentration, in a zone considered unstable in some circles, has led the consumer countries to diversify their supply sources, particularly after the oil crises. This is why North Sea, Alaska and offshore production has continued to grow despite higher costs than in the Middle East.

After September 11th, the United States sought to reduce its dependence on the Middle East and to increase its imports from other sources, such as West Africa and the Former Soviet Union.

New equilibria are taking shape: to what extent can Africa, Russia and the Caspian replace Saudi Arabia? This is the challenge today.

A strategic product par excellence, a base stock for motor fuels indispensable for daily life, oil is the central concern at the start of the 21st century. Will consumption explode or stagnate? Will the coming years see a shortage or a reasonable abundance of oil? Will the producing countries continue to favor cooperation or will they be prepared to use the "oil weapon" against consumers? Many questions need addressing, and uncertainties have been further aggravated by the terrorist attack on the World Trade Center and the Israeli-Palestinian conflict.

The Central Role of the United States

The United States remains by far the world's biggest oil consumer and importer. Faced with the threats of a shortage or embargo, American energy policy has repeatedly been the subject of debate. After the first oil shock in 1974, President Nixon launched the "Independence" plan, designed to permit the United States to recover the energy self-sufficiency that it lost in the late 1950s. "Let us set as a national goal", he said, "in the spirit of Apollo, with the determination of the Manhattan Project, to meet our energy needs without depending on any foreign source at the end of the decade". The project was unrealistic, but was nonetheless followed by similar initiatives up to the early 1980s. These projects enjoyed little success, and American dependence on foreign oil has still increased.

The oil aftershock and the decrease in the price of oil relegated concerns for security of supply to the background. But in 2000, the California crisis, the result of a deficit of power generation capacity in the west of the United States, degenerated into an American energy crisis: the price of electricity, as well as gas and home-heating oil, climbed to impressive highs. Unlike the crises of the 1970s, which resulted from the fear of an energy shortage, the crisis of 2000 was more the consequence of a botched deregulation of the energy markets. Two alternatives became available to the American electorate at the time of the 2000 presidential campaign: reduce energy consumption as proposed by Al Gore, the Democratic candidate; or increase supply, the program of George W. Bush.

George Bush won the race and proposed to open up new areas to oil exploration. But there was never any question of any sweeping change in American consumption habits. So the import of crude oil and finished products[1] simply continued.

In 2001, the United States consumed about 20 Mbd, produced 8 and imported 12 (crude oil and finished products). Four countries were the leading suppliers of crude and products: Canada with 1.3 Mbd, Mexico (1.1 Mbd), immediate neighbors and natural suppliers; as well as Venezuela (1.2 Mbd) and Saudi Arabia (1.5 Mbd). These four countries accounted for approximately 60% of American crude oil imports.

The attacks on September 11th drastically changed the situation. A drop in Saudi Arabia's sales to the United States was offset by a slight increase in supplies from Mexico. America demonstrated a marked determination to reduce its dependence on the Middle East. Yet the figures for American needs are implacable: the United States cannot do without Middle East oil. In late 2001, sales from Iraq to the United States actually increased.

The Deterioration of U.S./Saudi Relations

In 1932, Abd el-Aziz ibn Abderrahman al-Saud founded the kingdom that took his name. In 1933, he granted the first oil concession to Standard of California (Socal). The first oil discoveries occurred in the following years. Saudi Arabia's potential very quickly turned out to be considerable. In early 1945, President Franklin Roosevelt promised king Ibn Saud American protection. In exchange[2] the king supplied oil to the West and became a loyal ally of the Americans in the battle against communism, going as far as to back the Islamic opponents to the regime supported by the Russians in Afghanistan, from 1979 to 1988.

The alliance between the two countries is reinforced by their petroleum complementarities. The first obvious complementarity: since the 1950s, the United States imports and will continue to import increasing amounts of oil. Part of this oil will very probably continue to come from the Middle East. As a consensus on price: the United States, a big importer, does not want a high price, because this penalizes its growth, but an excessively low price is also disastrous. American production partly comes from a multitude of stripper wells, belonging to small proprietors[3]. An excessively low price of oil, as in 1986, can ruin thousands of Texan producers. Similarly, Saudi Arabia wants neither a low (because of the need for revenues) or a high (because of replacement of oil with orther energy sources) price.

Yet the alliance between Washington and Riyadh has made many circles unhappy. In Saudi Arabia, the presence of American troops is contrary to one of the first fatwas of the Omeyyad caliphs: to keep the "Land of the Prophet" free from infidels. It provokes the anger of certain Saudi quarters: in 1995, a bombing killed five Americans in Riyadh. In 1996, a second against American forces caused nineteen deaths at

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[1] See footnotes at end of text.

Dhahran.

The hostility of a fair share of the population of Saudi Arabia to the Americans is met by increasingly clear criticisms of a segment of American public opinion against the Riyadh regime. The Saudi monarchy is an absolute and virtually theocratic monarchy. The royal family, in power since 1932, bans any form of political opposition (no political parties, no voting rights, no unions). Only divine law – the Koran and prophetic tradition (Sunna) – could challenge the power of the king. This regime is the absolute opposite of American traditions.

American criticism has become much more violent after September 11th. Fifteen of the nineteen terrorists who hijacked the airplanes against the World Trade Center and the Pentagon were Saudi nationals. Ossama bin Laden is himself of Saudi origin. Hence the clamor of the American press against the Wahhabite kingdom.

The two countries, strongly bound by common interests in petroleum matters, are increasingly antagonistic. The United States is exasperated by the regime's lack of democracy and its close links with the most conservative Islamic circles. The Saudis are irritated by the lessons from the American press, U.S. support for Israel, and the "arrogant" policy of the U.S. administration. How can this dilemma be resolved?

The New Role of Russia and the Importance of Russian Oil

The fall of the communist regime brought about the collapse of oil production which, in the CIS (FSU minus the Baltic republics – the production of the CIS is, therefore, perfectly equivalent to that of the FSU) dropped to 7 Mbd in 1995, and to 6 Mbd in Russia at the same time. However, the reforms of 1998 (devaluation of the rouble) and the recovery of crude oil prices since 1999, have substantially improved the situation of Russian industry[4].

By virtue of its historic and geographic positions, Russia also plays a key role in the development of the Caspian. Five riparian countries share the resources of this region, Russia, Kazakhstan, Turkmenistan, Iran and Azerbaijan.

Many pipeline projects are on the boards, but they face many problems:

- pipelines routed towards Russia cross Chechnya, a very sensitive area today,
- Turkmenistan's oil and gas could be routed through Iran, but the United States is against this alternative,
- the routes terminating in the Black Sea entail transit through the Bosphorus, which is very narrow, and the Turkish authorities want to limit the traffic in this Strait.

September 11th altered the prospects. While the United States remains hostile to any routing of Caspian oil through Iran, routes across Russia no longer meet the same hostility. At the same time, Russian companies are participating in exploration in this region alongside private Western companies: thus Lukoil has declared its readiness to participate in the construction of an oil pipeline crossing Turkey and terminating at Ceyhan.

The New Equilibria after September 11th

Even if the solidity of the links between the United States and Saudi Arabia has been shaken by the attacks on September 11th, both countries continue to play a key role on the oil scene, and the petroleum geopolitics of the beginning of the XXIst century continue to be organized around the Washington-Riyadh axis.

The central question that exists is the following: can the United States manage without the Middle East? Some experts say, yes, drawing a parallel between the cost of the US presence in this area and the value of the imported oil. Yet the answer must be far more guarded. U.S. energy and oil requirements are considerable and steadily growing. Every American consumes 8 tons (oil equivalent) of energy and nearly 3 tons of oil annually. The potential for economies is considerable, since with similar levels of wealth, the Europeans and Japanese consume less than half of that energy. But the present choices of the American administration are clear: don't touch the "American way of life". Hence energy supplies must be increased without reducing consumption, and more oil must be imported in the coming years. Can imports from the Arabian-Persian Gulf be reduced? In principle, yes. Flows could conceivably be redirected so that the United States buys most of its supplies from Canada, Venezuela, Mexico, Russia and (North and West) Africa. Yet this energy independence would still not shelter the United States from the political upheavals of the Middle East. The oil industry is a world industry, and an incident on a field or on a refinery in the Middle East will affect oil prices throughout the world.

Furthermore, as brilliant as American power may seem, the United States needs the support of other countries, industrialized countries, as well as emerging countries, to deploy its foreign policy. This implies protecting the economic interests of its allies. Greater dependence of certain allied countries (especially Asian) on the Middle East countries will be the price to pay for lesser American dependence. This dependence can become critical for certain countries.

It must be remembered that in the Middle East, five countries own two-thirds of the reserves of the planet. Two of them form part of the "Axis of evil" according to the U.S. President: Iraq and Iran. Two others have very limited political clout: Kuwait and the United Arab Emirates. This leaves Saudi Arabia, an indispensable and unavoidable partner. A loosening of the links between Washington and Riyadh would mean a withdrawal of the United States from the Middle East, which is difficult to imagine.

Another country whose stature has changed since September 11th is Russia, which has profited from the repercussions of September 11th to accentuate its return to the group of nations that run the world. Criticism against Russian government action in Chechnya has been dispelled in the formation of the coalition against terrorism. After all, don't the Russians refer to the Chechens as terrorists? The Russian petroleum industry can benefit from the new situation. Although a rupture between the United States and Saudi Arabia is highly improbable, Russia, whose crude oil production is growing substantially, will certainly try to boost its market share and once again become a key player on the oil scene. The OPEC-non-OPEC debate concerning cuts in output has been transformed into an OPEC-Russia confrontation. Russian industry, reinforced by the control that it can exert on a good share of the resources of the Caspian region, will play a major role in the coming years.

However, without a major upheaval, the world will depend for several years to come on the Arabian-Persian Gulf

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The Economics of Micro-Generation: Case Studies from the UK

*By Jim Watson**

In recent years, three dominant trends have emerged in the energy supply industries of many industrialised countries. The liberalisation of electricity and gas markets has been accompanied by vertical de-integration into generation, transmission, distribution and retail supply. Environmental regulations have been tightened in response to issues such as acid rain and climate change. There has also been a renewed preoccupation with security of supply, both in its operational sense (the day to day security of energy networks) and its strategic sense (the adequate availability of energy resources).

Partly in response to these trends, there has been an increased interest in distributed electricity and heat generation as new electricity generation, power electronic and information technologies emerge. One of the most radical implications of the expected growth in distributed generation is the possibility of micro-generation in individual homes. If it catches on, micro-generation will fundamentally change the relationship between energy suppliers and consumers. As Amory Lovins points out in his recent book *Small is Profitable*, 'technological, conceptual and institutional forces are … driving a rapid shift towards the "distributed utility" where power generation migrates from remote plants to customers' back yards, basements, rooftops and driveways'.

By blurring the traditional boundary between energy supply and demand, micro generation presents utilities, regulators, consumers and equipment suppliers with a new set of challenges. Its advent has, therefore, attracted the attention of governments and energy companies alike. The International Energy Agency's recent review of this issue shows that policies are being developed in many countries to encourage renewable energy technologies and combined heat and power systems. To support these policies, work is also underway to rethink and reshape the way in which energy networks are structured and regulated.

Alongside these government initiatives, some of the world's largest energy companies have seized the opportunity to move into distributed and micro-generation technologies. The most notable example is the decision by ABB, the Swiss-Swedish engineering giant, to abandon its roots in large scale power generation to concentrate on decentralised sources such as wind power and micro turbines. Similarly, the world's biggest corporate takeover attempt – of Honeywell by General Electric in October 2000 – resulted in the acquisition of Honeywell micro-turbine and fuel cell technologies by GE. It is no coincidence that two of the world's largest oil companies – BP and Shell – are now amongst the world's top five developers of solar photovoltaic technologies.

This article focuses on some of the key economic challenges that will confront micro-generation technologies during the next few years. It investigates the economics of micro-generation investments in the UK, based on solar photovoltaic (PV) and domestic combined heat and power (micro-CHP) technologies. In its recent energy White Paper, the UK government confirmed that it expects these two technologies to make significant contributions to the energy system by 2020. It is, therefore, interesting to assess what incentives there are for householders and energy companies to invest in these technologies, and what barriers might prevent such investments.

Models for Financing Micro-Generation

The eventual size of the micro-generation market in the UK and other countries will depend on a number of factors including the availability of technologies, the costs and benefits of installation and the complex array of regulations that govern the energy system. Economic incentives of various kinds will have a key influence on decisions to invest in micro-generation by householders, energy suppliers or energy service companies. At present, it is not clear which of these potential categories of investor will own the majority of micro generation units, and how these units will be operated and maintained.

Some Alternative Approaches

There are a number of ways in which micro-generation units could be financed, owned and operated in the future. Table 1 summarises the key features of three possibilities and their implications for both householders and energy suppliers.

Table 1
Three Models for Financing and Operating Micro-Generation

	Plug and Play	**Company Ownership**	**Leasing**
Ownership	*Householder*	*Energy Supplier*	*Energy Supplier:* But possible transfer to Householder at end of leasing period.
Operation	*Householder:* Operation according to Householder needs for power and heat	*Energy Supplier:* Operation to help Energy Supplier balance supply and demand (could take into account Householder preferences)	*Shared:* Operation to help Energy Supplier balance supply and demand, taking into account Householder preferences
Costs and Benefits	*Householder* saves on energy bills, but has to pay capital cost.	*Householder* gets cheaper energy in return for hosting micro-generation.	*Householder* saves money on energy bills, and spreads capital costs.
	Energy Supplier loses kWh sales, and has to provide clear terms of grid access and buyback rates.	*Energy Supplier* avoids buying wholesale electricity, and can balance their system more cheaply	*Energy Supplier* retains some operational control and recoups capital investment through lease payments.

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Whilst the table does not cover all possibilities, it includes different options for ownership of the micro-generation unit, its operation and the financial costs and benefits for the consumer and the energy supplier.

The first 'plug and play' model is the simplest. It is probably the most common method for financing micro-generation installations at present. The household consumer pays for a micro-generation system (e.g., a micro-CHP or solar PV installation), and operates it to maximise their private economic benefits. Depending on the country in which these systems are installed, the up-front capital costs may be partly reduced through grants, tax breaks or loan schemes.

The second model is more complex, particularly because it requires remote control of the micro-generation unit by an energy supplier. It is already being considered by some energy companies. For example, the local electricity company in Hamburg, Germany intends to install 50 micro-generation fuel cell units that it will control remotely in this way. Under this model, there might be some kind of benefit sharing with the householder (e.g., in the form of lower energy bills).

The third financing model is an intermediate one. The micro-generation system is leased to the householder over a number of years by an energy company. Costs and benefits are shared, as is the day-to-day control of the unit. One possibility is for the householder to set their priorities for heat and electricity in advance. These priorities would then be taken into account by the energy supplier when it operates the facility. In common with the second model, communication and control signals could be passed between the consumer and the energy supplier.

Implications for the UK Energy System

When applied in the context of the UK energy system, these models for investment in micro-generation raise a number of important issues. To explore these issues in some detail, it is useful to test the models using those micro-generation technologies that are likely to be available commercially in the next few years. Solar PV and micro-CHP are good examples. Grants for domestic solar PV installations were introduced by the UK government over a year ago in an effort to catch up with established initiatives in Germany, the USA and Japan. For micro-CHP, at least two companies are planning to launch new products in the next year or so. One of these companies – PowerGen – expects that 30% of UK households will have a micro-CHP unit by 2020.

A central issue for the evaluation of these technologies is the extent to which different models for ownership and operation will alter the economics of investing in micro-generation. For example, the financial rules that govern energy investments by consumers are different to those that apply to investments by energy companies. As a result, the Plug and Play and Leasing models for investment are subject to different rules for UK sales tax (known as Value Added Tax or VAT) and tax investment allowances.

The Economics of Plug and Play

To illustrate some of the factors that affect investments in micro-generation in the UK, Table 2 compares the economics of a micro-CHP system and a solar photovoltaic (PV) system. In each case, the system is purchased by the householder using an available (or almost available) technology and operated on a 'Plug and Play' basis.

Table 2
Economics of Solar PV and Micro-CHP Investments by Householders

	Solar PV Solar Century Sunstation 12	**Micro CHP** BG Stirling Engine
Size	$1.5kW_p$	$1.1kW_e/5kW_{th}$
Installed cost to consumer	£4300 + 5% VAT*	£2500 + 17.5% VAT
Annual electricity generation	1100kWh	2700kWh (500kWh exported)
Electricity price (buy & sell)	7.5p/kWh	7.5p/kWh
Annual gas consumption	-	19050kWh
Gas price	-	1.5p/kWh
Annual ROC revenue**	£45	-
Payback period	**35 years**	**14 years**

Notes:
Calculations assume an average medium sized energy consumer, consuming 3300kWh of electricity and 19050kWh of gas, with net electricity metering.
* Assumes a 50% capital grant paid under the Department of Trade and Industry's current subsidy scheme.
** ROC revenue from the sale of Renewable Obligation Certificates at an average price of 4.0p/kWh.

The figures in the table give a rough idea of the economics of two micro-generation technologies, and some approximate investment payback times for householders. It is clear that, even with the current 50% capital grant scheme, solar PV still has a payback of several decades. The situation for Stirling engine micro-CHP technology is more attractive, though the payback period for this technology is still much too high to attract widespread interest.

These results are somewhat more pessimistic than those from some other assessments, particularly of micro-CHP investments. In a report to the Energy Savings Trust, EA Technology gave a much shorter payback period for these investments of 3-4 years. The difference may be explained by the fact that the EA Technology calculations are based on the marginal capital cost of micro-CHP (i.e., the difference between the cost of a CHP unit and the established alternative – a replacement central heating boiler). This type of comparison shows the premium that consumers would have to pay to upgrade to a micro-CHP unit instead of a condensing boiler. It is applicable only in circumstances when the consumer is forced to change their boiler due to a breakdown of their existing system. Whilst this scenario is expected by manufacturers to be one of the main drivers for micro-CHP in the UK, this marginal payback approach makes it difficult to compare micro-CHP economics with those of other technologies such as solar PV.

Barriers to Plug and Play

There are a number of economic issues related to the analysis in Table 2 that may inhibit the diffusion of 'plug and play' micro-generation in the UK and other countries. First, it is particularly important to note that the calculations in Table 2 do not include maintenance costs. These are likely to be

significant, and at least as high as those for current central heating systems. Commercial maintenance packages for these systems currently cost consumers between £100-£150 per year. If maintenance costs of £100 per year are included, the payback period for a micro-CHP investment increases to 25 years. However, it is likely that most purchasers of micro-CHP units will be replacing an existing central heating boiler. Therefore, they will not incur significant *additional* costs for annual maintenance and servicing. For the second case – solar PV – manufacturers claim that maintenance costs will be close to zero since installations are designed to be maintenance free during their lifetime. It remains to be seen whether this will be the case in practice.

Second, the data in Table 2 for the solar PV case assumes that such installations will be eligible for Renewables Obligation Certificates (ROCs) that are issued to renewable generators in the UK. Since April 2002, ROCs have been issued to electricity companies for each unit of renewable electricity they produce. Registered suppliers have to use these ROCs to prove that they have generated or purchased a proportion of their electricity from renewable sources. Initially, this proportion has been set at 3%, though the figure will rise each year to reach just over 10% in 2010. If a supplier is unable to meet this target in a given year, they can pay a fine of 3p/kWh for any shortfall. In principle, householders should be able to accumulate ROCs for solar PV and other renewable electricity they generate, and sell these to suppliers with a shortfall. In practice, the transaction costs of doing this are expected to be high. At present, it is not clear whether householders will be able to aggregate their PV output to overcome these transaction costs. If ROC revenue is not available, the payback period for solar PV micro-generation in Table 2 would increase to 54 years.

A third significant economic qualification to the data in Table 2 concerns net metering. It is assumed in each case that net metering agreements with the local electricity supplier are possible. These mean that the householder exports and imports electricity at the same price (around 7.5p/kWh). In many cases, electricity suppliers are unwilling to offer net metering, and will instead buy electricity exports at much lower prices. For the micro-CHP case, a lower tariff of 3p/kWh for electricity exports would slightly increase the payback period to 15 years.

Whatever buy-back tariffs are ultimately available to householders, new two-way electricity meters will be required to allow the accurate calculation of their electricity bill. Some types of meter could also bring additional benefits to consumers. For example, they could allow householders to access variations in energy prices at different times of the day. Exporting at a time of high electricity demand could bring greater financial rewards, and help to change consumer behaviour in a way that benefits the whole electricity system. Another related possibility is that a householder could benefit from locational charges for the use of the electricity distribution system. The UK is currently in the process of implementing a new charging structure for the use of distribution networks to bring it more into line with the practice in other countries. One possibility is that householders would receive a payment from a distribution company for installing generation that would strengthen a weak part of the electricity network.

In addition to these potential economic barriers to 'plug and play' micro-generation, there are also technical and regulatory issues that could deter householders from making such investments. Many of these are now being addressed in the UK within a government-industry body known as the Distributed Generation Co-ordinating Group (DGCG). One of the most important issues considered by the DGCG concerns technical connection standards. These require equipment to be installed to protect the electricity network and the micro-generation system in the event of system instability or faults. A new standard – known as G83 – has now been developed to specify what is required with the aim of ensuring that electricity distribution companies do not have to inspect the installation of each micro-generation unit on a case by case basis.

The Economics of Investment by Energy Service Companies

For the Company Ownership and Leasing investment models (see Table 1), energy companies in particular will have to weigh up a different set of costs and benefits to those that apply to the Plug and Play model. On the positive side, it is probable that an energy company would be able to 'bulk buy' micro-generation equipment and achieve substantial discounts on the usual retail price. They would also be able to use standard capital allowances to offset part of their investment costs against their tax bill. Under current UK corporation tax rules, these allow 25% of the investment costs to be offset each year on a reducing balance basis.

The extent of the bulk buy discount is difficult to predict. As an example, it could be assumed that this will reduce the micro-generation installed cost by around a third. This is illustrated in Table 3 using the micro-CHP case. A hypothetical bulk buy discount at this level brings the installed cost down from £2500 to £1667 (plus 5% VAT). A further discount over the lifetime of the micro-CHP unit will be forthcoming from the use of capital allowances.

Table 3
Possible Features of Energy Service Company Micro-CHP Investment

	Micro CHP BG Stirling Engine
Size	1.1kW$_e$/5kW$_{th}$
Installed cost	£1650 + 5% VAT (33% discount by bulk purchasing)
Capital allowance discount	£130 in year 1, £97 in year 2, £73 in year 3 etc.
Discount rate	12%
Annual electricity generation	2700kWh (500kWh exported)
Annual electricity consumption	3300kWh (average medium consumer)
Electricity price to ESCo	5.0p/kWh
Annual gas consumption	19050kWh (average medium consumer)
Gas price to ESCo	1.0p/kWh
Annual income from consumer	£432 (10% discount on previous energy bills)
Payback period	**12 years**

Notes: Calculations assume an average medium sized energy consumer – 3300kWh of electricity per year and 19050kWh of gas, with net electricity metering. They also assume that energy service companies will be able to buy gas and electricity a third cheaper than individual consumers.

Despite this reduction in investment costs, each household installation would still require an energy company to invest around £1500 up front – an investment that it would

have to recoup through consumer leasing payments, capital allowances and other savings. As Table 3 illustrates, one possibility would be that the energy company would agree to discount the consumer's total annual electricity and gas bills by a small percentage (say 10%) for a number of years. The installation of a micro-CHP unit would allow the company to offset some of its own electricity purchases (from the wholesale market) and to 'bundle' a number of services together – electricity, gas and micro-CHP maintenance – for a single annual charge. As the deregulated energy retail markets in many countries have shown, many energy companies are already bundling a number of products in this way to cut costs and make a profit.

As Table 3 illustrates, the economics of energy company investment in micro-generation using a leasing model are poor under present UK conditions. Assuming that the electricity and gas required for the household could be purchased at a 33% discount by the energy company, the payback period for this investment would be around 12 years. This is a substantial period of time, and is much too long for most companies to consider. It is possible, however, that it could be cut further if an energy company could find ways of reducing electricity, gas or micro-CHP equipment purchase costs still further. Alternatively, the company could offer customers a smaller discount on their bill.

Barriers to Leasing

Even if they were able to achieve further savings in costs, leasing investments by an energy company would still be difficult in the current UK market. One critical issue that is often cited in discussions of energy service approaches to investment is known as the 28 day rule. This allows consumers to switch electricity or gas suppliers by giving 28 days' notice to their current supplier. This rule is a cornerstone of the UK approach to energy deregulation, and is designed to protect consumers from 'lock-in' to high tariffs by suppliers. The problem is that the rule also makes it difficult for suppliers to offer energy service packages that depend on a relationship that is more than 28 days long.

Another issue that might impact on the attractiveness of micro-generation leasing or ownership by energy companies is information technology. New information technology investments might be desirable under these models to allow data and control signals to be passed between houses and energy companies. This would enable a much greater degree of coordination of household energy services by companies and consumers. However, it also implies a need for additional costly equipment and systems to interface consumer preferences and energy company requirements for balancing supply and demand. The cost of investing in this equipment may, however, be offset by the benefits to the energy company of being able to use a portfolio of micro-generation to help manage the operation of their network. As mentioned previously, the expected reform of distribution network tariffs in the UK could bring positive financial benefits for some micro-generators. In addition, a distributed micro-generation fleet could help a company to avoid paying for high-cost peak electricity. The aggregate effect may be to justify the costs of control and communication infrastructure.

Conclusions

This article has examined some of the key issues affecting the economics of micro-generation investment in the UK. In all cases except the forced purchase of micro-CHP due to central heating boiler breakdown, the payback time for such investment is over 10 years – too long for it to be justified purely on economic grounds. Of course, as demonstrated by the significant numbers of applications for the UK solar PV grant scheme, some consumers will wish to invest in micro-generation irrespective of the economics. Other factors, such as the desire to be a 'green consumer', the prestige of owning new technology, or a wish for energy autonomy might also be important.

The unattractive economics of micro-generation under current conditions are partly due to significant discrepancies in the tax rules for householders, energy companies and other parts of industry. To overcome this, it might be desirable to move towards a more level playing field. For example, if householders had access to the same tax allowances for energy investments as companies, payback times could be reduced considerably. A 100% first year tax allowance is currently available for companies investing in selected energy efficient technologies. Extending these to the average householder would cut the payback times cited in Table 2 to 29 years for solar PV and 11 years for micro-CHP. These periods are still too long to make investment attractive for many households.

Such a change in the fiscal rules would bring micro-CHP technologies closer to financial viability for consumers, and would help PV technology enter the timeframe of most mortgages. This has been recognised by some U.S. states, which now have tax concessions for PV investment. Meanwhile, the UK Treasury has shown a willingness to consider such changes, though there is no sign that they will be implemented in the near future. A wider implication of changes in tax incentives is that they would not just benefit micro-generation. They might also make it easier for householders to invest in many other energy saving measures, many of which have shorter paybacks and reduce carbon emissions more cheaply. Examples include more efficient central heating boilers, loft insulation and 'A' rated fridges and washing machines.

Changes in taxation alone are, however, unlikely to be sufficient to remove the barriers to demand side energy investments such as micro-generation. As the analysis of the UK situation has shown, many technical, economic and regulatory issues are being reconsidered to allow micro-generation to contribute to energy policy goals. To allow the full economic and environmental value of micro-generation to be realised, there is a need for radical reform in areas such as distribution network regulation and technical standards. Looking further ahead, the development and installation of new IT and control systems would also help. Such systems could allow micro-generation and other demand side technologies to be fully integrated within energy systems.

At the moment, the highly integrated and IT-intensive energy systems envisaged by some commentators seem to be a long way off in most countries. Even in countries with relatively decentralised energy systems such as Denmark and Holland, household energy generation is a new development. Micro-generation is at an early stage, and much depends on the reactions of the early adopters of technologies such as solar PV and micro-CHP. It has the potential to bring with it radical changes to the energy system, and to the roles of energy consumers and energy suppliers. However, much depends on the willingness of consumers to take a leap of faith and install that power station in their basement, rooftop or back yard.

Montreux Energy Roundtable 14th Annual, June 2003

Some Impressions

*By Paul Tempest**

The Montreux Energy Forum and Roundtable was founded in 1988/9 to provide an annual meeting-place for the chief executives of OPEC, the International Energy Agency and the U.S. Administration to review, in the company of selected top business executives, lead-academics, diplomatic representatives and other invited professionals the current policy options facing the global energy industry. The last 15 years span three U.S. Presidents, three IAEE Executive Directors and 4 OPEC Secretary-Generals, all of whom have derived benefit from the Montreux Energy consultations.

On June 16-18, 2003 we were privileged to welcome Claude Mandil, the new Executive Director of the IEA, Dr Subroto, former Secretary-General of OPEC, Adnan Shihab-Eldin, the current Director of Research at OPEC, Nordine Ait-Laoussine, former Minister of Energy in Algeria, Alessandro Ovi, Special Energy Adviser to the President of the European Commission, John Beale of the Environmental Protection Agency, Washington, and John Easton who has served in three key Presidentially appointed positions in the U.S. Department of Energy.

Among the major technical presentations were those of the Saudi Ministry of Petroleum, Saudi Aramco, Petrobras, the National Development and Reform Commission, Beijing, the Electric Power Research Institute, Palo Alto,USA, Conoco-Phillips, BP plc London, Oak Ridge Laboratory, USA, the World Energy Council and Toyota who displayed and demonstrated the prototype Mark II PRIUS advanced hybrid fuel-cell family car scheduled to be marketed from end-2003, offering 62mpg in inner-city use and highly competitive performance.

The conference was again located in the Montreux Palace Hotel with the Montreux Energy Roundtable banquet again held in the 13th Century main hall of the Chateau de Chillon.

Energy Security, the Middle East and Market Outlook

Has the world become a safer place since the World Trade Center attack of September 2001?

Despite the successful U.S occupation of Kabul and Baghdad and the vigorous pursuit of international terrorists, concerns about the abrupt reactions of current governments, notably those of Iran, North Korea and possibly Saudi Arabia, Russia and China led to a consensus that the global economy was still in a state of shock with much damaged investment flows to the developing world and reduced expectations of global economic growth over the next 2-3 years.

This would have serious impact on the global oil market: the oil price could expect further needle-point discontinuities and most probably a falling trend, both of which would tend to deter much needed new investment.

Much would turn on the success of the USA in creating a soundly-based regime in Iraq which might or might not provide a model for other neighbouring states. Any delay in the handing back of control of Iraq's oil and gas facilities is likely to provoke reprisals and rising anger within the region. However, the rebuild of Iraqi oil production and exports looks as if it will be slow, fragile and fraught with the same diplomatic obstacles which have frustrated the establishment of a Palestinian State or the resolution of differences between India and Pakistan.

Can OPEC Continue to Stabilise the Oil Market?

OPEC has effectively demonstrated its global economic value in smoothing the oil-price path whenever the OPEC price-target band of $22-28 pb looked in danger of being breached. To go on achieving this, OPEC, and particularly Saudi Arabia, will need continuing current or rising levels of spare capacity.

Nonetheless, OPEC is likely to continue to cede market-share to the non-OPEC producers led by Russia whose production is again coming level with that of Saudi Arabia. At some point OPEC's position is likely to turn round, as the many currently vigorous non-OPEC producers become less able to compete on costs and begin to deplete their flimsy reserves at a faster rate. The long-term prospect is, therefore, one of enhanced OPEC market dominance despite their current market weakness.

On the demand side, there was general agreement that the USA would continue to increase its massive oil import dependence, while China (and also India) would quickly become competing oil, gas and coal importers of massive and rising dimension.

We were unable to detect any real sense of urgency or crisis about energy supply security in the USA and Europe whereas there are now clear signs that China, Japan and the Republic of Korea are actively seeking relief by strengthening economic and trading ties with the lead Middle East producers.

Can Natural Gas/Coal Displace Oil in Euro-Asia?

While the USA will increase demand for LNG, the long-term global gas market play will be mainly in Europe and Asia with the rapid development of spot-trading of LNG and pipeline gas as the various connections linking the Siberian, Caspian, Iranian and other Gulf producers with Europe and China begin to materialise. A later phase will attach India, Republic of Korea and Japan to this network and will begin to tap remote Central Asian gas resources. Much hope is placed on coal gasification in China and Russia to supplement natural gas in this vision of a new and integrated Euro-Asian gas grid. Meanwhile South-East Asia remains particularly vulnerable to any interruption of oil supply from the Gulf.

How Can the Energy Sector Avoid an Investment Famine?

The reluctance or inability of the International Oil Companies to commit serious funds to developing low-cost sources in the Middle East is matched by severe budgetary constraints among all the producer countries. The current structure of the energy sector offers little incentive with some sluggish and out-dated international agencies and many poorly-informed producer governments.

(continued on page 14)

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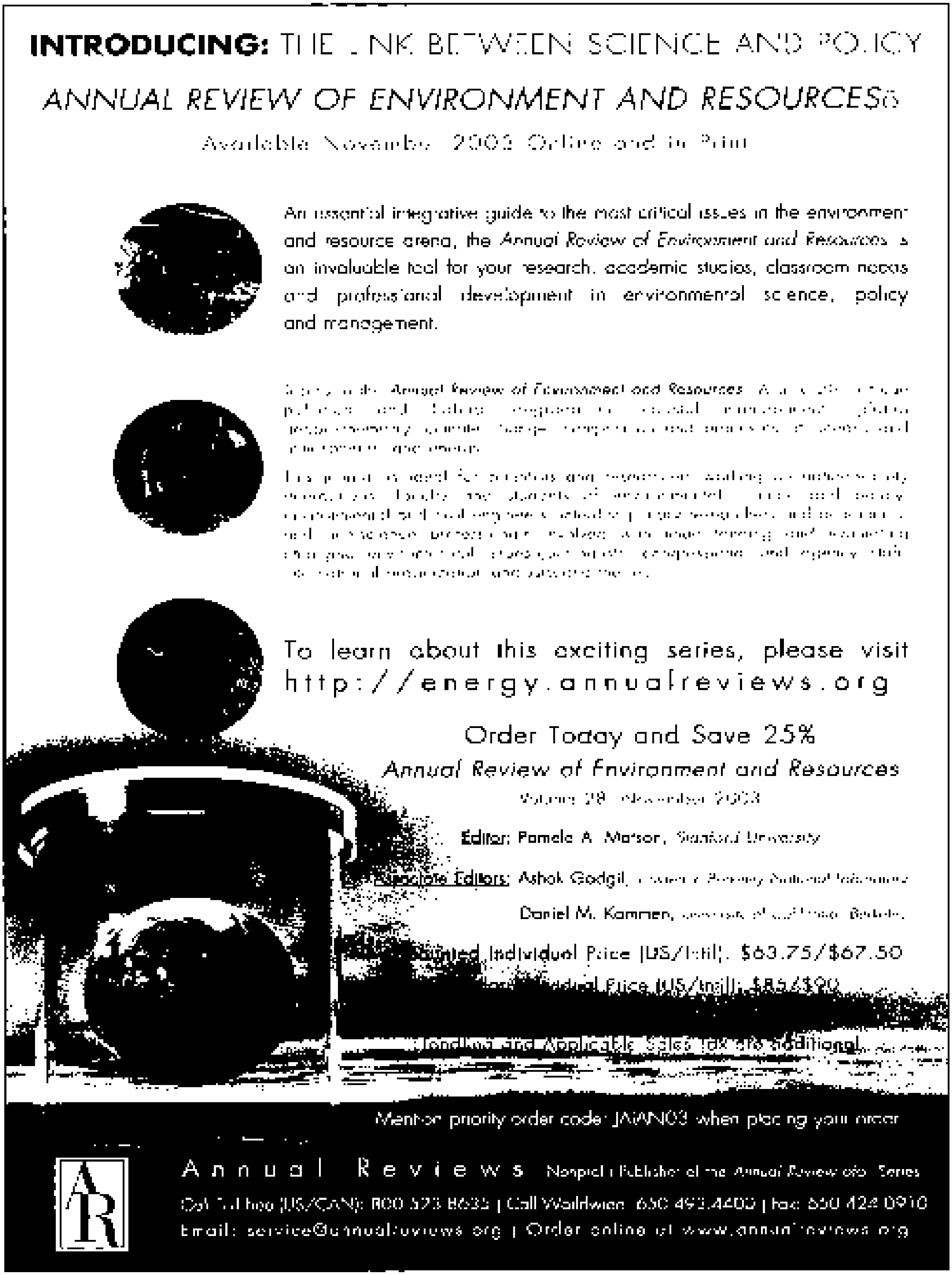
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Ontario's Electricity Market: An Update

*By John Grant**

Ontario's new electricity market, launched with optimism in May 2002, was severely challenged in its first year. Extreme summer heat, drought, unexpected and lengthy delays in the return to service of laid-up nuclear units, and extended forced outages of other major generation facilities all conspired to send wholesale prices soaring. Increases in transmission and distribution rates, still regulated but now permitted to generate commercial-equivalent rates of return, added to customers' sense of shock. In November the provincial government, responding to a hail of grass-roots criticism, announced a retroactive price freeze at 4.3¢ until April 30, 2006 (all figures in Canadian dollars) for small and designated customers. Although the wholesale market continues to operate, about half the load in the province is now sheltered from the hourly wholesale price through a subsidy mechanism. (As the wholesale energy price averaged 6.22 cents for the first twelve months, the effective subsidy for that period will come close to $ 1.5 billion, although the provincial taxpayer is on the hook for only about $ 500 million of this; dividends and other payments from public-sector entities such as Ontario Power Generation (OPG) and Hydro One provide cover for the rest. The government argues that the cumulative burden on taxpayers will fall to zero once the laid-up nuclear capacity has come back on-line, a view not widely shared in the industry.)

In addition to the freeze on retail energy prices, the government's November initiative froze or capped transmission, distribution, and other charges. The Minister of Energy was also given the authority to disallow proposed market rules passed by the Board of the Independent Electricity Market Operator (IMO) if it was considered that they would disadvantage consumers.

When the province embarked on the restructuring in 1997, it was a combination of soaring debt at the provincially-owned utility and embarrassing revelations of mismanagement in its nuclear operations that led the province to abandon public power paternalism for the hoped-for efficiencies of a private, competitive marketplace. Business risks were to be shifted from the taxpayer to private entrepreneurs; ratepayers would have free choice among suppliers. The government decided to establish full retail as well as wholesale choice from the outset; local distributors who wished to offer fixed-price contracts to their retail customers were required to set up arms-length retailing affiliates to do so, but would find themselves competing with private retailers on a province-wide basis. Customers who did not accept a retailer's offer were given a straight pass-through of the wholesale hourly spot price. The government also encouraged municipalities as owners of the over 300 local distributors to sell them or combine them into larger entities, and used a tax mechanism to give public sector companies a temporary advantage in bidding to acquire them. In the event the province's own transmission and distribution giant, Hydro One, swept up over a hundred of the small distributors; by early 2002 less than a hundred were left.

Early in 2002, the provincial Premier who introduced the restructuring program, Mike Harris, resigned, and his party selected Ernie Eves to succeed him. Harris had planned to sell off Hydro One, but a court ruled in April 2002 that the province had no authority to do so. In June Premier Eves introduced enabling legislation, but announced that the province would sell only 49% and would retain operating control of the company. On finding that the company's senior executives had been awarded extremely generous compensation packages, he proposed to fire the Board (who resigned en masse instead), and having appointed an interim Board, directed it to fire the C.E.O. for excessive spending. (She subsequently sued the company for wrongful dismissal and slander.) In January 2003 the Premier terminated the privatization and announced that the province would retain full ownership of Hydro One.

These developments led a number of observers to add Ontario to the list of failed experiments in restructuring. But despite these travails, the market's first year provided reassurance that the basic mechanism was sound. Wholesale transactions were settled successfully and on time, high prices attracted record volumes of imported power when needed, and a significant demand response from large industrial customers to anticipated high prices proved to be crucial in keeping the lights on on more than one occasion.

In retrospect, the backlash against price volatility at the retail level might have been manageable if the government had prepared the public better for the shift to marginal cost-based pricing. The public was told only that market competition would bring lower prices, not that heavy airconditioning demands on hot summer days would send their bills through the roof. Without interval meters or other tools to manage their demand, many small consumers were indignant at suddenly being expected to pay substantially higher amounts. But a number of energy retailers had, in fact, signed up some 20% of small customers for fixed-price energy contracts prior to market opening, and some distributors had chosen to continue billing their small customers on a fixed-price basis for a time (albeit with a catch-up to follow). Further mitigation was in the works, because, in acknowledgment of its market power, OPG, the dominant generator, was required by the government to pay customers a rebate calculated as a share of its revenue whenever energy prices exceeded 3.8 ¢/kwh. However, the first rebate payment would not have been made until the summer of 2003, and the rebate formula was so complex that it was never explained effectively to the public. In any event, small consumers who did see huge increases in their electricity bills during the summer of 2002 quickly communicated their anger to their political representatives, and the government quickly responded with the price and rate freeze. If the rebate had been better explained, if it been paid out in a more timely manner, if… Certainly, with hindsight, the summer's experience could have been prepared for much better from the point of view of winning consumer acceptance and understanding.

Prior to market opening, optimism about the size of the reserve margin of capacity available to the province may have led officials to expect that prices, and price volatility, would be relatively subdued during the crucial early months. That was not to be. While in May and June the average hourly

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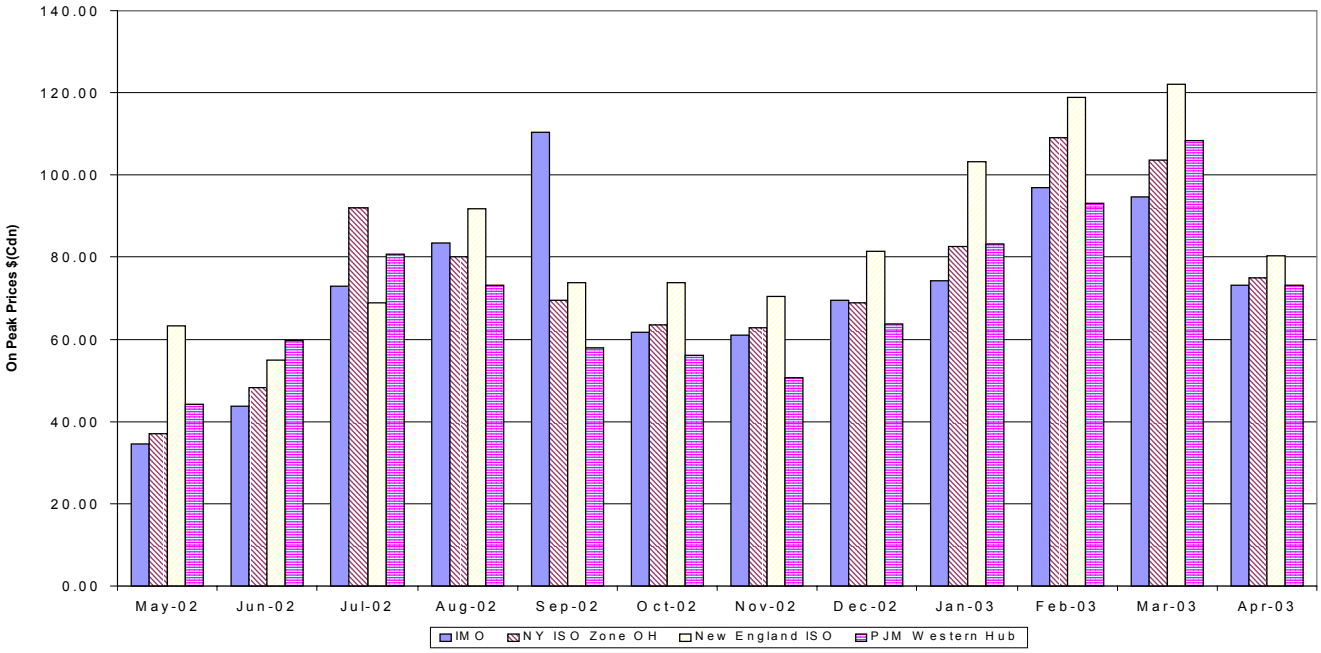
Ontario wholesale energy price (HOEP) was below 4 ¢/kwh, it averaged 6.2¢ in July, 6.9¢ in August and 8.3¢ in September. In October the IMO's Market Surveillance Panel noted a "serious shortage of generation capacity to meet Ontario's growing demand for electricity. If steps are not taken to address this situation, Ontario could face even more serious reliability problems next summer, leading to the possibility of supply interruptions…" In fact the monthly average HOEP continued to range between 5.1¢ and 8.9¢/kwh through April 2003. The IMO's Market Assessment Unit 's analysis of the May-August 2002 period concluded that there was no evidence of any abuse of market power during that period. Instead, it attributed high prices to "increased demand, a nuclear outage [an 840 MW unit whose return to service from a scheduled outage was delayed for over a month], deratings on fossil-fired generators due to environmental limits, and less hydro-electric energy available." In addition to these factors, a major contributor to the supply deficiency was the failure to return to service of a substantial amount of nuclear power generation (2060 MW in 4 units at Pickering A and 3300 MW in 4 units at Bruce A) that had been taken offline between 1995 and 1998. Pickering A was originally to have been restarted by summer 2000, but did not return to service during the first year of the market. As of spring 2003 the long-delayed in-service dates for 4 nuclear units at Pickering continued to be problematic; the two nuclear units at the Bruce station were also experiencing delays. As a result, earlier confidence that resource adequacy could be dealt with in a fairly leisurely way was replaced by concern that private investors would not come forward in time to avert serious insufficiencies in the years ahead.

As noted, strong demand was a factor in the equation. Whereas peak demand in 2000 was 23,428 MW, the strong economy and hot weather pushed the peak to a record 25,414 MW in the summer of 2002. Imports were necessary to maintain reliability 21 percent of the time during July and August; the IMO made emergency purchases 38 times during the summer. The peak amount imported was 4273 MW in September 2002, nearly 15 percent of the province's installed capacity, effectively the maximum that the transmission system could handle.

To keep the situation in perspective, however, despite all these problems, the average monthly HOEP tracked prices in neighbouring U.S. control areas quite closely, except in September. Arguably, the price responsiveness provided by the new marketplace was the decisive factor in keeping the lights on, given the physical challenges (see chart).

Nonetheless, it was inevitable that the stress test provided by the events recounted above would expose areas of weakness in the wholesale market's structure and rules. A major concern for market participants, for example, was the frequency with which pre-dispatch prices, recalculated hourly up to an hour ahead of real time, failed to predict the real-time Ontario energy price (HOEP), at which spot market transactions were settled. Large industrial customers in particular, willing and ready to manage energy demand in response to anticipated prices, were often frustrated when the high pre-dispatch price signals they acted upon were followed by much lower levels of HOEP (or the converse). Domestic generators, for their part, were frustrated when importers received guaranteed high pre-dispatch prices while they were receiving a much lower HOEP. (Because of time-consuming inter-control area coordination protocols, imports and exports, if accepted, are based on offers submitted no later than two

Average HOEP Relative to Neighboring Control Areas, On Peak



Source: Independent Electricity Market Operator, Market Surveillance Panel Monitoring Report on the IMO-Administered Electricity Markets for the period from September 2002 - January 2003, March 24, 2003, p. 21.

hours before real time. HOEP, on the other hand, is an average of five-minute market-clearing prices set during real time by domestic offers and bids, with the earlier-accepted imports and exports treated as "locked-in". For a number of reasons, HOEP tended to be lower than the pre-dispatch price at which intertie flows were set, so to ensure that the imports would remain committed the IMO provided a guarantee whereby the importer would be paid his offer price even if HOEP turned out to be lower.)

The extended failure of the laid-up nuclear units to return to service, and delays in expanding intertie transmission capacity with neighbouring Quebec, combined with the cancellation or postponement of a number of new generation proposals, drew worried attention to supply adequacy. The province's about-face on Hydro One privatization, the slow pace at which it was proceeding with decontrol and divestiture of OPG's generation assets, and its reassertion of oversight on the IMO's market rule amendments, raised concerns that the government intended to maintain its dominance as owner of generation in the province, with potentially adverse implications for effective and unbiased competition and thus for private entrepreneurs' willingness to enter the arena.

For its part, the IMO Board, recognizing the need to move ahead, began to develop a formal Market Evolution Program, relying on heavy stakeholdering with market participants and others to set priorities for development.

Four key issues were identified: first, how to bring a stronger demand response into the marketplace, that is, how to give loads better tools with which to reduce their, and the market's, exposure to high prices. Second, how to integrate Ontario's market more effectively with neighbouring markets, so that traders can better arbitrage opportunities among them and thus broaden the resources available throughout the region as a whole. Third, how to improve resource adequacy inside Ontario itself, in the short term and over the longer term. Fourth, how to integrate the wholesale and retail markets more effectively, in order to reduce prudential and cash flow issues and open the door to future demand response at the retail level.

One of the developments under consideration to address a number of these issues is a Day-Ahead Energy Market that would be largely consistent with FERC's Standard Market Design and thus coherent with counterpart markets in New York, New England, PJM, and the Midwest. In such a day-ahead market, generators and loads could lock in prices and quantities, which would provide large industrial and commercial customers with enhanced ability to manage their electricity usage. Mechanisms to facilitate longer-term contracting, in the interest of encouraging entrepreneurial investment in new generation capacity, are also being considered.

With a provincial election due no later than the spring of 2004, both the government and the industry are hoping for a cool summer and a timely return to service of the laid-up nuclear units to keep the level of rhetoric down. Looking forward, however, it is clear that the new regime, of whatever stripe, will have to take fundamental decisions about its future role. The industry generally wants Ontario to be a strong component of a competitive, well-integrated, cross-border regional marketplace, but to make this happen, private entrepreneurs must have confidence in the rules that will govern their participation as investors and traders. The current confusion about the roles and risk-absorbing responsibilities of ratepayers and taxpayers must also be resolved, if only because the province's fiscal position is at risk. One way or the other, the next twelve months will probably prove to be the most critical time in the evolution of Ontario's electricity market.

Petroleum Geopolitics *(continued from page 5)*

to satisfy a large share of its energy needs, and to run its transport system in particular. The role of the Middle East in the oil sector will, therefore, lose none of its importance. Yet many specialists have pointed out that despite the considerable weight of the Arabian-Persian Gulf in world reserves, never since 1973 has this region succeeded in recovering a majority share of the world crude oil market. The North Sea, Alaska in the 1980s, the Gulf of Guinea, the Caspian, and the Gulf of Mexico today, have wrested control of the oil market from the Middle East.

Footnotes

[1] Crude oil is almost never consumed as such, but in the form of automotive gasoline, diesel, fuel oil, etc., produced by processing crude oil in refineries. Lacking large crude oil resources, most consumer countries have sufficient refining capacities to supply their needs for finished products.

[2] cf. "Divorce entre Maison Blanche et Maison des Saoud" (divorce between the White House and the House of Saud), article by Alexandre Adler in le Monde, March 2002.

[3] The United States is the only country where the owner of the soil also owns the subsoil.

[4] The recovery of crude prices also significantly improved the health of the Russian economy, because oil and gas exports represent the chief source of foreign exchange revenues for this country.

Montreux Energy Roundtable *(continued from page 10)*

How Safe and How Economically Viable is Hydrogen?

Present hydrogen distributors are constrained by high distribution costs, the issue of carbon sequestration and concerns about safety. All three concerns are likely to be gradually overcome. Sooner or later, governments will come round to much more generous tax exemptions for hydrogen-propelled vehicles as part of a general swing towards fiscal stimulation of alternative energy.

Are the Key Environmental Issues Now Dead or Merely Temporarily Put to One Side

"Don't be afraid! The sky is not falling!" we were assured. There was, however, a strong consensus that recent environmental concern will return to haunt us and to question the wisdom of indiscriminate use of fossil energy.

Bollino Named

Carlo Andrea Bollino, IAEE VP for Development and International Affairs, has been appointed Chairman of Gestore Rete Trasmissione Nazionale, the Public National Electricity Grid in Italy.

North American LNG 2003

July 28-30, 2003 • Houston, TX

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The fundamentals behind the natural gas market in North America are creating opportunities for the development of LNG projects: the depletion of reserves in local fields, combined with a projected expansion of demand, is expected to drive prices higher in the mid- to long-term. Higher prices and a dearth of new local supplies have opened the door for the development of LNG terminals and trains, but new obstacles to project development have also arisen.

North American LNG 2003 brings together the leaders in the LNG market to discuss the future of the LNG industry, and how best to overcome current market obstacles and create profitable LNG projects. Gain invaluable insights into current and future developments in LNG market in North America:

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America's Perfect Energy Storm

*By Douglas B. Reynolds**

The U.S. Congress, as of this writing, is debating another energy bill and may even have passed it as of this publication; unfortunately probably without ANWR, but fortunately probably with tax credits for an Alaskan natural gas pipeline. I believe these tax credits are in North America's best interest. In my new book, *Alaskan and North Slope Natural Gas* (2003), I explain my reasoning.

In the early 1960's, M. King Hubbert (1962) asserted based on current oil discovery trends that the U.S. Lower 48 oil production would peak in 1969. It actually peaked in 1970. Critics of Hubbert said three things. First they said that U.S. production would continue to increase due to technology. Second they said that oil alternatives such as oil shale would be on hand to substitute for oil. Finally they said that the Middle East and Soviet oil reserves were so vast that there would never be a problem with having enough oil for the U.S. to import. All three reasons proved untrue. Oil production declined, oil alternatives never became feasible, and OPEC used its market power to reduce Middle Eastern oil output. Plus the Soviet Union had its own oil crisis, (see Reynolds (2002a) *Scarcity and Growth Considering Oil and Energy*), a crisis that the U.S. itself is about to experience.

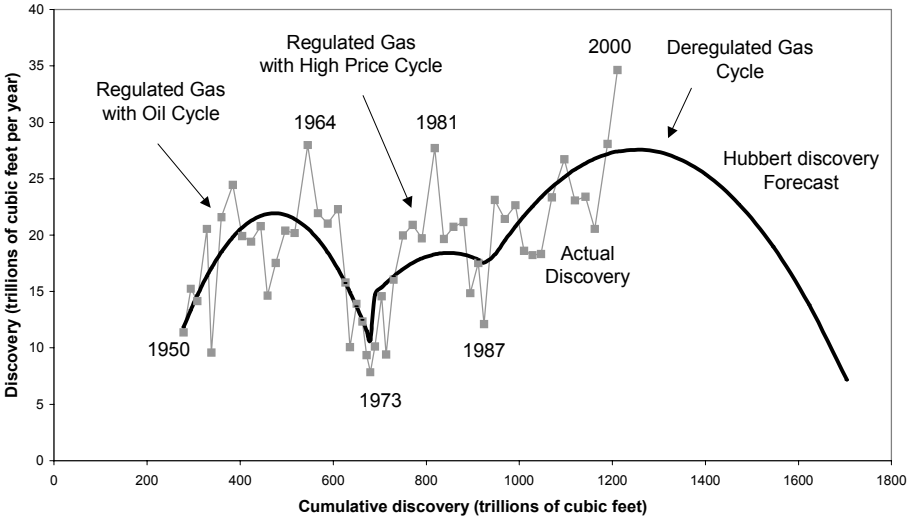
What no one predicted would happen and what actually did happen was that the world would go through two major recessions, with stagflation, trying to reduce the demand for oil and substitute into other already available energies such as coal, natural gas and nuclear power. The only real change was lifestyles. There were no new U.S. energy supplies, except those from Alaska, no radically new technologies, and no infinitely available crude oil from other regions.

Now North America has the same kind of problem as it had with oil but this time with natural gas. U.S. and Canadian natural gas supplies in the currently accessible areas in North America are about to hit the Hubbert peak. And when that happens a new round of radical market changes will hit North America with a possible sever recession and stagflation and with difficult substitutions into existing but less useful technologies. How can we be certain? We simply follow the road that Hubbert laid out.

First how did Hubbert come to his conclusions over oil? He looked at available data on proven oil reserve changes over the years. Hubbert, unlike Cleveland and Kaufman (1997), did not reinterpret oil data or analyze how the data came about. He simply used the data as is. He defined net increases in proven reserves plus production as discoveries and statistically quantified the chronological pattern. Reynolds (2002b) did the same only with a cumulative production pattern. One other idea that Hubbert suggested was that there could be multiple cycles.

If we do what Hubbert did for oil, only do it for natural gas, it is clear the same type of Hubbert pattern is emerging. First take the natural gas discovery data as it is, and second look for a pattern. I did this and it is clear that a pattern of three distinct Hubbert cycles has emerged. Figure 1 shows just such a multiple Hubbert curve for natural gas for the U.S. lower 48 states and southern Canada using a cumulative discovery relationship. Note though that cumulative discovery, a quantity, is statistically independent of discoveries, a rate, and is, therefore, not an I(2) variable, i.e., not a twice integrated non-stationary series. In other words, the current instantaneous velocity of my car (the rate of miles per hour) does not affect the mile marker I am at (the quantity of miles), although the mile marker I am at can affect my velocity, if I am at a rough stretch of road.

Figure 1
U.S. Lower 48 and Southern Canadian Natural Gas Discovery and Forecast Discovery as a Function of Cumulative Discovery



Using econometric techniques, it is possible to see that there are three cycles that exist. These are: the early oil cycle where gas was discovered associated with oil and where the gas market was regulated, the second cycle where high natural gas prices, above a critical level, created a push for new discoveries within a regulated market, and finally a third cycle where deregulation of the gas industry helped discover new reserves. The final cycle started after 1985 when gas deregulation was getting started.

Many believe that future high gas prices will create a vast new Hubbert cycle within the current accessible gas regions as prices begin to go above a new critical level. However, early indications are not promising since high prices and higher rates of exploration are giving disappointing gas discovery results. Also high oil prices never did create a significant increase in Lower 48 oil production above Hubbert's original oil curve. It shows an extremely inelastic supply. See Reynolds (2002b).

This leads to one conclusion. The U.S. is headed for a sever natural gas shortage based on the Hubbert curve pattern

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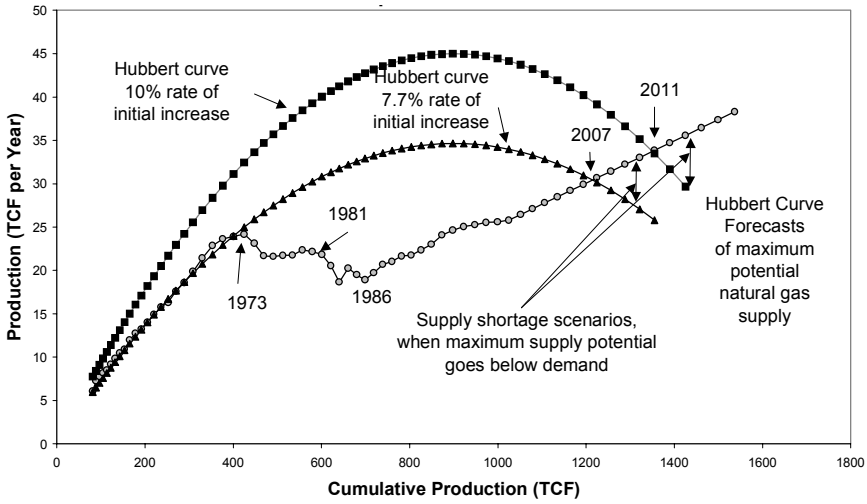
Figure 2
U.S. Lower 48 and Southern Canadian Natural Gas Production and Forecast Maximum Production as a Function of Cumulative Production



for natural gas discoveries. By using the natural gas discovery pattern, we can forecast ultimately recoverable reserves at around 1800 TCF and use that reserve base to forecast actual supplies. Figure 2 shows the gas supply forecast based on discoveries. The results show an imminent production decline. Without significant new supplies from outside the current region, this shortage will hit the U.S. swiftly.

Interestingly enough I have also heard that deep water gas exploration in the Gulf of Mexico may be disappointing owing to a peculiar problem of water seepage into the anticlines. In addition, the U.S. move to deregulate gas has in the short run increased supplies, but has also created greater volatility of prices. Volatility means risk, and risk reduces incentives for new infrastructure investment. So a gas shortage is a real problem. Deregulation of a capital intensive oligopolistic industry with immovable assets works well when the industry is expanding, but not when it is contracting.

On the other hand, other energy shortfalls will soon emerge. Oil too may be in short supply world wide owing to greater OPEC market power and OPEC's desire to preserve a precious resource for future generations. And there is a continuing lack of coal and nuclear power expansion due to environmental concerns. As oil, gas and conventional energy become in short supply either due to depletion or environmental concerns, the U.S. will move into a perfect energy storm. Gas and oil prices will shock upward. Alternative conventional energy supplies will not have expanded. Then the economy will move downward. Europe though should have less of a storm owing to its greater gas potential, but even there, gas supply problems could become a reality. See Banks (2003).

One solution is to get Alaskan and northern Canadian gas online as fast as possible. Congress can push this by giving tax incentives to an Alaskan gas pipeline. We already know we need the gas badly, now we need it quickly too. Unfortunately such a large project as a gas pipeline is very risky for companies which is why it behooves the entire U.S. to give incentives. The U.S. is at risk of a gas price shock. Therefore, the U.S. should help to reduce that risk by giving incentives.

But we are hearing a lot of opposition to giving tax incentives for a gas line because it is assumed that there will be plenty of gas or other alternatives and because of free market ideals. In fact, just like oil in the 1960's we are now paralleling what the arguments were with gas.

For oil in the 1960's, the argument was that technology would create plenty of new oil. But that didn't happen. Hubbert's forecast was right on the money. U.S. oil production declined even with higher prices and new technology. Now we hear that new technology will find plenty of new natural gas reserves. But what happened with oil is likely to happen with natural gas and the Hubbert curve will push supplies down.

In the 1960's, we heard that new alternative energy resources would come on line such as oil shale that would easily substitute for oil. But oil shale never panned out. Oil shale never became feasible even with government incentives. Now we hear that coal bed methane is going to save us, but so far large-scale production has been kept relative low and reserve production ratios for coal bed methane are often magnitudes higher than for conventional gas. Thus the claims of large methane reserves need to be modified by the reality of actual production output potentials.

In the 1960's we heard of vast oil reserves in the Middle East that could be available for U.S. consumption at pennies per barrel. But America failed to take account of OPEC's market power to increase prices and their desire to conserve a precious resource for future generations. So oil imports became more expensive than expected. Now there is talk of vast sources of LNG but the LNG exporters can collude and certainly will if they are at all interested in maximizing their revenue and preserving their valuable gas resources for future generations.

Today we hear that keeping free market competition without incentives is important to keep a level playing field for free trade. But within North America, energy prices are already high and will remain so, therefore, incentives will not affect other energy projects. Outside of North America there is not free trade and property rights of energy resources, and so this justifies tax incentives within North America.

Another problem with LNG and also with oil that is not widely understood is the risk averse nature of countries that control their own energy supplies. See Reynolds (2002a). Countries that control their oil and gas production through a single political entity or a host oil company are risk averse to exploration and development and, therefore, cannot expand production quickly or even expand it at all. Their hands are tied politically. They are so afraid to make a mistake that they generally move very slowly to expand their output. This means LNG will not be available nearly as quickly as we would like to think it will be. This is also a cause behind a new round of oil price shocks that could hit the world at any moment.

In order to try to increase gas supply sources and assure

(continued on page 29)

Lithuanian Energy: On the Way to Integration into the European Union

*By Jurgis Vilemas and Vaclovas Miskinis**

Lithuania is one of the candidate countries preparing to become a member of the European Union and has recently received an invitation to join NATO. The country is in transition from a centrally planned to a free market economy, and is experiencing fundamental transformations and facing many problems. Lithuania has inherited an energy sector with comparatively good technical infrastructure but inappropriate for a small independent state of its size. The Lithuanian economy through 1990 was energy intensive. In order to meet requirements of a modern economy significant changes have occurred during the transformation period, including changes in institutional structure, legal framework, modernization of technologies, etc.

Lithuania inherited from its Soviet past, a very powerful energy sector, including the Ignalina Nuclear Power Plant (NPP) with installed capacity of 3000 MW. This power plant is the most important energy unit in Lithuania, having a high stability of electricity production on a basis of comparatively cheap nuclear fuel. However, the steep decline in the Lithuanian economy over the last decade (to 60% of its 1990 level) resulted in the plant's inefficient use and over capacity. During the last decade, operation of Ignalina NPP was at the center of continuous discussions regarding its safety, reliability and efficiency.

During the last decade Lithuania became an attractive country for many reasons: 1) the possibility to make efficient investments in many activities – industry, transport and communications, services, etc.; 2) very favorable geographical position between East and West; 3) lower energy prices because of close proximity to Russian oil and natural gas sources; 4) well developed energy and transport infrastructure (power, natural gas and oil supply systems); 5) comparatively low cost and qualified labor force; 6) favorable opportunity for investors in future markets of energy, goods and services, etc.

Changes in the Lithuanian Economy

After the collapse of the former Eastern Block, almost all countries with centrally planned economies experienced a large reduction in economic activity. Based on the indicators prepared by the International Energy Agency, in the last decade, GDP dropped in the Slovak Republic, Romania, Hungary, Slovenia, Czech Republic and Poland to 80-93% of the 1990 level. The economic decline was deeper only in Croatia and Bulgaria – amounting to 64.1% and 73.2%, respectively. The period of economic slump was comparatively short in these countries. In the Commonwealth of Independent States (CIS) the processes of transition have been more dramatic and the decline of the economy much higher – GDP dropped in Georgia to 25.6%; in Republic of Moldova to 34.2%; in Azerbaijan to 36.5%; in Ukraine to 40.7%; in Tajikistan to 50.1 % and in Russia to 57.4 % of the 1990 level.

The economic slump in Lithuania was smaller than in the majority of the CIS countries: at the end of 1994, the GDP had fallen to 56.1% of the 1990 level. GDP began increasing in 1995. In 1996, the GDP increased by 4.7%; in 1997 by 7.3% and in 1998 by 5.1%. In 1999, as a consequence of the financial and economic crisis in Russia, the GDP decreased by 3.9%. Analysis of the basic macroeconomic indicators shows that the Lithuanian economy was able to recover from this crisis in 2000 as GDP once again climbed by 3.8%. In 2001, according the provisional estimations, GDP went up by 5.9%. The most recent forecast indicates GDP growth of 5.2% in 2002 and 5.5% in 2003.

The transition period in Lithuania was prolonged and rather severe in many aspects. However, steady progress in strengthening the performance of market-supporting institutions and undertaking the necessary reforms gives hope of a strong and long-term economic recovery. This progress could be characterized by several transition indicators, such as a growing private sector share of the GDP, the pace of privatization, liberalization of prices, removal of restrictions and tariff barriers on trade and foreign exchange, progress on creation of competition policy, etc.

According to an assessment prepared by the European Bank for Reconstruction and Development, Lithuania has made significant progress in several important areas of reforms required in the transition to a market economy.

One of the most important indicators of the attractiveness of the Lithuanian economy and its openness to developed countries is the growth of foreign direct investment. At the beginning of 2002 foreign investment was almost $2.7 billion. Until the middle of last decade foreign direct investment in the Lithuanian economy was very low. Since 1996 it has grown very fast. See Figure 1.

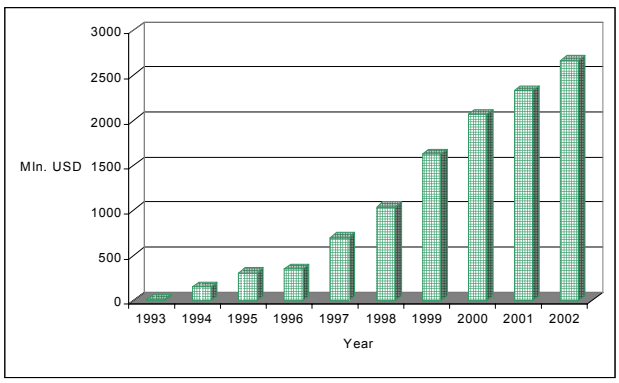
In 1993-1997 the major part (more than 70%) of foreign investment was oriented to manufacturing and wholesale and retail trade. In January 2002, foreign investment was more broadly spread with four economic activities dominating: manufacturing (25.6%), wholesale and retail trade (20.4%), financial intermediation (19.9%), transport, storage and communication (18.7%). The share of foreign investment going to the energy sector is still comparatively low (about 3%) because of delayed privatization of its infrastructure.

In 1997, the United States dominated Lithuanian foreign investment. Today, Denmark leads in foreign investment accounting for about 19% of the total, followed by Sweden.

Current Status of Energy Consumption

Lithuania inherited from its Soviet past a very powerful

Figure 1
Foreign Direct Investment in Lithuania



* Jurgis Vilemas and Vaclovas Miskinis are with the Lithuanian Energy Institute as Director and Head of Department, respectively.

energy sector, which was created not only to meet local needs, but also to satisfy the requirements of the large FSU North-Western region. The excess capacity is a result of the common central planning policy of the FSU, trying to create a fully integrated energy sector and economy. The existing energy sector (rather modern power plants, powerful oil refinery, one of the most modern regional oil terminals, developed natural gas and district heating systems) to some extent was helpful to the Lithuanian economy, mitigating problems at the beginning of the transition to a free market economy. However, at present it is rather difficult to efficiently use the surplus of existing capacity in the energy sector because of the large reduction of energy consumption in all branches of the national economy and the economic recession in neighboring countries. In addition, Lithuania has no transmission lines to Western countries.

Lithuania has almost no primary energy resources. In 2001, indigenous energy resources (wood, peat, straw, hydro, etc.) represented 8.5% of the total energy supply (including the extraction of local oil, increases the figure to about 14%). Their share during the period of 1990-2000 increased more than 4 times. Nevertheless, the primary energy supply is still dominated by imports from Russia – all crude oil, natural gas and nuclear fuel are imported from there. During the transition period the share of nuclear, the cheapest imported fuel, was rather high – it fluctuated from 24,7% in 1994 to 36,9% in 1996. In 2001 its share was 35%. The role of nuclear fuel is very important when seeking to increase the security of the primary energy supply, especially in the power sector. In principle oil products are the most important fuels in the Lithuanian energy balance – their share fluctuates around 35%. In 2001, the share of oil products decreased to 30.5%. The share of natural gas, the most attractive fuel in long-term perspective, was about 20% during this period. It decreased from 26.8% in 1990 to only 16.1% in 1993, but it increased to 25.4% in 2001. The role of coal has decreased throughout the period – from 3.7% in 1990 to 0.9% in 2001.

The sharp decrease in primary energy consumption together with changes in its structure was an important factor that softened the economic and social problems of the transition period in Lithuania. However, the decrease of primary energy consumption at the beginning of the transition period and its recent changes were influenced not only by the decline of economic activity and the development of internal consumption in the country. Because of the existing overcapacities, the changes in primary energy demand in Lithuania are strongly related to energy consumption in the power sector that is dependent on the export of electricity. Lower primary energy demand in 1999-2000 was related to both – lower final energy consumption and lower exports of electricity.

Total final energy consumption in Lithuania decreased from 8.7 mill. toe in 1990 to 3.9 mill. toe in 2001. Energy consumption decreased in all sectors of the national economy. Analysis of final energy demand by sectors shows a sharp decrease in the shares of agriculture, construction and industry. In 2001 final energy consumption in these sectors dropped respectively to 12, 20 and 25**%** of the 1990 value. At the same time energy demand in the trade and services sector decreased almost 3 times but its share in the final energy balance decreased slightly. Energy demand in the household and transport sectors decreased during the transformation period respectively to 74 and 79**%** of the 1990 value. Therefore, their shares increased significantly - from 21 and 17**%** in 1990 to 35 and 30**%** respectively in 2001.

When analyzing final energy consumption of different energy carriers (electricity, heat and fuel) one may notice that the final electricity consumption decreased from 12 TWh in 1990 to 6.4 TWh in 2001. District heat decreased almost 3 times and was about 10.0 TWh in 2001, and final fuel consumption decreased from 5 mill. toe in 1990 to 2.5 mill. toe in 2001.

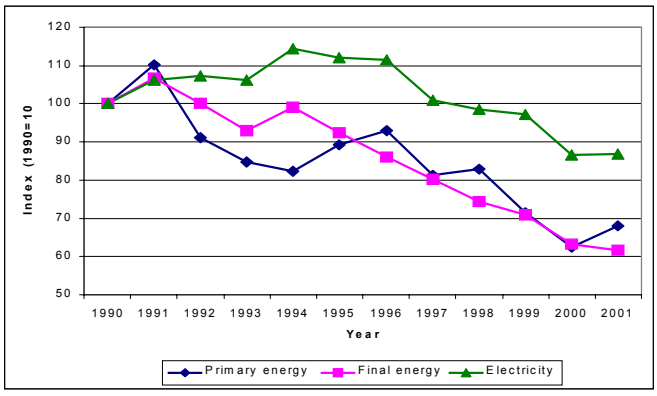
Changes in Energy Efficiency

One of the legacies of central planning is the inefficient use of energy in all transition countries. High energy intensity in these countries is caused by several factors: the past existence of very low energy prices; old and inefficient equipment and technologies; low thermal performance of dwellings and public buildings; comparatively large number of old private cars; inadequate or even non-existent metering and control of energy consumption, etc. Therefore, energy efficiency enhancement is one of the most important strategic objectives of the Lithuanian energy sector. At the beginning of the transition period, energy intensity in Lithuania was increasing because of the steep decline in economic activity in all sectors of the economy and the large share of the household and transport sectors in the total final energy demand. However, since 1994 final energy intensity in Lithuania has been decreasing steadily, and in 2000 it was lower in comparison to the 1990 level by almost 37%. See Figure 2. In 1993, Western experts were expecting that final 2000 energy intensity in Lithuania could be reduced by 32% of the 1990 level, on the assumption of fast reforms, but only by 18% on the assumption of a slow reforms scenario. Thus, the decrease of energy intensity by 37% in the past decade is one of the most important positive achievements of the Lithuanian economy.

Primary energy consumption in Lithuania depends very much not only on the total level of economic activity and changes in the GDP structure but also on the volume of electricity export. Therefore, the range of primary energy intensity fluctuation was comparatively large. As one can see from Figure 2, the relative decrease of electricity intensity in Lithuania is the lowest in comparison with other energy carriers. Nevertheless, the general tendency of more efficient energy consumption in Lithuania is evident – since 1994 the relative consumption of electricity, primary energy and especially final energy per unit of GDP has been decreasing.

Real changes of energy efficiency in various branches of

Figure 2
Changes in Energy Intensity in Lithuania



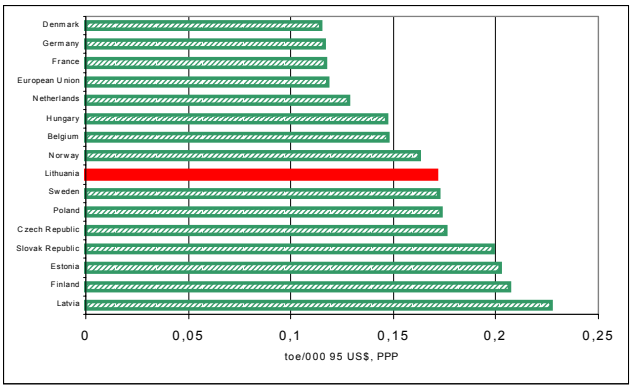
the economy could be explored using ratios of the final energy consumed in each sector per its value added. In many sectors these changes are very large. The energy intensity in agriculture and construction in 2001 was about 25% of the 1991 level. Energy intensity in the trade and services sector decreased during this period 3.5 times. Important changes in the structure of manufacturing and implementation of new technologies have decreased energy intensity in this sector by 2 times. Even energy consumption for freight and passenger transportation (including fuel consumption by private cars) per unit of gross value added in this sector decreased in 2001 to 73% of the 1991 level. At the same time the reduction of energy intensity (assessed as the ratio of energy consumption on total GDP) in the household sector was comparatively low – to 93% of the 1991 level. This reduction of energy consumption is a result not only of the implementation of energy saving measures but also of the lower level of comfort, especially in families with low social income.

Assessment of the energy saving potential in transition countries, in many studies prepared by the International Energy Agency, the European Commission and various statistical publications, is defined as a ratio of gross consumption of primary energy per unit of GDP using exchange rates. However, this indicator is not correct for comparison of real energy efficiency in Western countries and countries of the former Eastern Block because high energy intensity in the former centrally planned economies is determined not only by relatively high energy consumption but also by the low level of GDP. It is caused principally by price distortions and the differences of GDP evaluation. Therefore, a method of Purchasing Power Parity (PPP) should be used for comparison of the GDP level in developed countries and countries in transition. In this case the indicators of energy intensity in various countries could also be assessed more accurately. Using estimates of Purchasing Power Parity, primary energy intensity in countries of Central and Eastern Europe is about 1.3-1.9 times higher than the average of EU countries.

Indicators of primary energy intensity are not correct for the comparison of energy efficiency in various countries for other reasons as well. On the basis of analysis of energy balances one can see that the structure of primary energy consumption (losses of primary energy in a transformation sector, own use of power plants, non-energy consumption, transmission and distribution losses, and final energy consumption) in different countries varies greatly. Thus, primary energy consumption per unit of GDP depends very much on the structure of electricity generating capacities, on volumes of primary energy consumption for non-energy purposes, etc. In addition, the amount of primary energy consumption in Lithuania depends highly on the export of electricity and oil products because the capacity of the energy sector, constructed through 1990, considerably exceeds the requirements of the country. Lastly, final energy, i.e., that part of primary energy and secondary energy resources which is used by final consumers, is the real basis for the production of goods and the delivery of services.

Thus, seeking to compare more exactly the energy efficiency in various countries it is necessary to use the ratio of final energy consumption and GDP using estimates of Purchasing Power Parity. As shown in Figure 3, in 1999 this indicator for Lithuania was about 1.5 times higher than in Denmark and EU countries (on average), 1.3 times higher than in Belgium and Netherlands and only by 1.1 times higher than in the United States.

Figure 3
Final Energy Intensity in 1999
(GDP assessed in PPP)



Further increases in energy efficiency should be based on implementation of advanced technologies in manufacturing, modernization of heating systems, improvement of thermal insulation of residential houses and public buildings, increased share of new vehicles, etc.

Future Changes in the Lithuanian Energy Sector

The Lithuanian government implements radical reforms in the legal basis of energy sector and a broad program of its restructuring and privatization. In 1997, district heat activities were separated from the Lithuanian Power Company, a former highly centralized and vertically integrated monopoly structure, and newly created independent companies were transferred to municipalities. After long discussions, at the end of 2001, Lithuanian Power Company was split into 5 new companies: 2 electricity generation companies (Lithuanian TPP and Mazeikiai PP), high voltage electricity transmission grid (including the main regime controlling devices, Kruonis HPSP and Kaunas HPP) and 2 distribution companies. Restructuring of the power sector will provide the preconditions for further liberalization of activities in the sector and preparation for the development of the internal electricity market. Restructuring of another vertically integrated company, Lithuanian Gas, and its privatisation also provides the necessary conditions for opening of the gas market according requirements of the EU directives. The oil sector is almost fully privatised. An independent regulatory body was created which regulates energy prices where market conditions do not exist.

Further development of the Lithuanian energy sector will be greatly influenced by many internal and external factors. These factors are assessed in the National Energy Strategy (revised for the second time since 1994), which is presented for approval of the Seimas of the Republic of Lithuania. Strategic objectives of the energy sector based on the main factors that determine Lithuanian energy policy are the following:

1 to ensure reliability and safety of energy supply with least cost, minimal environmental pollution and permanent increase of energy efficiency;
2 to liberalise electricity and natural gas markets according to requirements of the EU directives;
3 to continue privatization of energy units;
4 to prepare for implementation (in terms coordinated with

the EU) of measures seeking to meet requirements of the EU directives;

5 to prepare for decommissioning of the Ignalina NPP, disposal of radioactive waste and interim storage of spent fuel;

6 to develop regional cooperation and collaboration seeking to create a common Baltic electricity market in a 5-year period;

7 to increase efficiency of district heating systems and increase the CHP share in the total electricity production to at least 35%;

8 to increase the renewable energy share in the primary energy balance up to 12%;

9 to integrate the Lithuanian energy systems into structures of the EU in a 10 year period.

The most important changes in the Lithuanian energy sector are related to the decision on decommissioning of Unit 1 of the Ignalina NPP before 2005 and Unit 2 before 2010. This power plant presently supplies up to 80% of internal electricity demand in Lithuania. The current import possibilities from the EU countries are very limited due to the absence of a power link to the Western electricity network. Therefore, after closure of Unit 1 and especially of Unit 2 at Ignalina NPP, Lithuania will shift from nuclear to existing conventional capacities. In order to meet electricity demand, Lithuania will rehabilitate conventional electricity generation capacities and install necessary environmental measures so as to meet environmental standards and targets and keep the possibility of using different fuels (heavy fuel oil, orimulsion and natural gas).

The majority of the existing conventional power plants in Lithuania (Lithuanian Thermal Power Plant, and combined heat and power plants -Vilnius Power Plant, Kaunas Power Plant and Mazeikiai Power Plant) have been in operation for about half their 40 year design lifetime. They are kept in good technical condition. International experience indicates that lifetime extension of thermal power plants by refurbishment of some components is usually a least cost and very efficient option in comparison with construction of new power plants, providing those old power plants are not obsolete in their principal technological features. All main thermal power plants in Lithuania have comparatively good technological parameters: steam pressure and temperature, overall thermal efficiency, etc. In Lithuanian TPP, four 300 MW units are operating at supercritical pressure and efficiency indicators do not differ from the newest western thermal power plants using steam cycle.

Thorough economic analysis performed at the Lithuanian Energy Institute shows that further operation of Lithuanian TPP is the least cost option. This power plant will cover the main share of growing electricity demand. New power plants based on modern combined cycle gas turbine (CCGT) technology will compete with the Lithuanian TTP. However, for particular Lithuanian conditions the Lithuanian TPP will become the main producer of electricity and it has several very important advantages in comparison with new CCGT power plant:

- higher reliability of uninterruptible energy production because of multi-fuel (gas, heavy oil, orimulsion) usage;
- new site is not necessary;
- delay of big investments needed for new capacities and decommissioning of old units until Lithuania economy becomes stronger;
- creation of competition between different fuels and protection from monopolistic fuel prices.

Rehabilitation of existing combined heat and power plants in Vilnius and Kaunas is also foreseen in the National Strategy. In addition, new generating capacities will be required after closure of Unit 2 at the Ignalina NPP. Because almost all Lithuanian towns have district heating systems the most preferable new additional capacities are CHP plants, based on natural gas or local renewables. The needed new CHP's for existing district heating systems are not very big and individual capacities are comparatively small. Total potential for new CHP plants do not exceed 400 MW.

After closure of the Ignalina NPP, Lithuanian energy balance will be very dependent on the import of fossil fuel. It is foreseen that in the case of the basic scenario total primary energy demand will increase about 30% during the period 2000-2020. However, total fossil fuel demand will increase by 1.9 times – from 5 mill. toe in 2000 to 9.4 mill. toe in 2020. Natural gas will become the main energy carrier in the Lithuanian energy balance and its share will increase from 25.4% in 2001 to 53% in 2020. In order to avoid reliance of all power sectors on one fuel – natural gas - and to have a bigger diversity of fuel choice and greater security of supply it is reasonable to keep existing possibility to burn natural gas, heavy fuel oil and in future orimulsion in Lithuanian TPP and the biggest CHP. Lithuania, without any capacities of seasonal storage of natural gas, is very vulnerable when winter limitations of gas supply occur (up to now in every winter Russia introduced strict limitations on gas supply). On the other hand, Lithuania already has very big seasonal storage capacities for heavy fuel oil and orimulsion. Some of them are based on new capacities built with financial support of the World Bank and EBRD.

Lithuania has made good progress seeking to get out of the economic recession, to increase energy efficiency in all sectors of economy, to perform radical reforms in the legal basis and its harmonisation with the requirements of the EU energy policy, to create the necessary institutions and to implement a broad program of restructuring and privatisation of energy units. Thus, the country is ready to prepare the Energy chapter for accession into the EU and welcomes the readiness of the EU and the international community in exploring substantial assistance for the closure of the Ignalina NPP, modernization of existing energy units and installation of necessary environmental measures.

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Renewables Prosper, Propelled By Regulatory Push, Financial Pull

*By Fereidoon P. Sioshansi**

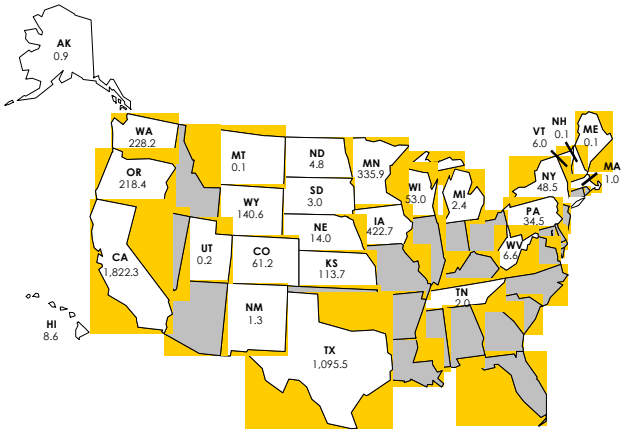
One of the few bright spots in the otherwise depressed generation business in North America and Europe is renewables. Pushed by government mandates and state requirements, and pulled by lucrative subsidies, tax credits, and financial incentives, they are making inroads everywhere — but notably, in Europe — and making a comeback in the Unites States.

Other countries, developing as well as developed, are also warming up to the potential of renewables. In many developing countries, distributed generation (DG), which includes many renewable installations, is making rapid inroads. Constantly improving technology and falling prices are helping the economics of renewables and DG. The environmentalists, who typically do not favor large central stations, tend to be fond of renewables.

In the United States, renewable portfolio standards provide the necessary push, while tax credits offer a strong pull. Thirteen states currently have such standards, which provide a mandated goal and deadline. Not surprisingly, there has been a surge of interest in renewables, with wind as the dominant contributor. According to the American Wind Energy Association , there are now 4,685 MW of installed wind capacity in the Unites States, with California, Texas and Iowa as the top three states.

In the U.S. Renewables Are Mandated through Portfolio Standards

States with renewable portfolio standards



Source: American Wind Energy Association.

But other renewables are also benefiting. Calpine Corporation, for example, recently signed a contract for 200 MW of geothermal energy with Southern California Edison Company. The contract, which has received the blessing of the California Public Utilities Commission, is to begin delivery of power by the end of the second quarter of 2003. Calpine is the world's largest geothermal power generator, with 19 facilities in the geysers area of Northern California.

Dollars Are Flowing In The Wind

Installed wind capacity in the U.S., January 2003

Source: American Wind Energy Association (AWEA).

Internationally, wind energy has been a big winner. The worldwide installed wind capacity at the end of 2002 is estimated around 30,000 MW, and is expected to grow significantly in the next decade.

There are rosy predictions of growth for distributed generation as well, especially in developing countries where the transmission systems do not adequately serve rural populations. A study by the World Alliance for Decentralized Energy, for example, predicts that, with supportive government policies, DG can potentially grow to 100GW by 2010, exceeding that of centralized generation. China is currently the world leader in DG, providing an estimated 15% of its electricity needs through *decentralized energy*, which must mean not connected to the national network. DG has strong proponents in developing countries as well.

In the UK, long considered a laggard within the European Union, things have taken a turn for the better for renewables. In February 2003, Tony Blair's government released its long-awaited Energy White Paper, which set highly ambitious goals for reducing greenhouse gas emissions to be accomplished, in part, by adding considerable amounts of renewable energy. The new policy sets a goal of reducing UK's carbon emissions by 60% by 2050, and doubling the share of renewables to 20% by 2020.

Prime Minister Blair gave his blessings to the scheme, but his Environment Secretary, Ms. Margaret Beckett, was more cautious, calling the targets " … demanding and stretching." There is some speculation on the vague wording of the document and what it really says. Some read the goals as *ambitions* that may or may not be achieved. This suspicion is strengthened by a lack of specificity in the document. Everybody agrees that achieving these goals would be hard, if not impossible, and will take sustained commitment, as well as funds. The CO_2 reduction goal, for example, does not appear realistic in the absence of more nuclear energy.

As might be expected, Britain's recently released policy statement has been vague and highly controversial. Environmental groups were generally pleased, especially since the government appears to want to reduce carbon emissions by increasing the reliance on renewables and through efficiency improvements, rather than increasing the share of nuclear energy. But even they criticized the government for not

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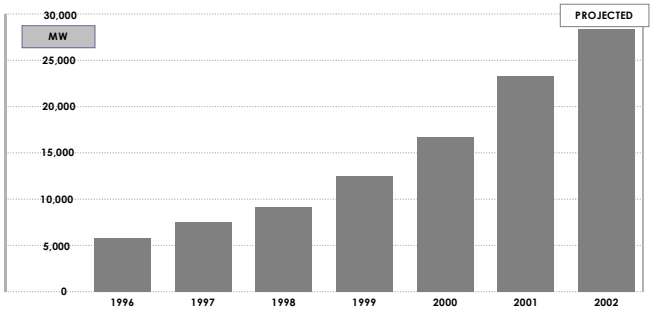
committing to specific targets. The Institute for Public Policy Research, for example, warned that the " … White Paper is chronically short on detail."

Wind Energy: Global Growth Industry
Worldwide installed wind capacity; MW



Source: American Wind Energy Association

Nuclear proponents, as might be expected, cried foul, pointing out some of the inconsistencies in government policies. Sir Bernard Ingham, who is the Secretary of the Supporters of Nuclear Energy, a lobbying group, for example, characterized the government's paper as "incompetent, irrelevant, and frankly dangerous." He said, "At a time when greenhouse emissions are rising in Britain, it [the White Paper] proposes to continue to allow the nuclear industry, which emits no greenhouse gases, to run down. Wind power is not only seriously intermittent, it is also seriously expensive."

Given these favorable government policies, it is not surprising that investors are catching on.

A recently released report by Clean Edge, a San Francisco-based market research firm, concludes that renewable energy technologies are becoming increasingly attractive to investors, now accounting for 2.3% of total investments by venture capitalists. That may not sound like much, but represents a significant growth from a mere 0.7% only three years ago.

The Clean Edge report, in part reads, "While most industries, especially the technology sector, are seeing sluggish or negative growth, many clean-energy technologies are experiencing double-digit annual growth rates," The report goes on to say: "We believe that solar power, wind power, and fuel cells will continue to exhibit aggressive annual growth for the foreseeable future."

The report projects that renewable energy will become an $89 billion industry by 2012, up from just under $10 billion now. It forecasts that spending on photovoltaics will grow from $3.5 billion to $27.5 billion, wind power investment will increase from $5.5 billion to $49 billion, and investment in fuel cells will climb from $500 million to $12.5 billion by 2012.

The reasons for the growing popularity of renewables may be traced to many factors including:

- **Regulatory mandates**. A number of U.S. states and the European Union (EU) have set highly ambitious targets for renewables for the next decade.

An EU directive, for example, has set a goal of 22% for green electricity in Europe's energy mix by 2010, and has mandated an investment of 165 million euros in renewable energy resources. Great Britain's recently published White Paper aims to reduce the country's carbon emissions by 60% by 2050, mostly through renewables and energy efficiency. To achieve this goal, the UK has to generate 30%–40% of its electricity from renewables. The current level is 1.3%. California, Texas, Massachusetts, and a number of other states, have aggressive mandates which will push the development of renewables, mostly wind, for the rest of the decade.

- **Financial subsidies**. Many countries have special financial incentives to subsidize renewable technologies.

These vary in form and function. For example, tax credits in the United States, research and development funding by governments, etc., in different countries but the effect is to make renewables compete with less expensive conventional technologies.

- **Environmental edge**. Renewables are non-polluting, although they are not necessarily environmentally benign.

This gives them an edge over conventional technologies, especially if carbon taxes come to pass as a reality in the years to come. Environmentally-conscious consumers have indicated their willingness to pay a premium for so-called *green energy*, another factor contributing to the growth of renewable technologies.

- **Improved technology**. Wind and solar technologies have seen tremendous improvements in the past two decades, making them more reliable, requiring less maintenance, and generally offering higher output per unit of investment.
- **Falling costs**. The costs of most renewable technologies continue to fall, reducing the subsidy gap.

The Clean Edge report, for example, says that the price of solar energy has dropped significantly to $2.50/W, from $6/W only a decade ago. Over the next few years, solar energy costs are expected to come down further to $1/W for modules and $3/W fully installed, which amounts to 8¢–12¢/ kWh in generated electricity. Likewise, wind energy generation costs have come down to levels where they can compete with conventional electricity with little or no subsidies.

Taking these factors into account has emboldened investors who installed 6,886 MW of new wind capacity in 2002 alone: 5,871 MW of it in Europe. Corin Millais, the CEO of the European Wind Energy Association, is excited about the industry's prospects. The EU mandates, even assuming some slippage, will continue to push developments for years to come. He believes that global wind business will be worth 25 billion Euros by 2010, extrapolating current growth patterns.

Renewables are well-suited to the developing world for different reasons. Worldwide, there is currently 31 GW of installed wind capacity, growing at 32% annually in the past five years, according to the American Wind Energy Association. The major manufacturers, American and European, are gearing up to supply the needs of the growing industry.

General Electric, based in Fairfield, CT, sees big promise in wind power. It is injecting its corporate muscle into the still-evolving world of wind power. A year after the purchase of Enron's wind turbine business, the company expects GE Wind Energy to generate more than US$1 billion in revenue during 2003 and expand about 20% annually thereafter. GE is to supply 130 of its 3.6 MW turbines for a proposed 420 MW wind farm off the coast of Cape Cod in Massachusetts. If approved , certainly not an easy sell, it would be among the world's largest wind farms.

The Empirics and Implications of Technological Learning for Renewable Energy Technology Cost Forecasting

*By Peter H. Kobos**

Introduction

Experience curves are often used to forecast capital and electricity costs for renewable energy technologies. Ideally, such curves should capture cost improvements due to both capacity additions and R&D expenditures. There is growing interest to understand how both capacity additions and R&D expenditures affect these costs through recent experimentations with experience curves.

Contrary to the growing energy security and global environmental concerns in the late 1990s, renewable energy technologies, particularly in the U.S., continue to suffer from declining real public R&D investments. Additionally, proponents for renewable energy technologies often rely on undeniably aggressive cost reduction schemes – undermining the credibility of future cost projections.

To address these issues, this paper takes a critical approach to parameterize how the one factor and recent experimentations with a two factor experience curve can be used to forecast costs. An overview is given of these curves for wind and solar photovoltaics using a dynamic simulation model. Increased manufacturing efficiencies, possible economies of scale and financial incentives including federal R&D expenditures all potentially contribute to cost reductions.

Conceptually, the progression of cost innovations through time moves in steps due to technological breakthroughs at the component level while at the same time progressing smoothly when analyzing the technology as a whole. Using experience curves allows technology analysts to parameterize how technology costs have decreased over time through various factors, and potentially how the costs may evolve in the future. Additionally, policy makers often look to cost forecasts to help understand the economics between investing in current energy technology with clear short-run generation and cost advantages, or investing in research and development (R&D) for new energy technologies that hold a promise to achieve strategically and environmentally sound energy production.

Cost forecasts are often used to supplement requests for R&D (or the more inclusive Research, Development and Demonstration (RD&D) expenditures for renewable energy projects. Estimating the relative impact of RD&D on the cost of emerging energy technologies is a critical step in planning for a new energy production portfolio, yet this step often proves difficult to formalize. RD&D investment is a crucial vehicle by which newly evolving energy technologies may be brought to "commercial maturity" within a time frame relevant to climate change negotiations and energy security concerns (Wene, 2000, 24). A general framework to analyze RD&D in cost forecasting is, therefore, of great interest to technologists and policy makers alike.

This paper investigates such a framework using both the classic experience curves through learning by doing based on cumulative capacity and a modified experience curve methodology including an additional learning by searching factor based on cumulative RD&D for cost forecasts of select renewable energy technologies. RD&D analysis of cost reductions in the experience curve framework has been explored in other studies and serves as the starting point for this study (Klaassen and Miketa, 2002; Kobos, 2000, 2002; Kouvaritakis *et al*., 2000; Cory *et al*., 1999; Schrattenholzer, 2000a; Schrattenholzer and Kobos, 2000; Watanabe *et al.*, 2000; Wene, 2000).

To illustrate these concepts the Renewable Energy Systems and Learning Model (RESALM) develops representative scenarios to forecast technology costs. These scenarios, based on the experience curve results, allow for transparent cost forecasting analysis for various levels of installed capacity, RD&D levels, and other states of the world from 2000-2020.

Methods

An experience curve models the relationship between cumulative capacity and per-unit cost of a technology. As the cumulative production capacity increases, the producer learns how to streamline the manufacturing process thereby lowering the cost per unit of output. Learning (and modeling it) in economic systems is not a new concept: it was first stated explicitly by Arrow (1962), builds on the work by the Boston Consulting Group (1972) and had been used in years past to develop renewable energy cost forecasts (GE, 1977). Exploring this idea for policy relevance in energy systems, however, has regained favor in energy cost modeling (Klaassen and Miketa, 2002; Kouvaritakis *et al*., 2000; Schrattenholzer, 2000a; Wene, 2000; Neij, 1997, 1999; Watanabe *et al.*, 2000).

A standard experience curve captures the relationship between cumulative capacity at a given time for a technology and the per-unit cost of that technology. Cumulative capacity as a single variable represents several cost reducing variables including materials research, economies of scale, increasing skill in the labor force, and the implementation of overall RD&D investments.

Through regression analysis, technology-specific 'learning by doing' elasticity estimates (a) can be calculated. Subsequently, progress ratios (progress ratio = 2^{-a}) and the corresponding learning rates (learning rate = 1- progress ratio) can be calculated. A progress ratio of 80% implies that for every doubling of capacity, costs per unit of output decrease by 20%. Similarly, a learning rate of 20% implies that for every doubling of capacity costs decrease by 20%. This process is called 'learning by doing.'

The per-unit cost for a given technology can be measured as production cost, installed cost, or generation cost. Each cost metric has its own assumptions that are extremely important to clarify for cross-technology and cross-country comparisons. Energy cost (i.e., $/kWh) is one metric used to track the cost behavior of energy generation costs between energy technologies. This cost metric, however, is problematic due to a large variance in the financial assumptions built into this levelized energy cost (LEC). For instance, the interest rate, system efficiency, system lifetime, and daily power output can vary dramatically across studies.

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*Peter H. Kobos was one of the two IAEE Council Interns for the year 2002. From June 2001 to November 2002 he was an on-site contractor at Sandia National Laboratories in Albuquerque, NM as part of his dissertation research. This article is an abridged version of a paper presented at the 22nd annual USAEE/IAEE meeting, October 6-8 in Vancouver, B.C. E-mail: phkobos@sandia.gov

The learning trajectories obtained from an experience curve analysis based on energy cost, therefore, can mask the trajectory behind numerous assumptions. The purpose of energy technology experience curve analyses are to highlight the role of learning by doing in the manufacturing process through capital cost reductions, and not to necessarily account for energy market financial developments. There is still considerable uncertainty behind the learning trajectories using capital costs ($/kW) as the financial metric, however, it is believed this metric more accurately represents the nature of learning by doing in the production process as postulated by Arrow (1962). Thus, the cost parameter representing capital costs per rated energy output ($/kW) is the metric of choice for this study.

Two Factor Experience Curves: Cumulative Capacity and RD&D

Until recently, the concept of learning in the experience curve framework represented a composite of variables that generally may reduce costs (Neij, 1997). Clearly the reduction of costs can occur through a number of separate parameters. The effect of RD&D investment on cost reduction (and ultimate market diffusion) has been of particular interest from a public policy perspective. McDonald and Schrattenholzer (2001), in complementary fashion to the solar photovoltaic analysis of Watanabe *et al.* (2000), argue for the inclusion of an R&D proxy in cost estimate modeling.

Klaassen and Miketa (2002), Kobos (2000, 2002), Criqui *et al*. (2000), Kouvaritakis *et al*. (2000), Cory *et al*. (1999) and others explicitly model R&D or RD&D expenditures in an experience curve framework similar to that of cumulative capacity in the one factor experience curve. RD&D expenditures can help explain cost reductions through a knowledge stock effect.

A two factor experience curve captures the relationship between cumulative capacity and the cumulative knowledge stock at a given time for a technology on the per-unit cost of that technology. Through regression analysis, technology-specific 'learning by doing' and 'learning by searching' elasticity estimates can be calculated.

The diminishing influence of RD&D from years past on cost reductions for the current technology can present a modeling challenge. Therefore, a knowledge depreciation factor or "rate of obsolescence" is included in the learning effects on cost reductions (Watanabe *et al.*, 2000, 301; Argote, 1999).

Additionally, the length of the time lag between RD&D expenditure and commercial deployment of the technology is of significant interest to both industry and academia (Li and Rajagopalan, 1998; Watanabe *et al.*, 2000). To help account for the dynamic nature of RD&D investment, this study includes a time lag scenario between initial RD&D and subsequent cost reductions.

Estimation, Evaluation and Model Structure

Using the cost, cumulative capacity and knowledge stock data, three central statistical tools including the t-statistic, serial correlation tests and multicollinearity tests are employed to evaluate the relationship of cumulative capacity and knowledge stock to cost. This study uses the Ordinary Least Squares (OLS) method of regression to estimate the initial learning elasticities for the one and two factor experience curves. These techniques offer insight to the general magnitude of learning by doing and learning by searching elasticities.

The type of RD&D to include and the magnitude of the depreciation factor for the knowledge stock are also the subject of much debate. This study uses world-level technology cost and federal RD&D statistics with scenario-based time lag and depreciation factors to highlight the past, present, and potential future situation(s) for renewable energy sources.

The Renewable Energy Systems and Learning Model (RESALM) developed in Powersim® Studio 2001 for this study is a policy-oriented, scenario-based dynamic simulation model. This model analyzes experience curve scenarios through 'what if' types of questions, such as: 'what if the worldwide installed capacity of wind energy technology were to double in the next decade – how would costs change?'

The model also generates levelized energy costs (LEC) based on the capital cost scenarios. The model includes the technology lifetime and an assumed interest rate to calculate the capital recovery factor (CRF) as an input to the LEC calculation. The model allows users to specify the desired scenario for all the inputs outlined in the model structure. The levels of the inputs are simply starting points for a more flexible analysis, and they are initially held constant in this study.[1]

Figure 1 outlines the RESALM framework for experience curve-based cost estimates from 2000 to 2020.

Results

The wind energy analysis uses the IEA (2002) energy technology RD&D database and the EIA (2001) statistics at the worldwide level to derive the learning by searching elasticity. The cost data comes from an experimental database of the International Institute for Applied Systems Analysis (IIASA) (Schrattenholzer, 2000b). The worldwide capacity dataset was provided by Dodd (2001).

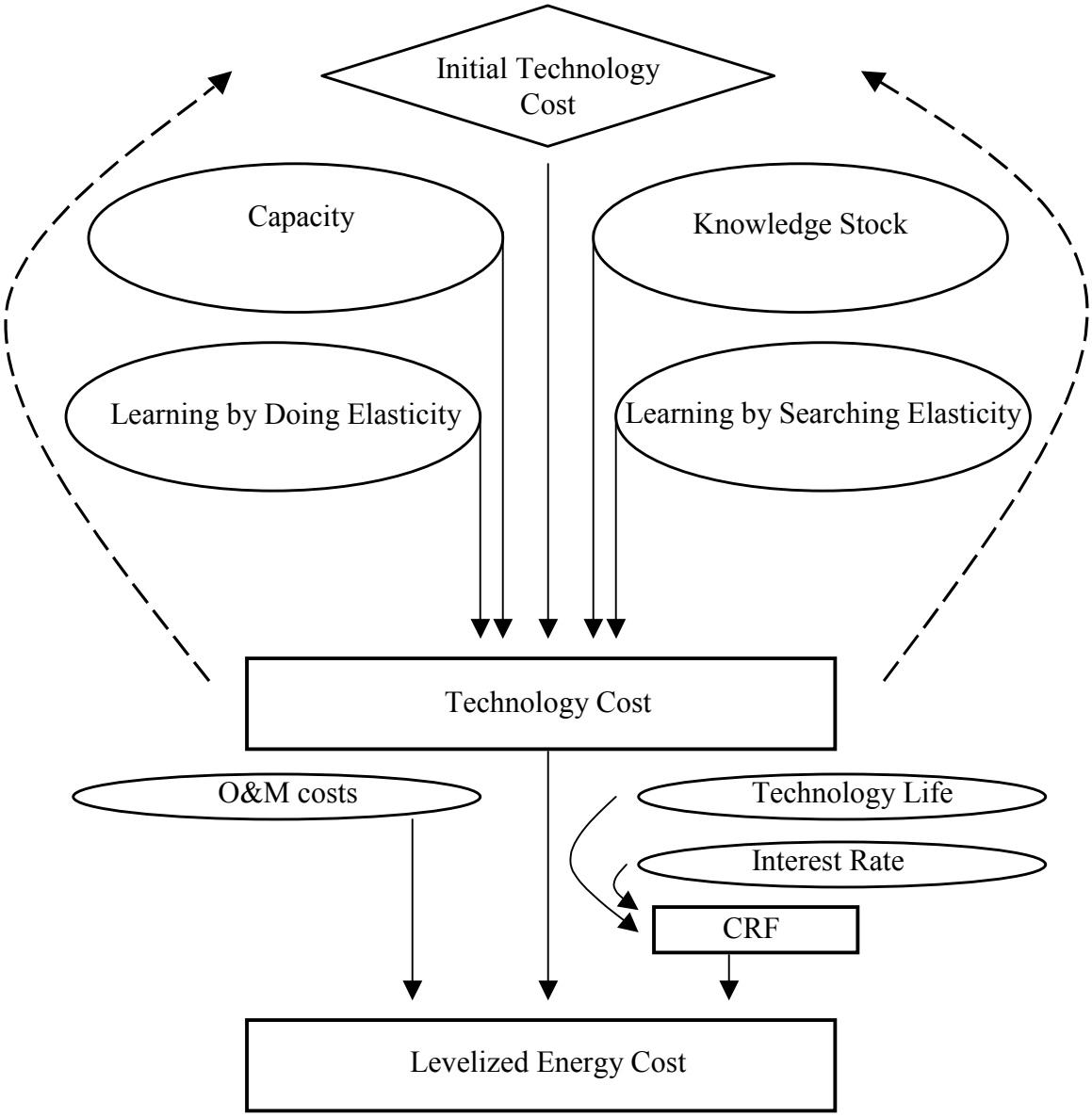
The solar photovoltaic analysis uses the IEA (2002) energy technology RD&D database and the EIA (2001) statistics at the worldwide level to derive the learning by searching elasticity.

[1] See footnotes at end of text.

Table 1
Estimated Wind and Solar Photovoltaic Energy One Factor Experience Curve Learning Rates

Technology	Region	Time Period	Estimated Learning Rate (%)	Performance Metric (dependent variable)	Experience Metric (independent variable)
Wind	World	1981-2000	17.1	investment cost ($/kW)	cumulative capacity (MW)
Solar PV	World	1975-2000	28.9	investment price ($/kW)	cumulative shipments (MW)

Figure 1
Overall structure of the Renewable Energy Systems and Learning Model (RESALM).



The cost and capacity data proxies come from two reports by Paul Maycock (2001a, 2001b).

Table 1 illustrates wind and solar photovoltaic one factor experience curve learning rate results.

Table 2 illustrates select learning rate scenario results for the two factor wind and solar photovoltaic experience curves.

For wind technology the initial time lag scenarios tested include 3 to 6 years based on Poore (1997) and EWEA *et al.* (1999). Similarly, the depreciation factors employed for the wind analysis are scenario-based but in line with those used in other studies (Criqui *et al.,* 2000). They illustrate various degrees of 'forgetting' in the R&D-based knowledge stock variable. The depreciation factor scenarios employed for the full wind analysis include 0, 2.5, 5 and 10% per year. Table 2 illustrates the statistically robust results for the 5 year time lag and 2.5% depreciation factor for the wind results.

The solar photovoltaic technology initial time lag scenarios range from 3 to 5 years based on the 3 year time lag analysis of Watanabe *et al.* (2000). The scenario-based depreciation factors in-

Table 2
Estimated Wind and Solar Photovoltaic Energy Two Factor Experience Curve Learning Rates

Technology	(time lag, depreciation factor)	Time period	Cumulative Capacity Learning by doing rate (%)	Knowledge Stock Learning by searching rate (%)
Wind	(5 years, 2.5%)	1981-2000	14.0	18.7
Solar PV	(3 years, 10%)	1975-2000	18.4	14.3

clude 0, 2.5, 5 and 10% per year for the full analysis and build on the obsolescence rate concept of Watanabe *et al.* (2000). Table 2 illustrates the results for the 3 year time lag and 10% annual depreciation factor for the solar photovoltaic results.

The solar photovoltaic equation results were examined and corrected for serial correlation using an Autoregressive scheme of the first order, and indicated a moderate but acceptable level of multicollinearity.

The Table 2 results are employed in the model for scenario analysis. Three representative two factor experience curve scenario runs from RESALM for wind and solar photovoltaic technology are shown in Figures 2 and 3, respectively.

Figure 2
Projected World Average Wind Capital Cost ($/kW) and LEC Cost (cents/kWh) Scenarios[2]

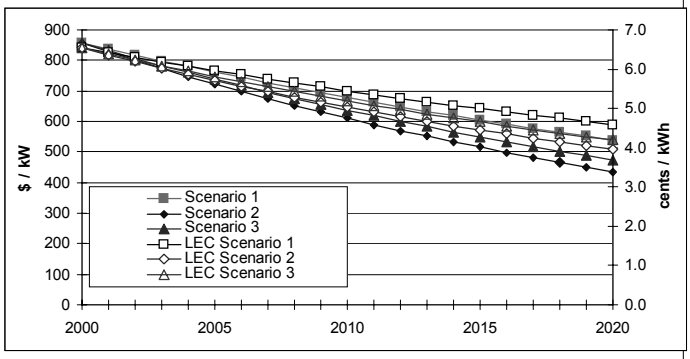
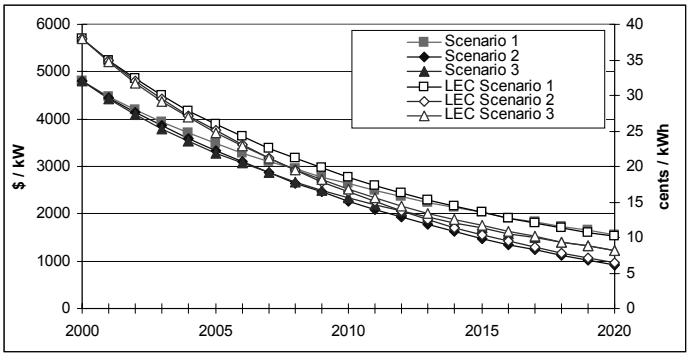


Figure 3: Projected World Average Solar Photovoltaic Capital Cost ($/kW) and LEC Cost (cents/kWh) Scenarios.[3,4]



Based on these model runs, the estimated capital cost for wind energy technology range from 435 to 538 $/kW in 2020. The estimated LEC for these runs range from 3.96 to 4.59 cents/kWh in 2020. The estimated capital costs for solar photovoltaic technology range from 924 to 1561 $/kW in 2020. The estimated LEC for these runs range from 6.38 to 10.09 cents/kWh in 2020. The levelized energy cost calculations in RESALM do not include transmission costs, taxes or profit considerations.

Discussion

Cost forecasting tools such as RESALM can give perspective to increasing renewable energy installations and RD&D levels that may affect the energy costs from select sources. Using tools such as this also adds much-needed perspective into experience curve-based cost forecasting, and understanding the limits to this forecasting technique. For example, maintaining learning rates such as those presented in Tables 1 and 2 may not be possible over the next several decades. Indeed, these rates are somewhat aggressive relative to those presented in other studies. Klaassen and Miketa (2002), for example, find for select European countries that wind energy technology two factor learning curve learning by doing and learning by searching rates are 5.4% and 12.6%, respectively. Additionally, solar photovoltaic learning by doing and by searching rates range from 25% and 9% based on the results of Criqui *et al*. (2000) to 17.5% and 10% based on the results of Klaassen *et al*. (2001) to 25% and 10% based on the results of Kouvaritakis *et al*. (2000), respectively. Therefore, the results presented in this study should be taken as illustrative of the model's framework based on the working datasets and assumptions.

Further analysis of the technologies presented may offer vastly different cost scenarios. Different learning rates, levels of installed capacity or shipments, LEC factors, and RD&D implemented in RESALM can add perspective to 'what if' questions relevant to market, technology and policy issues. Utilizing less aggregated datasets, more technology specific information (e.g., separating crystalline silicone and thin-film photovoltaic technologies) and modeling additional balance of system component cost changes are a few potential areas of further research. Finally, maintaining consistent dialogue with technologists in the wind and solar photovoltaic energy industries can only improve the learning rates and thereby cost forecasting inferences.

Footnotes

[1] This is the base case scenario. Contact the author for additional details.

[2] Scenarios: (1) Base Case, (2) High capacity growth scenaio, (3) High RD&D growth scenario.

[3] The learning cost reductions for solar photovoltaic technology occur only with the module/cell component for this study and is initially set to 2830 $/kW in 2000. The complete capital cost scenarios in RESALM also include additional area-related balance of systems costs and additional power-related balance of systems costs.

[4] Scenarios: (1) Base Case, (2) High capacity growth scenario, (3) High RD&D growth scenario.

References

Contact the author.

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News from the Italian Affiliate

In 2002, as in past years, the Italian Affiliate has developed various activities at a variety of institutional levels.

Conferences and Seminars

The AIEE organized 10 national conferences and meetings addressing current energy topics; 7 in Rome and 3 in Milan, with the participation of government, corporate and academic energy decision making institutions. We also participated as cosponsors in many other seminars in Rome, Capri, Milan and Copenhagen.

Among these it is worth mentioning a one-day conference organized in February together with Cap Gemini Ernst & Young on "Utilities and Multiutilities: Making Deregulation Work" that brought together more than 150 participants and 20 speakers to discuss the aspects of the problem in Italy.

Another important event was the conference organized with The Committee of Presidents of the Italian Regions that discussed "The Development of Energy and Environmental Policy" in our country.

Educational Level

After last year's successful experience, the AIEE organized this year, with the University of Rome-Department of Engineering, the second edition of a Masters programme in the Management of Energy and Environment that we believe is absolutely necessary in the new liberalization process characterized by revolutionary changes and new rules that pave the way for the opening of the energy markets.

The Masters programme organised as a one-year course from January to June (450 classes) with a limited number of places which grants highly efficient teaching and practical classes, with quality courses delivered by more than 50 professors, economists and industry experts. It is designed to supply the participants with the knowledge and skills necessary to succeed in rapidly changing energy markets. The Masters in fact provides the students with a solid overview of the oil, gas and electricity industries in connection with the new energy market and growing environmental problems.

The Masters programme covers both theoretical and practical aspects (project works, case studies, role playing and business games) and is structured in four modules. Each module is organized in sub-modules dealing with a specific topic, e.g., markets, regulating polices, etc.

The subjects treated by each sub-module are accurately chosen to meet the actual requirements of the energy sector giving the student a complete and up-to-date view of all its aspects: economic, legal, contractual, commercial and environmental.

The programme is open to university graduates, but some of its modules are also opened to personnel from the energy sector who wish to update and specialize in certain specific fields. Therefore, some institutions and companies sent their employees to participate in 1-day or 1-week courses within specific sub-modules of their interest.

Here is a brief summary of the Master's programme content.

Module 1. General Management

Purpose: To give the basic elements of corporate management, mainly for participants who do not have a degree in economics and law.

Contents

Elements of Micro and Macroeconomics

Demand and prices; production and costs; corporate management; markets and the role of the state; quantitative methods, models and simulation techniques.

Principles of Corporate Economy

Introduction to corporate management; the balance sheet; balance sheet indicators; elements of financial management; management business administration; principles of economic analysis.

Module 2. Management of Energy and Energy Technologies

Purpose: The first part gives a general view of the historical and political evolution of energy. The second part deals with the various energy resources, technology and energy systems.

Contents

Introduction to the Energy Problem and to the Energy Cycle

History of energy; geopolitics of energy; forms of energy and the energy cycle; primary and secondary sources and energy conversion; energy final uses.

Fossil Energy Sources – oil, natural gas and coal

Fossil energy sources; oil cycle and technologies; exploration and production of oil and gas; refining and distribution of petroleum products; natural gas cycle; coal cycle.

Renewable Sources and Energy Efficiency

Introduction to renewable sources; renewable sources production and technologies; the market of renewable resources; rational use of energy; green certificates; energy efficiency and white certificates.

Conversion and Transformation Systems

Energy direct conversion; systems with fluid engines; nuclear fission and fusion and the fuel cycle.

Power Plants

Electricity production: types of generation power plants; electricity transmission.

Module 3. Management of Energy Markets and Trading

Purpose: Deals with the problems concerning market regulation, the pricing and policies connected to the energy markets. Explains the fundmental techniques of energy commerce and trading.

Contents

Grid Markets

Characteristics of the electricity sector; the role of electricity production; electric grids and distribution; the national electricity exchange market; the electricity trading market; the characteristics of the natural gas sector.

Regulation Policies

Gas regulation policies; electricity regulation policies; regulation of local utilities; the role of the Ministry of Industry and of the Authority in Energy Regulation; the role of international organizations.

Policy, Finance and Contracts

Economic and financial policies; energy policy in Italy; petroleum law and finance; electricity contracts; natural gas negotiation.

Prices, Tariffs, Economic Analysis and Authorization

Prices of petroleum products and futures markets; electricity prices and tariffs; gas prices and tariffs; economic analysis of energy projects; the authorization process; project financing.

Management and Trading

Energy management and planning; planning in the oil and electricity industries; electricity and gas trading; trading and brokerage.

Module 4. Environmental Management

Purpose: To provide an understanding of the relationship between energy and environmental problems, analysing the conditions for the development and achievement of energy projects in connection with their environmental impact.

Contents:

Energy Activities and Environmental Protection

Oil cycle and the environment; electricity production and environment; environment and transport; innovation and environment; energy use of wastes; social and economic cycles and technological cycles.

Energy and Environment

Environment and ethics; energy social costs; environmental taxes; environmental policy; Italian environmental programmes.

Environmental Evaluation of Energy Projects

Environmental constraints and location problems; energy and environmental authorizations; introduction to energy VIA; petroleum and the VIA; electricity and VIA.

Security and Environmental Protection

Security of energy systems; environmental balance sheet; companies environmental policy; environmental certifications and standards.

This year the Masters included 20 participants, graduates in various fields (engineering, economic, law) and a group of employees of the Ministry of Industry that participated in some modules as a specialization and training course, as agreed between the AIEE and the Ministry of Industry.

The tuition cost of the Masters is quite low and the AIEE, through the sponsorship of some of its institutional members, offers scholarships for total or partial coverage of the cost.

AIEE Publications

The AIEE continued the publication of its monthly newsletter *Energy and Economy* and of the quarterly *Letter on Energy*. AIEE also developed, improved and updated its website giving online access to all these publications and the programmes of the AIEE conferences and proceedings. These can now be downloaded using a password.

An agreement was made with the publishing house, Eliconie, for the AIEE book collection and a new volume, *Contracts of the Electricity Market*, written by Matteo Falcione was printed in March. The book was a great success and it was well received by the specialized press.

Services

At the beginning of 2002, AIEE started a new service called "The Monitoring and Forecasting Service on Energy Prices and Tariffs", directed by Vittorio D'Ermo, which is a model of analysis and forecasts based on several international data sources and on updated economic growth evaluations of our country.

Its quarterly reports estimate the evolution of the main energy markets and the prices of the main energy sources – oil, coal, gas, electricity and petroleum products.

Edgardo Curcio

America's Perfect Energy Storm *(continued from page 17)*

more energy security, the U.S. needs to actively encourage the development of available U.S. reserves, and there are no bigger U.S. reserves than those on Alaska's North Slope.

You might say that since all of this is so obvious, then just let the companies take care of it. After all they will maximize their own profits by doing so. But risks are too great for companies to do this by themselves, and there is risk to the consumer as well. So it behooves the U.S., through tax incentives, to mitigate the risks and get Alaskan gas on line sooner. Even Canada's energy consumers will be helped.

Alaskan gas will not solve all of the problems and there may still be a gas shortage, but it will help. Incidentally more Alaskan oil could help too by opening up ANWR. And ANWR oil can produce revenues that can easily be used to save a number of truly endangered species or more critically affected habitats like the spotted owl or the Florida Everglades. In addition ANWR may hold even more gas than oil and that gas too can be used to help U.S. gas supplies. Plus gas is a cleaner fuel.

The more we look at the U.S.'s precarious energy situation, the more it makes sense to exploit Alaskan energy. Lets get Alaskan gas online. Lets open up ANWR.

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Photos from the Prague Conference
Technical Tour Photos

Session Photos

Social Photos

6TH IAEE EUROPEAN CONFERENCE 2004

Hosted by:
Swiss Association for Energy Economics (SAEE) and Centre for Energy Policy and Economics (CEPE)

Modelling in Energy Economics and Policy

Swiss Federal Institute of Technology Zurich (ETH) – Zurich – Switzerland
September 2nd and 3rd, 2004

Sessions and themes of the Conference will be structured along the following topics:

Econometric energy modelling
Electricity market modelling
General equilibrium modelling and energy policy analysis (Top-down)
Input-Output models
Integrated energy system models (Bottom-up)
New modelling concepts
Strategic modelling challenges for energy companies
Modelling-induced technical progress in energy policy
Modelling of environmental impacts of energy production
Modelling strategic business behavior
Modelling regulation activities

**** CALL FOR PAPERS ****

Abstract Submission Deadline: January 31, 2004
(Submission opening November 1, 2003)
(include a short CV when submitting your abstract)

Abstracts should be between 300-600 words. All abstracts should clearly address the themes of the conference listed in the invitation. 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:
Centre for Energy Policy and Economics (CEPE), Marianne Schindler, ETH Zentrum WEC C 12.1 CH-8092 Zurich, Switzerland
Phone: (+41) 1 632 06 50 / Fax (+41) 1 632 16 22 / E-Mail: marianne.schindler@cepe.mavt.ethz.ch

General Organizing Committee:

Massimo Filippini (Chairman), Centre for Energy Policy and Economics (CEPE), ETH Zurich and USI;
Eberhard Jochem, (Co-Chairman), Centre for Energy Policy and Economics (CEPE), ETH Zurich
Daniel Spreng (Co-Chairman), Centre for Energy Policy and Economics (CEPE), ETH Zurich

Scientific Committee

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More information about the conference and the registration formalities are available under
www.saee.ch/saee2004/

!!!!! MARK YOUR CALENDARS – PLAN TO ATTEND !!!!!

Integrating the Energy Markets in North America: Issues & Problems, Terms & Conditions

23rd IAEE North American Conference
Supported by the USAEE/IAEE/AMEE/CAEE
October 19 – 21, 2003
Mexico City – Camino Real Hotel

We are pleased to announce the 23rd IAEE North American Conference entitled, ***Integrating the Energy Markets in North America: Issues & Problems, Terms & Conditions***, scheduled for October 19-21, 2003, in Mexico City at the Camino Real Hotel.

Please mark your calendar for this important conference. Some of the key selected themes and sessions for the conference are listed below. The plenary sessions will be interspersed with concurrent sessions designed to focus attention on major sub-themes. Ample time has been reserved for more in-depth discussion of the papers and their implications.

North American Energy Security and Reliability
Session Co-Chairs: Juan Eibenchutz, CNSNS-Mexico and Barry Worthington, U.S. Energy Association

- Interdependence
- Opportunities
- Vulnerabilities

Energy Trade and Transportation: Forward or Reverse?
Session Co-Chairs: Joseph M. Dukert, Energy Consultant and Shirley J. Neff, Goldwyn International Strategies

- Competitive economics or dated policies
- Transparency and regulatory harmonization
- Corporate interests versus political realities

Gas and Power–Convergence or Divergence?
Session Co-Chairs: Michelle Michot Foss, University of Houston and Xavier Estrada, Consultant

- Midstream issues: affiliate, market power
- LNG: myth or reality?
- What if low gas prices really were the excuse for power restructuring?

Environment and Energy in North America
Session Co-Chairs: Rafael Fernandez, PEMEX-Mexico and Jean T. Bernard, Universite Laval

- Present energy/environmental state of affairs under NAFTA
- U.S. energy policy and growing environmental concerns
- Looming regional environmental challenges

Oil and Gas in Mexico
Session Co-Chairs: José A. Ceballos, PEMEX and Roberto Osegueda, PEMEX

- Oil and gas reserves
- Natural gas supply-demand balance
- PEMEX strategic plan 2003-2011

Role of State Owned Utilities in North America
Session Co-Chairs: Andre Plourde, University of Alberta and Daniel Reséndiz, CFE

- Present role of state owned utilities (SOUs)
- Obstacles/opportunities created by SOUs
- SOUs' role vis a vis private enterprises

Mexico City is a city filled with history and a great place to begin or end a pre/post vacation. Single nights at the beautiful Camino Real Hotel are $110.00 per night. Contact the Camino Real Hotel at 5255-5263-8889, to make your reservations. Conference registration fees are US$570.00 for USAEE/IAEE/AMEE/CAEE members and US$ 670.00 for non-members. Your registration fee includes 2 lunches, a dinner, 3 receptions and numerous coffee breaks, all designed to increase your opportunity for networking. These prices make it affordable for you to attend a conference that will keep you abreast of the issues that are now being addressed on the energy frontier.

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

Integrating the Energy Markets in North America: Issues & Problems, Terms & Conditions

23rd IAEE North American Conference

Please send further information on the subject checked below regarding the October 19-21, 2003 IAEE North American Conference.

_____ Registration Information _____ Sponsorship Information _____ Accommodation Information _____ Exhibit Information

NAME: _____
TITLE: _____
COMPANY: _____
ADDRESS: _____
CITY,STATE,ZIP: _____
COUNTRY: _____ Phone: _____ E-mail: _____

USAEE Conference Headquarters
28790 Chagrin Blvd., Suite 350 • Cleveland, OH 44122 USA
Phone: 216-464-2785 • Fax: 216-464-2768 • Email: usaee@usaee.org

Visit the conference on-line at: http://www.usaee.org/energy/

USAEE BEST STUDENT PAPER AWARD GUIDELINES

USAEE is pleased to once again offer an award for the Best Student Paper on energy economics. The award will consist of a $1000.00 cash prize plus waiver of conference registration fees at the 23rd IAEE North American Conference, October 19-21, 2003. To be considered for the USAEE Best Student Paper Award please follow the below guidelines.

- Student must be a member of USAEE or IAEE in good standing.
- Electronically Submit COMPLETE paper by **July 25, 2003** to USAEE Headquarters.
- Paper MUST be original work by the student (at least 50% of work completed by the student seeking award).
- 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 of your main faculty supervisor or your department chair. Also, include a copy of your student identification card.
- 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.

Complete applications should be submitted to the USAEE Headquarters office no later than July 25, 2003 for consideration. Please submit all above materials electronically to usaee@usaee.org

NOTE: The recipient of the $1000.00 cash prize will receive notification of this award and be presented the award at the Mexico City IAEE North American Conference. This individual will also receive a complimentary registration to attend the meeting. Please note that all travel (ground/air, etc.) and hotel accommodations, meal costs in addition to conference-provided meals, etc., will be the responsibility of the award recipient.

For further questions regarding USAEE's Best Paper Award, please do not hesitate to contact David Williams at 216-464-2785 or via e-mail at: usaee@usaee.org

* *

23rd IAEE NORTH AMERICAN CONFERENCE
STUDENT SCHOLARSHIPS AVAILABLE

USAEE is offering a limited number of student scholarships to the 23RD IAEE North American 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.

USAEE scholarship funds will be used only to cover conference registration fees for the 23RD IAEE North American Conference. All travel (air/ground, etc.) 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 electronically to USAEE Headquarters office no later than October 7, 2003. Email to usaee@usaee.org

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 USAEE reserves the right to verify student status in accepting reduced registration fees.

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

Broaden Your Professional Horizons

Join the IAEE

www.iaee.org

International Association for Energy Economics

In today's economy you need to keep up-to-date on energy policy and developments. To be ahead of the others, you need timely, relevant material on current energy thought and comment, on data, trends and key policy issues. You need a network of professional individuals that specialize in the field of energy economics so that you may have access to their valuable ideas, opinions and services. Membership in the IAEE does just this, keeps you abreast of current energy related issues and broadens your professional outlook.

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
Conservation of Energy	International Energy Issues
Electricity and Coal	Markets for Crude Oil
Energy & Economic Development	Natural Gas Topics
Energy Management	Nuclear Power Issues
Energy Policy Issues	Renewable Energy Issues
Environmental Issues & Concerns	Forecasting Techniques

• **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.

To join the IAEE and avail yourself of our outstanding publications and services please clip and complete the application below and send it with your check, payable to the IAEE, in U.S. dollars, drawn on a U.S. bank to: International Association for Energy Economics, 28790 Chagrin Blvd., Suite 350, Cleveland, OH 44122. Phone: 216-464-5365.

- -

_____**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.

PLEASE TYPE or PRINT

Name: ______________________________

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Mail to: IAEE, 28790 Chagrin Blvd., Ste. 350, Cleveland, OH 44122 USA or
Join online at http://www.iaee.org/en/membership/

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Conference Proceedings on CD Rom
26th International Conference
Prague, Czech Republic, 5-7 June, 2003

The Proceedings of the 26th International Conference of the IAEE are available from IAEE Headquarters on CD Rom. Entitled ***New Challenges for Energy Decision Makers***, the price is $100.00 for members and $150.00 for non members (includes postage). Payment must be made in U.S. dollars with checks drawn on U.S. banks. Complete the form below and mail together with your check to Order Department, IAEE, 28790 Chagrin Blvd., Suite 350 Cleveland, OH 44122, USA.

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Please send me ____ copies @ $100.00 each (member rate) $150.00 each (nonmember rate).
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FUTURE USAEE / IAEE EVENTS

Annual Conferences

October 19-21, 2003	23rd IAEE North American Conference Mexico City, Mexico Camino Real Hotel
July 8 - 10, 2004	24th USAEE/IAEE North American Conference Washington, DC Capital Hilton
September 2-3, 2004	6th Annual IAEE European Conference Zurich, Switzerland Swiss Federal Institute of Technology
June 3-6, 2005	28th IAEE International Conference Taipei, Taiwan Grand Hotel

Officer Nominations Announced

Arild Nystad, Past President and chair of the Nominating Committee, has announced the following nominations for the Association's officers for 2004-2006:

For President-elect	Arnold Baker (USA)
For VP of Conferences	Einar Hope (Norway)
For VP Publications	Georg Erdman (Germany)
For VP and Secretary	Majid Abbaspour (Iran)

The Nominations Committee this year was composed of David DeAngelo, Ulf Hansen, Kenichi Matsui and Paul Tempest as well as Nystad.

Ballots will be mailed shortly.

Calendar

17-20 August 2003, Energy 2003, Real World - Real Solutions at Lake Buena Vista, FL (Orlando). Contact: Joann Stirling, Conference Coordinator, Florida Solar Energy Center, 1679 Clearlake Road, Cocoa, FL, 32922, USA. Phone: 321-638-1014. Fax: 321-638-1010 Email: joann@fsec.ucf.edu URL: www.energy2003.ee.doe.gov

28-29 August 2003, The 3rd of MPE 2003, International Pipeline Conference & Exhibition at Jakarta Convention Center (JCC). Contact: Budhi Maryanto, VP Business Development, Debindo Multiexpo, YDP Exim Bank Bld 7th Flr, Ste 701, Jl. Tanjung Karang No.3-4A, Jakarta, 10230, Indonesia. Phone: 62-21-3900735. Fax: 62-21-3900736 Email: supplychain@biz.net.id URL: www.debindoexpo.com

August 30, 2003 - September 6, 2003, 2nd International ICCR Climate Summer School at Grindelwald, Switzerland. Contact: Martin Grosjean, Dr, NCCR Climate, Berne, Swizterland. Phone: +41 31 631 31 45. Fax: +41 31 631 43 38 Email: nccr-climate@giub.unibe.ch URL: www.nccr-climate.unibe.ch

3-6 September 2003, International Training Program on Utility Regulation and Strategy at Gainesville, Florida. Contact: Sanford Berg, Director, Public Utility Research Center PURC, PO Box 117142, Matherly 205, University of Florida, Gainesville, FL, 32611, USA. Phone: 352-392-6148. Fax: 352-392-5090 Email: purcecon@notes.cba.ufl.edu URL: www.purc.org

7-9 September 2003, 11th Annual Middle East Petroleum & Gas Conference at Dubai, UAE. Contact: Conference Organizer, The Conference Connection Inc, Raffles City, PO Box 1736, 911758, Singapore. Phone: 65-6222-0230. Fax: 65-6222-0121 Email: info@cconnection.org URL: www.cconection.org

September 9, 2003 - November 9, 2003, Gas & LNG Sales Contract Negotiations at Traders Hotel,Singapore. Contact: Ms Maria William, Marketing, TOTAL FOCUS CONFERENCES, 5B Crescent Road Singapore 439292, 439292, Singapore. Phone: +65 - 62453550. Fax: +65 - 64419832 Email: admin@sgtfc.com URL: www.sgtfc.com

10-11 September 2003, 7th Annual Asia Upstream 2003 at Orchard Hotel, Singapore. Contact: Babette Van Gessel, Global Pacific & Partners. Phone: 27-11-778-4360. Fax: 27-11-880-3391 Email: info@glopac.com URL: www.petro21.com/events

11-12 September 2003, 23rd Annual Bonbright Center Electric and Natural Gas Conference at Atlanta, GA. Contact: Office Coordinators, Bonbright Center Energy Conference, Terry College, 278 Brooks Hall, Athens, GA, USA. Phone: 706-542-1964. Fax: 706-542-8374

15-17 September 2003, 4th Annual Conference: Nigeria Oil and Gas 2003 at London. Contact: Elina Watson, CWC Associates. Phone: +4420 7089 4200. Fax: +4420 7089 4201 Email: ewatson@thecwcgroup.com URL: www.thecwcgroup.com/conferences

15-16 September 2003, 2nd Annual Aboriginal-Energy Partnerships at Hyatt Regency Calgary, 700 Centre Street South, Calgary, Alberta. Contact: Graham Christison, Marketing Coordinator, The Canadian Institute, 1329 Bay Street, Toronto, Ontario, M5R 2C4, Canada. Phone: 877-927-7936 x404. Fax: 877-927-1563 Email: graham@canadianinstitute.com URL: http://www.canadianinstitute.com/contentframes.cfm?ID=2218

17-19 September 2003, 4th Annual Nigeria Oil & Gas Conference 2003 at London. Contact: Kate McHugh, Miss, CWC Associates Ltd, 3 Tyers Gate, London, SE1 3HX, UK. Phone: +44 20 7089 4200. Fax: +44 20 7089 4201 Email: kmchugh@thecwcgroup.com URL: http://www.thecwcgroup.com

22-23 September 2003, 2nd Black Sea Energy Summit at Bucharest, Marriott Grand Hotel. Contact: Brindusa Vladutu, Senior Conference Adviser, The Forum for Regional and Interregionala Development. Phone: +40 21 326 48 30. Fax: +40 21 326 48 32 Email: bvladutu@forum.ro URL: www.forum.ro/summit

22-23 September 2003, Pipeline Inspection and Integrity Management at The Ardoe House Hotel, Aberdeen. Contact:

(continued on page 36)

Calendar *(continued from page 35)*

Customer Services, Oil and Gas IQ (A division of IQPC), 15 -19 Britten Street, London, SW3 3QL. Phone: +44 (0) 20 7368 9300. Fax: +44(0) 20 7368 9301 Email: enquire@oilandgasIQ.com URL: www.iqpcoilandgasIQ.com/GB-2061/ediary

23-23 September 2003, Challenges for Energy Policy - Corporate Strategies (European Energy Market) at Cologne, Germany. Contact: Walter Schulz, Institute of Energy Economics, Albertus-Magnus-Platz, Cologne, 50923, Germany. Phone: 49-221-170-9180. Fax: 49-221-65-4437 Email: seminare@faz-institut.de URL: www.seminare-faz-institut.de

23-24 September 2003, Portfolio Optimisation in Oil and Gas at The Café Royal, London, UK. Contact: Customer Services, Oil and Gas IQ (A division of IQPC), 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.oilandgasIQ.com/GB-2049/ediary

23-25 September 2003, POWERGEN Asia at Ho Chi Minh City, Vietnam. Contact: Zeph Landers, Event Coordinator, PennWell Corporation, PennWell House, Horseshoe Hill, Upshire, Essex, EN9 3SR, UK. Phone: +44 (0)1992 656 629. Fax: +44 (0)1992 656 704 Email: powergenasia@pennwell.com URL: www.powergenasia.com

24-26 September 2003, 4th International Energy Symposium 2003 - Energy Investment Opportunities at Salzburg-Schloss Fuschl, Austria. Contact: Conference Coordinator, Symposium Office, Kohldorferstrabe 98, A-9020 Klagenfurt, Austria. Phone: 43-1-53605-32560. Fax: 43-1-53605-132560 URL: www.energysymposium.at

24-27 September 2003, 6th Intl Power Generation, Transmission and Distribution, Oil & Gas Conference at Istanbul, Turkey. Contact: Efsun Sar, Intl Sales Coordinator, ITF Instanbul Trade Fairs, Turkey. Phone: 90-212-663-0881 x2621. Fax: 90-212-663-0973/74 Email: efsun.sar@itf-exhibitions.com

25-26 September 2003, 2003 BIEE Academic Conference at St. John's College, Oxford. Contact: Mrs. Mary Scanlan, Administration Secretary, BIEE, The British Institute of Energy Economics, 37 Woodville Gardens, London, W5 2LL, UK. Phone: 020-8997-3707. Fax: 020-8566-7674

27-28 September 2003, MiddleEast Energy Strategy To The Year 2016 at Tehran, Iran. Contact: Conference Coordinator, APS Energy Group and IICIC, PO Box 19395-7177, Tehran, Iran Email: apsnews@spidernet.com.cy

September 29, 2003 - October 1, 2003, 4th Middle East Refining and Petrochemicals Exhibition and Conference at Bahrain. Contact: Fawzi Al Shehabi, Arabian Exhibition Management, PO Box 20200, Manama, Bahrain. Phone: 973-550033 URL: www.petrotech.com.bh/

29-30 September 2003, 2nd Annual European Coal Outlook Conference at Le Meridien, Nice, France. Contact: Morenike Ogunmefun, Customer Service Executive, Informa Group PLC, Enterprise House, 45 Station Approach, West Byfleet, Surrey, KT14 6NN, United Kingdom. Phone: +44 (0) 1932 893 895. Fax: +44 (0) 1932 893 858 Email: cust.serv@informa.com URL: www.coalevents.com

1-2 October 2003, 3rd Annual Middle East & Central Asia 2003 at JW Marriott Hotel, Dubai, UAE. Contact: Babette Van Gessel. Phone: 27 11 778 4360 Email: babette@glopac.com URL: www.petro21.com

5-9 October 2003, World Forum on Energy Regulation at Rome, Italy. Contact: EGA, Professional Congress Organisers, Viale Tiziano, 19 00196, Rome, Italy. Phone: 39-0632812-1. Fax: 39-06324013 Email: energyforum2003@ega.it URL: www.energyforum2003.org

IAEE Newsletter

Volume 12, Third Quarter 2003

The *IAEE Newsletter* is published quarterly in February, May, August and November, by the Energy Economics Education Foundation for the IAEE membership. Items for publication and editorial inquiries should be addressed to the Editor at 28790 Chagrin Boulevard, Suite 350, Cleveland, OH 44122 USA. *Phone:* 216-464-5365; *Fax*: 216-464-2737. Deadline for copy is the 1st of the month preceding publication. The Association assumes no responsibility for the content of articles contained herein. Articles represent the views of authors and not necessarily those of the Association.

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

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