IA EE INTERNATIONAL ASSOCIATION FOR ENERGY ECONOMICS

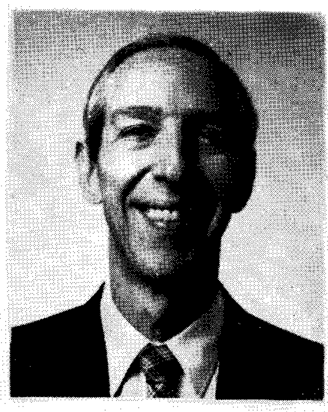
# Newsletter

**Published by the Energy Economics Education Foundation, Inc.**

**Editor:** *David L. Williams* **Contributing Editors**: *Paul McArdle, Tony Scanlan and Marshall Thomas*

First Quarter 2002

## President's Message



I am very pleased and excited to take over as President for 2002. Arild Nystad and his Council did a great job in keeping the organization moving in a positive direction. I would like to build on his and past successes. The IAEE is a strong, world wide organization with over 3000 members in 35 countries. We are thriving, but we should not become complacent. Our challenge for the future is to make sure that our members are served well; that our Journal and Newsletter continue to excel; that we find ways to attract new members; that we build new affiliates in areas where the IAEE does not exist or is weak; that we continue to build support among students and draw them into the organization; and that we find new leadership for the future.

We have several meetings this year that should be excellent, including the 25th International meeting in Aberdeen and the 22nd North American meeting in Vancouver. Planning for both meetings is well in hand, with strong programs planned for each. We have mapped out future conferences – Prague in 2003, Teheran in 2004, and Taipei in 2005. We already have had a planning session for the Prague conference this past fall and I can assure you that the Prague conference will be outstanding. We have excellent teams in place for each conference that will pull together the kind of programs we have come to expect and to keep the organization moving forward.

We will be continuing several of the programs that have met with great success — the student scholarships, and student Council members. The student Council members made excellent contributions through participation in Council meetings and in organizing mini-conferences with outstanding papers. The student scholarship program drew 36 applications — a record number and we gave out $11,000. This is a valuable way to support students around the world and we will discuss the possibility of expanding the number of scholarships, and/or raise the amount provided. For the first time, we will be organizing a student paper competition for the Aberdeen conference as another way of attracting students to the IAEE. The best student paper winner will be given a $1,000 stipend and will be asked to present the paper at the Aberdeen conference. At the Aberdeen Conference, our 25th International meeting, we will be holding a former presidents session on the last day of the Conference. I have received a tremendous response from our former presidents — it should be an exciting session and a chance for all of us to re-engage with colleagues that we have not seen for some time. I hope many of you will be at Aberdeen and will join with us in this unique session.

This year we will be discussing a policy to provide financial support for meetings in locations where there is some doubt about its financial success. Our goal is to hold IAEE meetings in as many places where there is interest and hopefully expand our membership at the same time. Another idea that we will be discussing is to hold a one day meeting in a new location, such as Argentina, to see if we can develop new members in areas where we do not have many members. We will look at other ideas for reaching out to new members as well.

The IAEE is thriving, but needs to look to the future to ensure that there are sufficient new members to keep it the vibrant and exciting organization that it is. I look forward to working with all of you in 2002 to maintain the momentum and build on past achievements and successes.

*Len Coburn*

## Editor's Notes

Paul Tempest, in a speech to the British Athenaeum Forum, looks broadly at the prospects for energy, including security of supply, market stability and leadership, availability of resources, and prices, as well as the reform needed in international agencies. Faith in mankind, especially human energy and ingenuity, rational analysis and common sense leads him to conclude optimistically.

Kenneth Skinner examines the steps needed to establish a real-time load curtailment market, noting the need to refocus

*(continued on page 2)*

***Contents:*** 

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

on demand-side incentives. He notes that the cost of such programs must be recoverable through the offerings, market rules should be designed to allow free entry of such offerings, care must be given to assure the retailer bearing the cost is compensated and load profiling must be designed to identify peak hour load reductions with appropriate compensation.

Efforts to implement wholesale electricity markets have achieved mixed results. Many observers attribute these outcomes to "seams issues." Initiatives to form regional transmission organizations (RTOs) have led to intensified debate. Michael Bailey and Christoper Eaton analyze major seams issues to assess whether North America is moving toward a seamless environment.

During 2001 IAEE invited Alberto Elizalde Baltierra and Stine Grenaa Jensen to serve as student advisors to the Council. We reported in the last issue on the conferences they helped organize. In this issue we present two papers prepared by them.

Alberto Elizalde Baltierra analyzes changes occurring in the dynamics of competition in the Mexican natural gas value chain since the beginning of the restructuring process (1995). He makes use of the "five forces" model to study these modifications. From teh analysis, he finds that the five forces have in general evolved towards a more competitive natural gas industry in those portions of the natural gas value chain that have been opened to competition through government policy.

The legislative restructuring of the Danish electric power industry calls for both a reduction of emissions and the development of renewable energy production. Stine Grenaa Jensen analyzes the equilibrium effects of introducing emission permits and green certificates as regulatory mechanisms to accomplish this.

*DLW*

## Future IAEE Events

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|---|---|
| June 26-29, 2002 | 25th IAEE International Conference<br>Aberdeen, Scotland<br>*Aberdeen Exhibition and Conference Centre* |
| October 6-8, 2002 | 22nd USAEE/IAEE North American Conference<br>Vancouver, BC, Canada<br>*Sheraton Wall Centre Hotel* |
| June 5-7, 2003 | 26th IAEE International Conference<br>Prague, Czech Republic<br>*Dorint Prague Hotel* |



## !!!!! Congratulations !!!!!
## 2001 IAEE Student Scholarship Award Winners

IAEE is pleased to announce the 2001 IAEE Student Scholarship Award Winners.

Mitali Das Gupta, Jadavpur University – Calcutta, India
Raza Fathollahzadeh, University of Technology – Sydney, Australia & University of Tehran, Iran
Ramunas Gatautis, Lithuanian Energy Institute, Lithuania
Kumudu Gunasekera, Boston University, USA
Hermann Logsend, University of New Mexico, USA

Thirty-six qualified applications were received for consideration. Criteria used for selection included: 1) student enrolled in an advanced degree program, 2) research topic in the field of Energy Economics, 3) faculty/student advisor recommendation, 4) commitment to IAEE, and 5) financial need.

IAEE President Leonard Coburn and Council members Arnold Baker and Jean-Philippe Cueille represented the 2001 IAEE Student Scholarship selection committee.

## Two Aberdeen Conference Highlights Announced

### Chief Executives to Meet

Chief Executives of Global Energy Institutes will meet in Aberdeen on 26th June immediately prior to the IAEE Annual International Conference.

The annual *Global Energy Coordination* meeting will be held in Aberdeen on the afternoon of 26th June. This meeting is chaired by the Secretary-General of the World Energy Council, Gerald Doucet. The Chief Executive Officer of each of the following organisations will be present or represented:

- World Petroleum Congress
- International Gas Union
- Eurelectric
- IAEE
- World Nuclear Association/Uranium Institute
- International Federation of Industrial Energy Consumers
- World Coal Institute

The purpose of the meeting is to co-ordinate future plans (to avoid clashes), to exchange information on how these organisations operate and to co-ordinate data and statistical systems.

### *BP Annual Statistical Review* launch at IAEE Aberdeen

The *2002 BP Annual Statistical Review* will be launched by Peter Davies, Vice-President and Chief Economist, BP at 09.00 on Saturday, 29th June at the Conference with a detailed commentary on recent energy trends, current developments and prospects. Copies of the *BP Review* will be available for all attendees.

# GEE

## Market Challenges of Fuel Cell Commercialisation

Two Day International Conference,
September 12 – 13th 2002, Berlin, Germany

Organised by the *Gesellschaft für Energiewissenschaft and Energiepolitik e.V.* (GEE) and sponsored by the *International Association of Hydrogen Energy* this two day conference will provide a forum for professionals and academics to discuss the challenges that face commercialisation of fuel cells.

Suggested Topics of Interest Include:

- Economics and Politics of Commercialisation
  - Market cost projections and implications
  - Speed and Impact of 'Learning Curves' on the economics
  - Role of government
  - Future economics of differing drive systems
  - The critical role of other actor groups
- Building and Nurturing Market Demand
  - Niche Market Commercialisation
  - Can a 'market pull' for fuel cells be created
  - The Developing World and fuel cells
  - Why could fuel cells fail to reach the mass market
  - California – Lessons that can be learnt

******************** Call for Abstracts *******************

(Deadline for Abstract Submission: March 2002)

Abstracts for papers must be 200 words or less and indicate in which topic / area of interest the proposed presentation would be included.

For more details, pre-registration information or abstract submission please contact:

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## British Institute for Energy Economics
## International Association for Energy Economics
## 25th International Conference
# Exhibition and Conference Centre, Aberdeen, Scotland
## June 26th – 29th, 2002

## Innovation and Maturity in Energy Markets: Experience and Prospects

## ***** Program & Social Activities *****

On behalf of the British Institute for Energy Economics it is our pleasure to invite you to Scotland for the 25th International Conference of the IAEE. Please mark your calendar for this important event, the silver jubilee conference, and the first time that the IAEE has come to Scotland.

The conference will bring together a remarkable set of speakers for its plenary sessions. However, the centrepieces of the conference will be its concurrent paper sessions which will form the heart of the meeting. Submissions are welcome in all areas of energy economics, but those which lie within the main themes are particularly welcome. The conference has five main themes all of which are important globally:

**Renewable Energy:** The pace of development of all forms of renewables. Barriers to development. Technical progress, reduction of costs and government incentives.

**The Role of Government**: Government regulation in all stages of the energy industries. The impact of environmental policies on energy. Taxation of energy. The evolving geopolitics of energy.

**Natural Gas**: The problems of gas development at global and regional levels. The determination of prices. The reserve position. The place of natural gas within the power generation sector. Security of Supply.

**The Oil Industry**: Technology and the resource base. The development of the offshore industry. Taxation. New frontiers. The Future of the North Sea Industry. Oil price developments and market mechanisms.

**IT and the Energy Sector:** How has the impact of IT developed, or is the revolution over? The place of e-commerce. The provision of information by governments and its role. IT and market transparency. IT and its impact on costs.

### Student Best Paper Award

The IAEE will award a price for the Best Student paper of $1,000 plus waiver of conference fees. For guidelines please see the conference website http://www.abdn.ac.uk/iaee. Complete applications should be submitted by 30th April 2002 to David L Williams, Executive Director, IAEE Headquarters, 28790 Chagrin Blvd., Suite 350, Cleveland, OH 44122, USA. For further questions regarding the scheme contact David Williams. Tel. 216 464 5365 or email at iaee@iaee.org.

### Conference Registration

Registration may be made electronically via the special conference website at http://www.abdn.ac.uk/iaee. This gives the full details of the fees payable. Alternatively payment can be made by mail to Pamela Strang, IAEE Conference Secretariat, Room 25, University of Aberdeen, Regent Walk, Aberdeen AB24 3FX, UK. Fax No. +44 (0) 1224 272271. Cheques should be made payable to University of Aberdeen – IAEE Conference.

### Hotel Reservation

Favourable rates for delegates have been made with 4 hotels. Bookings should be made through Aberdeen and Grampian Convention Bureau, 27 Albyn Place, Aberdeen AB10 1YL. Tel. No. +44 (0) 1224 288815. Fax No. +44 (0) 1224 581367 or electronically at http://www.abdn.ac.uk/iaee.

Visit the IAEE website at http://www.iaee.org for the latest information or visit the conference website at www.abdn.ac.uk/iaee.

### Brief Program Overview

**Thursday, 27 June 2002**

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| 9am-10.30am | Opening Session – Plenary One - Towards a New Global Energy Policy. Lord Lawson*, BIEE President, Gordon Brown, UK Chancellor of Exchequer, Vicky Bailey*, Assistant Secretary, US DOE, Robert Priddle, Executive Director, IEA, Gerald Doucet, Sec – Gen. World Energy Council. |
| 10.30am-11am | Coffee Break |
| 11am-12.30pm | Plenary Two - The North Sea in a Global Context. Tony Hayward*, Group Vice-President and Group Treasurer, BP, Brian Wilson*, UK Minister for Energy, Kjell Pedersen, CEO, Petoro |
| 12.30pm-2pm | Lunch - Lord Lawson on Energy Privatisation; IAEE Awards |
| 2pm-3.30pm | Co-plenary Three - Middle East - Joint Chairs: Herman Franssen and Paul Stevens<br>Co-plenary Four - US Regulation - Chair: Michelle Michot Foss<br>Shirley Neff, US Senate Committee on Energy and Natural Resources, Brett Perlman, Texas Public Utilities |

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|---|---|
| | Commission, Donald Santa, Troutman Sanders |
| 3.30pm-4pm | Tea Break |
| 4pm-5.30pm | Parallel Sessions 1 to 5: 1. Student Session: Chair: Chang Youngho; 2. Renewables: Chair: Elizabeth Marshall; 3. European Energy Issues: Chair: J-P Cueille; 4. Climate Change: Chair: David Laughton, University of Alberta; 5. Potential for the International Companies: Chair: John Holding, Saudi Arabian Texaco |
| 7pm-10pm | Gala Dinner, Ardoe House Hotel, South Deeside Road, Blairs, Aberdeen |

**Friday, 28 June 2002**

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| 8am-1pm | Registration at Aberdeen Exhibition and Conference Centre |
| 9am-10.30am | Co-plenary Five - Topic to be confirmed. Chair and Lead speaker: David Newbery*, University of Cambridge, Jonathan Stern, RIIA; Other speakers to be confirmed<br>Co-plenary Six - Energy Deregulation and Liberalisation in Developing Countries Chair: Paul Stevens, University of Dundee; John Besant-Jones, The World Bank; Peter Pearson, Imperial College, London |
| 10.30am-11am | Coffee Break |
| 11am-12.30pm | Co-plenary Seven - Asia: Joint Chairs: Hoesung Lee/K. Yokoburi<br>Co-plenary Eight - Norway - Chair: Arild Nystad |
| 12.30pm-2 pm | Lunch – The Perils of Forecasting - Lead Speaker: Michael Lynch |
| 2pm-3.30pm | Parallel Sessions 6 to 10 - 6. Oil and Natural Gas Production Prospects; 7. Technology and Decentralisation; 8. Unsustainable Development; 9. Coal and Nuclear Issues; 10. New Financial and Market Instruments |
| 3.30pm-4pm | Tea Break |
| 4pm-5.30pm | Parallel Sessions 11 to 15 - 11. The Role of Government, Chair: David Jones, BIEE; 12. Increasing Efficiency of Energy Use, Lead Speaker: Lee Schipper; 13. Lessons from California 2001, Chair: Perry Sioshansi; 14. IT and the Oil Industry; 15. IT and non-oil Energy |
| 7pm-10pm | Scottish Gala Evening, Beach Ballroom, Aberdeen |

**Saturday, 29 June 2002**

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| 9am-10.30am | Plenary Nine -Malcolm Brinded, Country Chairman, Shell UK; Peter Davies, BP. Presentation of BP Statistical Review of World Energy |
| 10.30am-11am | Coffee |
| 11am-12pm | Parallel Sessions 16 to 20 - To be allocated |
| 12pm-12.45 pm | Closing Session: Past Presidents: Reflections on Twenty-Five Years of the World of Energy. Chair: Leonard Coburn, IAEE President |

* Subject to final confirmation

**Social Delights**

The Conference will be held in Aberdeen, Scotland, the “Oil Capital of Europe” and operations centre for North Sea oil. Major and smaller oil companies and service companies have prominent presences in the city. The timing of the conference ensures that attendees can enjoy daylight for nearly 24 hours per day. June is also generally the warmest month of the year. Aberdeen has many attractions including an ancient University. It is also the ready gateway to magnificent scenery, many castles, ancient and modern, malt whisky distilleries and golf courses.

The welcome reception on the evening of 26 June will be held in the Elphinstone Hall at the ancient University of Aberdeen. This will give delegates an opportunity to see the campus, including the unique King’s College chapel.

On the evening of 27 June the gala dinner will be held at Ardoe House, a magnificent 19th century Baronial Mansion with modern ballroom facilities. It is located in beautiful surroundings beside the river Dee about 4 miles from the city.

On the evening of the 28th there will be a Scottish evening featuring a reception with Scottish food and entertainment.

**Cultural Programme**

Three social tours will be available. During the conference on 27th June a coach tour of Aberdeen for partners has been arranged. This will include a visit to some of the ancient buildings in the city including the University (founded 1495), the spectacular beach and the famous Winter Gardens. On 29th June, after the conference, a visit to Royal Deeside has been arranged. The highlight of this tour is a visit to Crathes Castle which dates to the 16th century. This castle has unique turrets and interiors and beautifully laid out gardens. On Sunday 30th a tour has been arranged to visit Fettercairn malt whisky distillery and Fasque House. This involves a journey over spectacular highland scenery. A sample of the whisky will be available. Fasque House dates to the 19th century. It was and is the family house of the Gladstone family, including the UK Prime Minister William Ewart Gladstone. The interior has been extremely well preserved to illustrate how he lived back in the 19th century.

**Getting to Aberdeen**

Aberdeen is served with 11 daily direct flights from London (Heathrow and Gatwick). There are also several direct flights from London Luton (Easyjet), London City airport, Manchester, Newcastle, Birmingham, Leeds/Bradford, Humberside, Norwich and Glasgow. There are direct international flights from Amsterdam and Stavanger. A special deal has been struck

*(continued on page 13)*

# The Prospects for Energy

## Energy Markets and Institutions Need Strengthening

*By Paul Tempest**

*"The positive development of a society in the absence of creative, independent-thinking, critical individuals is as inconceivable as the development of an individual in the absence of the stimulus of the community".*

***Albert Einstein***

**Preface**

*The Athenaeum, from its foundation in 1824, has had a long and distinguished involvement in the development and use of primary energy and in the original scientific research concerning the generation and use of electricity. Many Club members have since helped carry the torch of scientific enquiry in the field of global energy through to the present day.*

*Our first presiding Chairman, Sir Humphrey Davy, conducted fundamental electro-chemical research in the period 1801-27. Among the general public, he is still mainly remembered as the inventor of the coal-miner's safety lamp.*

*Michael Faraday, our first Secretary, can claim an even greater position as the first and foremost applied scientist in the history of electricity, establishing the principles of electro-magnetic induction and constructing the first electric motor and transformer. Within the Club, he also applied himself to the problem of adequate and improved ventilation and safety in an era when the Athenaeum coal-burning fires, cooking stoves and primitive lighting presented a hazard to the health of the staff.*

*By 1824, steam had already begun to transform manufacturing industry, the pumping of water and transportation. Within one year, the world's first passenger steam railway was in operation between Stockton and Darlington. Many of the "new energy" engineers such as Brunel and Stephenson joined the Club seeking and enjoying dialogue with like minds and a broadening of their horizons.*

*In the 20th Century, several of our 10 physicist and 11 chemist winners of the Nobel Prize and other members made key contributions which led to major advances in energy processing and use. Another member and Nobel Prize winner, Sir Winston Churchill is also remembered for his involvement in the Royal Navy's switch from coal to oil, and, in the Second World War, in the strategic decisions to secure vital access to oil supply and to deny it where necessary. Through to present times, the Club membership has attracted a quorum of energy scientists and economists, as well as government and corporate leaders in the energy sector.*

Energy is the lifeblood of the global economy today. Like the red corpuscles which the heart pumps round the human body, an abundant supply of energy - oil, natural gas, coal and, to a lesser extent, nuclear power and hydro-electricity - remains absolutely essential to provide the goods, services and living standards we now enjoy. There are no practical alternatives in the short-term.

Even so, two of the six billion people on earth at present have no regular access to electricity or transportation fuels and little hope in aggregate of securing such an access, as population growth is still out-stripping the spread of use of primary energy. The great disparity between energy-rich and energy-poor is, therefore, likely to persist, and the finite number of the energy-poor is steadily increasing, not decreasing.

Among the one billion global inhabitants, who consume 60% of the energy total, access to ample energy is very widely taken for granted, particularly in the industrialised world. Nonetheless, recent renewed threats to Middle East and Central Asian oil and natural gas supply and shortfalls of natural gas and electricity in California have provided a salutary warning. Without adequate contingency planning, much new technology and abundant long-term investment in new and conventional energy sources, energy supply will quickly plateau and fall, the pace of global economic growth will most certainly slacken and the system, as we know it, will atrophy.

The recent terrorist attacks in New York and Washington have demonstrated these points rather sharply – initial market panic and an oil-price spike, followed by a sag, as the prospects for economic growth were seen to weaken, indicating a marked slackening of energy investment. The trading community, which is more or less incapable of looking more than six months ahead, finds itself today expecting $18 oil at a time when the current geo-politics of the Gulf point in the opposite direction towards multiple political explosions throughout the Middle East and the strong possibility of major interruptions to global oil and gas supply.

**Security of Energy Supply**

While markets remain nervous and fearful and attention is riveted on the political confrontations in the Gulf and the rapid dissolving of the anti-terrorist alliance, many nations are, therefore, now again reviewing their dependence on imported energy supply. Such imports have to be paid for. In times of shortage, there will again be very high costs and acute competition for what exports remain available in the markets. Availability cannot be assured by other means such as long-term stock-piling or long-term barter deals.

Even the largest countries are vulnerable. The United States, which absorbs one quarter of total global energy, now depends on imports for well over half its massive consumption of oil. Germany and Japan have a much greater degree of oil import dependence. China, which still uses, in per capita terms, only one-fifteenth of the energy consumed by each person in the United States, has moved in the last ten years from the ranks of major oil exporters to become a massive and growing oil importer. During the same period of ten years, Russia has seen its oil consumption cut by half and its domestic oil production slump by a third. In the coal sector, China with one quarter of global production has, within the last five years, cut its production by one third.

In the emerging world, some sixty-five countries are now massively and increasingly dependent on imported energy. Many have great difficulty now in generating hard currency to pay for these imports. Their demands are becoming more

*Paul Tempest is Vice-President of the British Institute of Energy Economics and the Executive Director of the Windsor Energy Group. He is a past president of the IAEE. e-mail: tempest@greenwich40.co.uk This address was delivered to an Athenaeum Forum Dinner Discussion held in the Athenaeum Club, London, on 16th October 2001.

desperate and more strident, and they are finding common ground in listening to the bin Laden/Taliban rhetoric and critique of U.S. economic policy.

These developments represent abrupt and fundamental structural change of considerable impact on the global economy, on global trading patterns, and on how each state behaves towards its neighbours, its trading partners and its commercial rivals.

Afghanistan's energy and economic isolation and deprivation has become a rallying call, which many find hard to ignore.

Let us pass on to the good news.

**Market Stability**

The fact that the energy market is now very much larger than ten or twenty years ago and that it will continue to grow with a more balanced energy mix, very many new players and a cross-multiplicity of interest is, on balance, a source of hope for a sound, stable network and for future long-term investment. Interdependence on traded energy should produce co-operative solutions to demand strains and supply shortfalls and above all, a much more rapid sharing of the benefits of new technology. The need for adequate energy to sustain global economic growth is now very widely understood and accepted. Indeed, the imperative of avoiding supply discontinuities such as the oil crises of 1973-4 and 1979-80 - with consequent crippling inflation, economic paralysis and turmoil in government financing and the banking sector - has brought caution and awareness to the conduct of economic policy world-wide over the past two decades. In this there is also much ground for hope.

**Market Leadership**

The United States has been deeply shocked, angered and saddened by recent events. It is confused by the response of the Middle East states to its new military operations in the area. Yet few question U.S. leadership in global economic finance, in the generation of new technology of all kinds including energy and in the solution of many global dilemmas. The United States has shed the constraints of the Cold War. If we are going to achieve a gradual (and it looks like a 30-50 year) transition to a hydrogen and largely non-fossil-fuel based global economy, we still need the United States to give a strong, confident, far-sighted lead.

**Resource Availability**

Nor do we need to be concerned about fossil-fuel availability at the global level. Proven reserve/production ratios are 40 years for oil; 60 years for natural gas; 230 years for coal. The probable reserves estimates more than double these very high numbers and these are all based on recent levels of technology, which is constantly advancing. The immediate problem is local; it concerns the market allocation of current supplies and the crucial dependence of many countries on oil supplies from the Middle East.

Oil accounts for over 40% of the global energy mix. Coal and natural gas are roughly level at 25% each. As the oil-price is the international starting-point for almost all energy pricing, it is likely to continue to be buffeted by world events and conflicts. Every collapse, say towards $10 per barrel will, as in 1986 and 1999, bring almost every brand-new exploration project to a halt and many in the appraisal phase into a "hold" or "wait and see" status. Equally, any significant supply threat is capable of sending prices soaring above $30, triggering global fears of dislocation, inflation and economic recession. Thus energy investment does not proceed at all smoothly, but rather, unevenly and intermittently on the crest of giant waves.

**Price Stability**

Whenever the screens go blank, the air-conditioning fails or the streets are suddenly empty in United States, Europe or Japan, we can be fairly sure that the ensuing outcry will be loud enough to trigger action and that there will be a readiness to shoulder much higher energy costs than hitherto in order to draw out both new investment capital and a rational market re-allocation of existing supply.

Without the "super-majors" to turn to, we depend at present in each of these "mini" oil crises on governments and very largely on two governments – first that of the United States of America, and second, largely through the representations of the United States, that of Saudi Arabia, the single global oil producer with sufficient volume and flexibility to cut or increase its production on the scale needed to reverse the market trend. That Saudi Arabia chooses to operate through a screen or fog – that of OPEC, the now eleven-member so-called "petroleum exporting country cartel" founded in Baghdad in 1960 and domiciled in Vienna - is neither here nor there.

OPEC has, nonetheless, over the past twenty years, played, a particularly valuable role in this regulatory function. Its current $22-28 guidelines are acceptable to most consumers and its efforts to moderate or enhance supply when necessary are largely regarded as sensible steps to achieve price stability.

**New Energy Use Technology**

A more significant and more efficient relief to supply/demand imbalance is more likely to come from new technology in the utilisation of energy. Here, at least, there is already clear light at the end of the fossil-fuel tunnel. Internal combustion engines are becoming less and less thirsty and less pollutant. Highly efficient combined cycle gas turbines have completely changed the market for heat and power. Hybrid petroleum/fuel cell/battery vehicles are already on sale with 70mpg (and 100mpg promised shortly), albeit at production costs much higher than their conventional equivalents. There are hydrogen and battery-powered urban coach fleets and hydrogen-fuelled delivery trucks in Chicago, Vancouver and other cities of North America. As a guide to the scale of the potential for savings, the world record for a petroleum-driven passenger vehicle has just exceeded 10,000 mpg and several vehicles have recently crossed Australia entirely on solar power.

Meanwhile, as our most congested cities slowly grind to a halt and about one third of us – two billion – suffer increasingly from the effects of urban pollution, the restructuring of the towns and cities will begin to change lifestyles and services. New public transport, city-centre pedestrianisation, licensed vehicular access, penal parking and other taxation are already becoming the norm world-wide, opening the door for new and cleaner technology.

**Curbing the Military**

Another area of hope is the chance of curbing the vast

*(continued on page 8)*

**The Prospects for Energy** *(continued from page 7)*

appetites of the military, particularly for gasoline, diesel and jet-fuel. Almost anywhere in the world, admirals, generals and air-commanders will assure you at any time that they need more weaponry and that, on active operational service, they have to allocate 10-20% of their pitifully tight budgets to fuel supply, without which nothing moves. If, as happened to me once in 1986, you can arrive in the Pentagon with a plausible scenario for a five-year oil-price path some five dollars below their budget assumptions, you will be greeted rapturously - rather like Santa Claus bearing sacks and sacks of additional unexpected fighter squadrons, nuclear submarines and tanks - and transported instantly - as if on a magic military carpet - from one welcoming four-star general to another and on to the very highest in the land. However, as the memory of the Cold War recedes, and if demilitarisation and disarmament ever become more fashionable, there may be scope for a reduced military demand for fuel.

### Taxation

Less hope can be placed on the non-interference of governments. Energy, so inelastic in demand, is such a tempting and relatively painless source of public sector revenue.

For the producer governments who agree to restrict supply and inflate prices, the additional revenue provides first and foremost additional means to secure their regimes. It is the easy option which avoids the cost, fuss and risk of investing in new capacity and it blocks outsiders from meddling further. Pressure from consumers can be bought off with part of the enhanced income.

For the consumer governments, the myth that high taxation of oil products will curb demand can be set against the historical record and found to be largely illusory. Governments can be greedy to the point of strangling the energy cash-cow. The United States provides a model of low taxation, low subsidisation of energy, and high economic efficiency which challenges much of the logic applied in Western Europe and Japan.

The role of government in energy is thus, again, under rigorous scrutiny. A heavy hand produces inertia, inflexibility and ultimately a dangerous isolation from world markets. Civil servants and ministers are, generally speaking, no match for the formidable teams of corporate tax lawyers and consultants fielded by the companies – highly-focused, well-motivated and highly rewarded. Privatisation has proved no easy panacea and has generally led world-wide to new forms of government supervision and regulation. Brave attempts to create brand-new efficient, competitive markets out of the feeble framework of state monopolies, oligarchies and cross-industry alliances have been partly frustrated.

### Institutional Weakness

What emerges strongly from the markets is a point about the political feebleness of the institutional structure. It was, you might remember, the final remark of Professor Eric Hobsbawm in his Athenaeum Lecture 2000, the third in the series. In addressing The Prospects of Democracy, he concluded :

> "In short, we shall be facing the problems of the twenty-first century with a collection of political mechanisms dramatically ill-suited to dealing with them. They are effectively confined within the borders of nation-states, whose numbers are growing, and confront a global world which lies beyond their range of operations. It is not even clear how far they can apply within a vast and heterogeneous territory which does possess a common political framework, like the European Union. They face and compete with a world economy effectively operating through quite different units to which considerations of political legitimacy and common interest do not apply - transnational firms. These by-pass politics so far as they can, which is very far."

In the energy sector, the four "oil super-majors" may well survive the massive financial pressures and expectations placed upon them. Yet they are all four ill-equipped to ensure the equitable distribution of oil and gas in a supply emergency or to manage their ultimate replacement by other fuels. Many national governments are also poorly-equipped and at risk. The leading international agencies charged with this task of emergency allocation of market supply are particularly hampered.

### Reform of the International Energy Agency

On the consumer side, the International Energy Agency (IEA) was founded in 1974 in Paris to represent and protect the interests of the leading industrial consuming and energy importing countries, all members of its parent body, the OECD. Since then, the IEA has developed its expertise to become No.1 in the collection, collation and analysis of global energy data. Its judgment, aggregation and informed commentaries are highly regarded and carry weight in the energy and financial markets, who also listen carefully to its scenarios and often inflated predictions of future demand. Yet, in political terms, the IEA has difficulty in representing a global international interest. It is still tied to the interests of the industrialised world and it is never possible to completely disentangle its recommendations from the interests of its largest member. Without United Nations status and without a clear UN mandate, the IEA will remain a lame duck in the formulation of a global energy policy. That it should remain tied to the interests of the industrialised world is not an acceptable way forward for the rest of the world.

There are also wider concerns regarding the probity and efficiency of global markets which impinge on the energy sector. Most leading players would prefer systems of self-regulation rather than overlapping national government legislation and ill-defined responsibilities for new international agencies. The oil futures markets, for example, are vulnerable to manipulation by irresponsible producer and financial sector interests. So far, mechanisms for accurate up-to-date data-reporting and for legal redress are scanty.

So, as Professor Hobsbawm pointed out, one of our biggest problems is the inadequacy of our institutions to handle these global issues which are playing a rapidly increasing part in our lives. New technologies will, I hope, bring new leaders and also, with them, new institutions and mechanisms, free from the baggage and inertia of the recent past and present. Meanwhile, it would be quite an easy matter for the United States to throw open the IEA to the rest of the world as a token of its concern for the energy interests of other states and as evidence that it is listening carefully to what they have to say.

### Human Energy

The long-term solution of global energy supply availability lies essentially not in the ground or under the sea. To leave the future of energy entirely in the hands of assorted generals, politicians, diplomats, economists and the like would itself be dangerous. The long-term answers must lie in the well-spring of human energy, in human ingenuity, rational analysis and common-sense and what today and always lies deeply buried in the human brain.

This gives me hope. Mankind is, through the internet and world-wide web, mobile telephone, mini-processor and other devices, on the brink of a quantum leap in non-confrontational communications between individuals and between companies world-wide, a cross-border pooling of ingenuity on a scale barely dreamed of twenty or even ten years ago, a new mechanism for concentrating human enterprise, where ego-centric, sectoral, corporate and national self-interest and other protective barriers can be progressively circumvented or dismantled, where distortion and corruption can be more quickly exposed, where opportunity and risk can be rigorously evaluated, where the lunatic fringe can be easily discredited, and where common sense and freedom of expression are likely to prevail.

One high probability is, I think, extremely important. It has been acknowledged, only for the first time this year, by the *Athenaeum* after one hundred and seventy-seven years of apparently intelligent debate among a grand total of some fourteen thousand members, all male, with the recent vote to admit women to full membership beginning 1 January 2002).

The brain-power of women, with all their innate superiority in communication and language skills, social sensitivity, multi-task dexterity, non-confrontational responses to conflict, through-life hands-on experience of caring - from the new born baby to the dying geriatric - is, through the internet and other media, being rapidly released from entrapment at home, drudgery at work and total exclusion from many, if not most, of the commanding heights of our economy, society and culture. In the 20th Century, principles of equality of opportunity have been firmly established. In the 21st Century, we can be sure that the way women think will progressively impact and modify the way we all behave and develop, hopefully with immense benefit to society, education, health and international relations.

Surely, with such a surge of human brain-power, change of direction and acceleration of technology, we will be able to continue to work out how to produce adequate energy for rising, if fluctuating, levels of economic welfare, without destroying too many other species on this fragile planet, too much of our natural environment, or even each other.

In summary, we give every indication of being able to create in time the new and cleaner energy technology we so badly need. But the way will be neither smooth nor painless. I am reminded of a remark by Dr. Samuel Johnson whose great spirit and inspiration so permeates the character of the *Athenaeum* to this day. He was speaking, admittedly, in the mid-18th Century , referring to a brewery, and addressing the feasibility of establishing new and more convivial day-care centres for those in need. No matter, the principle is what is important:

> "We are not here to sell a parcel of boilers and vats, but the potentiality of growing rich beyond the dreams of avarice."

This brings me back to the two billion global inhabitants who have not yet enjoyed - or suffered - this affluence of abundant energy. In the very long-term, I have some doubts. As I observe the frenetic, competitive stimulus of these new freedoms of electronic and satellite communication, I note, both among the young and middle-aged as well as among the elderly, the accompanying prevailing neurosis of broken-hearted individuals being cut adrift from a stable social pattern – the fear of not being able to keep up, of being side-tracked and ultimately discarded.

I find myself comparing this despair with the resilience of primitive peoples I have met deep in the rain-forests and on the remote coasts of Africa, South-east Asia, and South America. Facing daily hardship and challenge without the benefits of advanced technology, education, electricity, transport or modern medicine - or even the homely comforts of the *Athenaeum* - they clearly are also equipped with a strong energy, will, intelligence and instinct to preserve their pattern of life. We may eventually come to acknowledge that those primitive skills and mentalities are ultimately of equal, if not superior, value in the struggle of mankind to survive.

Plans are well underway for the Prague IAEE 2003 International Conference. Those meeting in Prague for the annual program committee meeting are as follows (listed from left to right): Ivan Benes – Prague Program Chair; Len Coburn – IAEE President; Virve Rouhiainen – Finish Affiliate President; Paul Tempest – IAEE Past President; Michelle Foss – IAEE President-Elect; Georg Erdmann – GEE President; Frits van Oostvoorn - IAEE Council; Jan Myslivec – Prague General Conference Chair; Jiri Schwarz – Program Committee; Roberto Rios-Herran - Program Committee.

Stay posted to the IAEE web site (www.iaee.org) for updated program announcements and hold the dates: June 5 to 7, 2003.

# Market Design and Pricing Incentives for the Development of Deregulated Real-Time Load Responsiveness Markets

*By Kenneth Skinner**

## Introduction

Because of recent price volatility and resulting high prices, there has been a renewed interest in the consequences of supply and demand imbalance. The supply response is to build new generation. However, adding supply alone will not solve all of the problems, especially those associated with extreme price spikes. Both supply and demand responsiveness need to be addressed. On the demand side, market participants and independent system operators are reexamining the incentives and steps necessary to develop market-based demand responsiveness. In regulated markets, the cost and responsibility of Demand Side Management (DSM) programs were built into the rate-base or funded through green energy surcharges. In deregulated markets, where DSM programs or renewable energy investment must be recoverable through market-based pricing, these programs have been considered uneconomic and thus neglected.

In this paper I consider the necessary steps required of an effective and functioning real-time load curtailment market. Clearly, legislators and market participants need to re-focus on demand-side incentives. However, the issue is not so much whether these should exist, as how to create a competitive market where demand-side offerings are appropriately priced. First, in a deregulated market, the cost of demand-side programs must be recoverable through the offerings, not built into the rate-base. Second, market rules should be designed to allow free entry of competing suppliers of demand-side offerings. Third, care must be given to assure that the retailer bearing the cost is compensated, regardless of where the load reduction actually occurs. Finally, and perhaps most importantly, the current technique of load profiling must be redesigned to identify peak hour load reductions and compensate end-users appropriately.

In addition to market design issues, the paper further suggests a market-based method of pricing real-time load curtailment based on real-option valuation. The promise of real-time load reduction can be thought of as a strip of European call options. The strike-price is given by a contractually agreed upon threshold price between the energy provider and energy consumer. From price volatility determined from historic price data or implied from forward markets, a premium value is calculated for the right to curtail future load. Option premiums, profit sharing and limit orders can provide financial incentives for functioning demand responsiveness markets.

## Supply and Demand Imbalance

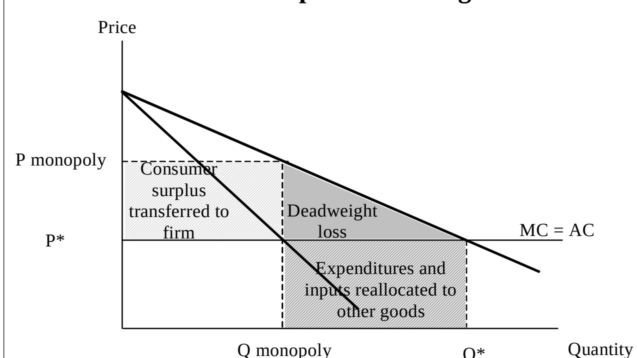
Because of recent price volatility occurring in deregulated wholesale power markets, legislators have begun questioning the fundamental reasons originally given for deregulating the electric utility industry. Early on, those favoring deregulation pointed to the advantage of perfectly competitive price determination in anticipation of lower energy costs.

However, in order for perfectly competitive prices to develop, fundamental assumptions of competitive markets must be met. One of these assumptions—the ease in which firms are able to enter markets—plays an important role in the development of competitive markets. Market entry assures that 1) long-run profits are eliminated by the new entrants as *prices* are driven to be equal to marginal cost, and that 2) firms will *produce* at the low points of their long-run average cost curves. Even in oligopolistic markets, long-run profits and prices exceeding marginal cost can be eliminated if entry is costless.

The recent California experience has highlighted the full extent of barriers facing new generation, and the cost to society when entry is constrained. In discussing the price setting power of monopolies, Nicholson (1992) states "The reason a monopoly exists is that other firms find it unprofitable or impossible to enter the market. Barriers to entry are therefore the source of all monopoly power" (p. 559). Figure 1 demonstrates the affect of market power in reducing output below optimal levels and raising market price to capture consumer surplus.

Because of decreasing economies of scale characteristic of large coal-fired steam facilities, electric utilities have traditionally been thought of as natural monopolies. If at any time due to transmission constraints, forced outages, or collusion amongst market participants (as was the case in the well-documented UK experience) a generator is able to command monopolistic power, prices will exceed marginal cost and consumer surplus will be transferred to monopoly profits.

**Figure 1**
**Monopolistic Pricing**




Only recently have electricity markets been contestable. A recent EIA (2000) report noted that with the exception of comparing variable operations and maintenance costs at nuclear plants to that of combined-cycle units, "the capital costs and both the fixed and variable operations and maintenance costs of combined-cycle plants, and conventional and advanced combustion turbines, are lower then the traditional baseload coal and nuclear technologies." (p. 42). As smaller units begin to compete with large baseload facilities, the market can no longer be characterized as a natural monopoly. Thus, significant advances in technological innovation have opened the door for competitive market pricing. H.R. Linden

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(1997) noted in the *Electricity Journal*, "Under pressure of competition, the all-in cost of a combined-cycle plant has dropped to $450 per kilowatt, less than half that of a new clean coal plant. In combined-cycle configurations, heat rates have dropped. This has made natural gas at $2.50/million Btu competitive with coal in terms of variable cost when the much lower non-fuel operating and maintenance costs of gas are figured in."

However, until the barriers to entry are relaxed, prices will not be set at marginal cost. Because entrepreneurial merchant generation is unable to quickly enter the market to capture excess rents, existing generation is able to charge prices exceeding marginal cost.

There are several reasons why entry is constrained including site development and permitting delays, turbine availability and construction lead-time. Both advanced and conventional combined-cycle technologies require 3 years construction lead-time, while coal and nuclear plants require 4 years.[1] Once the facility is built, transmission rights and fuel availability constraints can limit market participation. Finally, scheduled maintenance and physically operating constraints can limit real-time market participation. It is apparent that physical generation by itself will not provide real-time market entry and exit required to assure marginal cost pricing.

**Real-Time Load Responsiveness Market**

In this paper, I suggest that the solution to costless entry is found in the "negawatt" market of real-time load curtailment. Unfortunately, effective programs designed to encourage active negawatt markets are only beginning to develop. A recent study by E SOURCE (2001) noted "As the electricity and gas industries struggle to take their first competitive steps, new pricing approaches will necessarily emerge, offering end users the opportunity, at least theoretically, to select the right product at the right price for them, as opposed to being subjected to the "class-average" tariff. But so far, research conducted by E SOURCE has uncovered few examples of pricing innovation in those regions that now have open access. In fact, regulated utilities may be more creative in providing options to their large end users—something quite unexpected given the flexibility open markets possess."

Theoretically, real-time load management is analogous to physical ancillary generation markets. Rather than dispatching and curtailing generation, real-time load management curtails and dispatches load. However, due to the high cost of monitoring and telemetry equipment and current limitations in market design, practical real-time load management is only available to large industrial consumers.

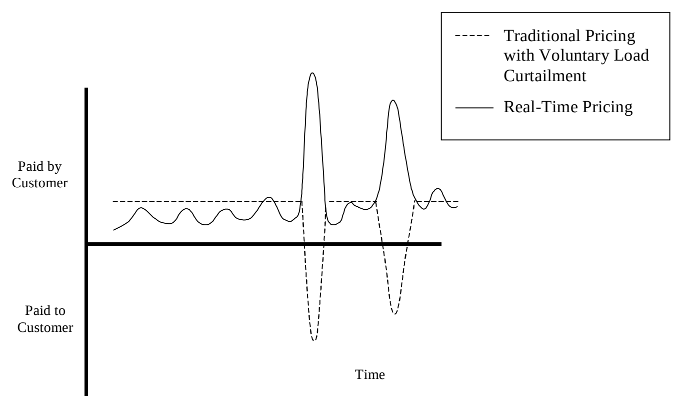
However, residential consumers can also participate in load curtailment markets. Residential customers can be encouraged to shift demand from peak to off-peak hours via a multi-tier tariff. For example, a simple two-tier system that prices peak power consumption differently from off-peak would provide incentives to shift non-essential activity to off-peak hours. Although limited, the opportunities for residential consumers provide a significant potential source of peak-load reduction. However, the current system of load profiling is fundamentally inconsistent with real-time load measurement and pricing. Until communities or entrepreneurial service providers commit to investing in multi-tier load monitoring, residential participation in load curtailment markets cannot develop.

Demand responsiveness markets will be most effective when shedding peak-load. E SOURCE (1999) demonstrated that small demand reductions could effectively bring wholesale prices way down. In many service territories, peak demand for the system, which may represent only 100 hours or so per year, creates the need for 10 to 25 percent greater system capacity.[2] In order for peak load shedding markets to develop, peak load price signals must be passed to end-use customers. As price signals become apparent, more end-users will find the flexibility and desire to sell back megawatts into the grid.

Current load curtailment programs are designed to benefit both the energy service provider (ESP) and the energy consumer. State regulators and ISO's encourage the programs. However, due to the cost of administrating the programs, the ESP must retain a large portion of the benefit in order to breakeven. Additionally, end-use customers tend to be risk-adverse when threatened with full exposure to real-time spot markets.

The most successful programs avoid much of the down-side price risk through voluntary participation. Instead of threatening users with possibility of extreme energy costs, voluntary programs entice them with rewards for curtailing usage. These programs pass the price signals to the consumer, and, therefore, the incentive to curtail. However, if the consumer chooses not to respond and continues current consumption, they pay the conventional stable rate for electricity. Under voluntary load curtailment, shown in Figure 2, the energy user pays a standard rate that is designed to average out the highs and lows, but during a price spike event, the user can "sell back" the curtailed energy to the ESP. [3]

**Figure 2**
**Voluntary Load Curtailment Pricing**




As previously noted, current voluntary curtailment programs benefit both the ESP and the energy consumer though revenue sharing. The arrangement accounts for the shared risk and administrative expenses incurred by the ESP. However, other than for recovering administrative expenses, the ESP can be a neutral participant in the negawatt market. A functioning real-time negawatt market would automate much of the demand response activity. First, the energy consumer would determine ahead-of-time the strike price and

*(continued on page 12)*

[1] See footnotes at end of text.

**Real-Time Load Responsiveness Markets** *(continued from page 11)*

level of curtailment consistent with their opportunity costs. The strike price would then be compared to expected system price on a day-ahead and hour-ahead basis. If the expected system price exceeds the strike price, the customer is automatically notified. Ultimately, the real-time transition from system energy to backup-generation would also be automated. The negawatt market participant would automatically transition off of system load.

**Competing with Generation Companies**

Ideally, the ESP would be indifferent to either paying GenCo's the spot market price for wholesale energy or paying the negawatt participant for load curtailment. Under this scenario, the end-use customer receives the full benefit of equivalent spot market prices for participation in the negawatt market. The benefit to the ESP is less apparent. If the load curtailment generates enough savings, the market would face a less expensive marginal unit setting market price. In this case the ESP would receive a higher return on power sold to fixed tariff customers.

Load responsive negawatt markets can provide system capacity through either reducing consumption or switching to backup-generation. For the purpose of calculating the cost to shed system load, the two options are equivalent. Both switching to backup-generation and shedding load represent opportunity cost. However, the advantage of focusing on the cost of backup-generation is that it effectively sets an upward bound on cost. The annualized cost of backup-generation effectively caps the power market annualized price. At the point where system cost exceeds the cost of new generation, negawatt market participants would be better off installing new backup-generation than purchasing from the power market. Negawatt markets would compete directly with GenCos, creating a demand response cap to market price and volatility.

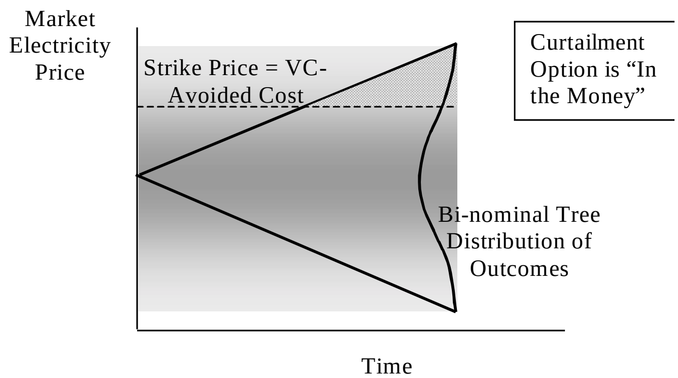
Although negawatt market participation can be either through reducing consumption or switching to backup-generation, for the purpose of market pricing, we consider all participation as if though backup-generation.

**Real-Option Pricing**

Using real-option valuation of participant opportunity costs, price incentives exist for negawatt market development. The opportunity to switch from system load to backup-generation may be modeled as a series ("strip") of options on Btu spreads, and option valuation techniques employed. Figure 3 represents the possible outcomes of valuing a negawatt participant strike price for real-time market entry. The figure demonstrates how the end-user determines at what point to sell back to the negawatt market. That point is the strike price at which the end-user exercises the option to participate in the negawatt market. The strike price is the variable cost of backup-generation less system power purchase costs. At the strike price, the participant is better off running backup-generation and collecting market revenue for its equivalent capacity contribution, than purchasing energy from the retail energy market.

The option value is equivalent to the amount an end-user would be willing to pay in order to participate in the negawatt market—the net cost of backup-generation. The approach effectively caps system volatility and peak-price. Volatility and peak price would never exceed the cost of installing new backup-generation (less avoided system cost).

**Figure 3**
**Pricing the Real-Time Market Entry "Strike Price"**




The Btu spread associated with Figure 3 represents the differential between electricity and fuel prices, in Btu-equivalent measures. Such a spread is most commonly calculated between electricity and natural gas, and known as the spark spread. In our case, we are considering the spread between backup-generation fuel oil and electricity. Prices are adjusted for heat rate. Thus, each curtailment market backup-generating unit has its own spark spread. The spread is location-specific, and the adjustment factors may possibly take into account location-specific, transportation over pipelines and electricity transmission lines.

The spark spread may be positive or negative. When the spark spread is positive, it means that fuel oil is more valuable burned for electricity by backup-generation than as a raw commodity. When the spark spread is negative, it means that the fuel oil a generating unit burns is more valuable than the electricity the unit produces. An arbitrageur would pay an end-use customer with a long-term fuel contract not to operate in such cases, but to give its fuel over to the arbitrageur for sale in the commodities market. In essence, when a generating unit's spark spread is negative, its generating capacity has no immediate value in the energy market.

An electric generating unit can be thought of as a means to capitalize on the spark spread. When the unit's spark spread is negative, the curtailment market participant should purchase its power from the retail energy market. When the unit's spark spread is positive, the market participant should operate its backup-generator in direct competition to the power generation companies.

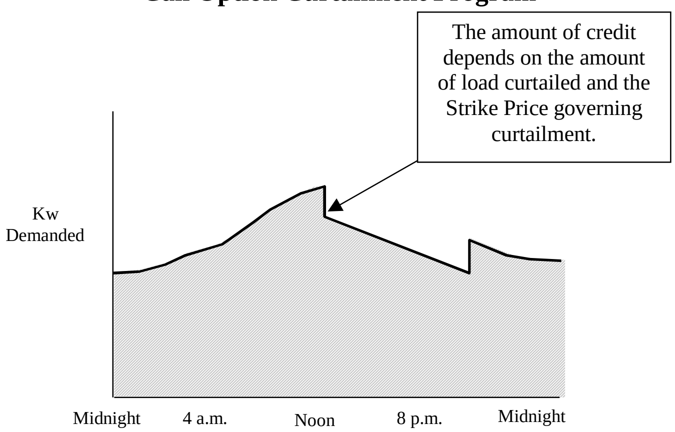
However, to burn fuel oil for electricity requires having backup-generating capability available. While an arbitrageur trying to take advantage of a negative spark spread need only to find a buyer (and associated transportation) for the fuel, to take advantage of a positive spark spread an arbitrageur needs backup-generating capacity (or the equivalent ability to reduce power consumption). If such backup generating capacity were instantly available and costless, then arbitrage would drive a positive spark spread to zero effectively capping energy market prices via market participation.

**The Cinergy Baseline Reduction Program**

Although competitive negawatt markets do not currently exist, entrepreneurial energy service providers are currently using a real-options theory to value curtailment products. The Cinergy Baseline Reduction Program is one example. Participants in this program are able to choose the level of risk that curtailment will occur and the amount of energy curtailed. Choosing a lower Strike Price increases the possibility of curtailment.

Participants receive a corresponding premium payment and an energy credit for curtailed energy. The premium payment is based on the Strike Price, the option load contracted, and the operational plan selected. A "Call-Option" in this case gives the ESP the right to purchase energy from the end-use customer at the agreed upon Strike Price. The Call Option is exercised when the ESP marginal cost of electric energy, including all variable cost associated with delivering the energy, is projected to be equal to or greater than the Strike Price. Figure 4 represents how end-user load shape responds to the Call Option.

**Figure 4**
**Call Option Curtailment Program**




The Cinergy load curtailment program contains many of the elements necessary for negawatt market development including option pricing, risk sharing, voluntary participation, ESP customer support, and reliability. Such programs will provide the foundation for development of real-time load responsiveness markets.

### Conclusion

Theoretically, real-time load management is analogous to physical ancillary generation markets. Rather than dispatching and curtailing generation, real-time load management curtails and dispatches load. Responsive load "negawatt" markets can be developed to create real-time entry and exit fundamental to competitive priced electric power markets. Negawatt markets would compete directly with GenCos, creating a demand response cap to market price and volatility. Generators would compete with backup-generation, the cost of which sets the market cap.

Using a market-based method of pricing real-time load curtailment, based on real-option valuation of participant opportunity costs, price incentives exist for negawatt market development. The promise of real-time load reduction can be thought of as a strip of European call options. The strike-price is given by a contractually agreed upon threshold price between the energy provider and energy consumer. From price volatility determined from historic price data or implied from forward markets, a premium value is calculated for the right to curtail future load. Option premiums, profit sharing and limit orders can provide financial incentives for functioning demand responsiveness markets.

### Footnotes

[1] Energy Information Administration, *Assumptions to the Annual Energy Outlook,* DOE/EIA-0554 (Washington DC, January 2000), Table 37, Cost and Performance Characteristics of New Central Station Electricity Generation Technologies.

[2] David Stern, Manager, Product Support, POWERdat/BaesCase, Resource Data International, FT Energy, 3333 Walnut Street, Boulder, CO 80301, tel 720-548-5427.

[3] Dick Montague, "Voluntary Load Curtailment Systems for Win-Win Load Control," E SOURCE Report EIC-13 (December 2000).

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### Aberdeen Program *(continued from page 5)*

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# An Update on North American Electricity Markets: Still Coming Together at the Seams?

*By Michael Bailey and Christopher Eaton**

The past few years have witnessed an unprecedented move toward wholesale electricity markets around the globe. Several regions in North America have implemented or are planning to implement electricity trading arrangements and market infrastructure – including independent system operators (ISOs) and power exchanges (PXs) – to capture economic efficiencies while maintaining reliable delivery of electrical energy.[1] Efforts to restructure the electricity industry across market regions have taken on a diverse set of characteristics and met with varying degrees of participation and success. By any measure, wholesale electricity markets have experienced considerable challenges in achieving their two primary objectives – economic efficiency and reliable energy delivery.[2] One of the most pressing challenges facing the industry today involves divergent legislation, regulatory policies, market rules, business practices, and information technology and their adverse impacts on interregional trade in and delivery of wholesale electricity and related products. These issues are commonly referred to as "seams issues."

For our purposes, a "seam" can be defined as a line formed by the abutment of two or more contiguous regional markets which creates a weak or vulnerable area or gap. Thus, we define seams issues as *impediments to interregional trade in and delivery of electricity and related products and services which result in economic inefficiency and/or a threat to reliability*. From the economist's perspective, these issues may take the form of transaction costs, barriers to trade, or negative externalities. They are interesting because of their adverse effects on efficiency and reliability and associated policy challenges. At a time when jurisdictions across North America are continuing to move toward wholesale electricity markets as the preferred model, seams issues have emerged as critical obstacles to success by threatening both efficiency and reliability objectives. In an attempt to address these concerns, the U.S. Federal Energy Regulatory Commission (FERC) made the elimination of seams issues a major part of Order No. 2000, an order designed to bolster the development of wholesale electricity markets by encouraging the formation of large-scale regional transmission organizations (RTOs).[3]

There is ample evidence linking seams issues with transaction costs and other sources of market inefficiency and threats to reliability. Regulatory orders and studies of the wholesale electricity markets in the United States recognize progress that has been made to facilitate interregional trade, but also point to several seams-related areas for improvement.[4] Assessments by reliability groups show that market-based business practices and trading patterns are increasingly straining the capabilities of North America's transmission grid.[5] Industry observers and participants acknowledge the importance of resolving seams issues and are working toward solutions.[6] There is widespread agreement on the prevalence of seams issues and their adverse effects and some steps have been taken to identify and address these issues. In a previous paper, the authors introduced a seams issues analytical framework, applied this framework to several seams issues, and discussed policy responses. Our purpose here is to provide an update on whether North American electricity markets continue to move toward a seamless electricity market environment – i.e., whether they are still "coming together at the seams" – and to advance the policy debate.

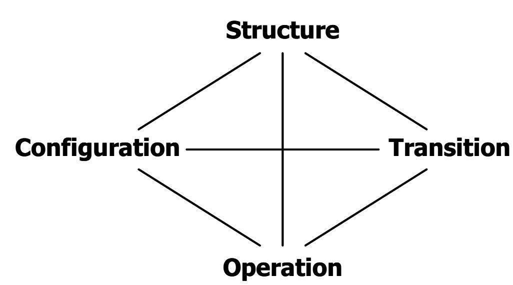
## Seams Issues Examined

Whatever their underlying form, seams issues threaten to hinder the development of regional wholesale electricity markets and limit their ability to deliver efficiency and reliability benefits. The considerable volume, diversity and complexity of seams issues has frustrated many attempts to perform structured analysis and formulate appropriate policy alternatives.

### Analytical Framework

To facilitate discussion and analysis of seams issues, we have developed the following analytical framework that divides seams issues along two axes: *configuration/transition* and *structure/operation* (refer to Figure 1). Issues along the configuration/transition axis are primarily related to the ongoing effort to establish regional wholesale electricity markets to meet efficiency and reliability objectives. Issues along the structure/operation axis are primarily related to the convergence of market structure and harmonization of market rules and business practices.

**Figure 1**
**Seams Issues Analytical Framework**




To date, most efforts to identify and address seams issues have focused on structure/operation seams issues, while detailed analysis of configuration/transition issues has been reserved for a broader discussion around the evolution of regional markets. This analytical framework is designed to stimulate a balanced debate between strategic or "evolution"-oriented issues (i.e., those along the configuration/transition continuum) and tactical or "snapshot"-oriented issues (i.e., those along the structure/operation continuum). It is also designed to help distinguish between seams issues which

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This paper is based on the authors' earlier paper – entitled "North American Electricity Markets: Coming Together at the Seams?" – prepared for the 24th Annual International Conference of the International Association for Energy Economics and published in the conference proceedings. The original IAEE paper has been modified to address recent developments in the move toward seamless energy markets in North America. Some concepts and material were drawn from related articles published in *The Electricity Journal*.

See footnotes at end of text.

require different types of policy responses in terms of scope and scale, objectives, players, roles, instruments, and activities. While this analytical framework brings some needed structure to support rigorous policy analysis, it should be noted that seams issues are interrelated and may not fall wholly along a particular axis or within a particular category. The value of this framework resides in its usefulness as a tool to add structure to the policy debate on seams issues by identifying relevant analytical dimensions and links. Below we use this framework to discuss eight prominent types of seams issues, four along each axis. The analysis and policy review rely heavily on FERC's Order No. 2000, related RTO compliance filings, and subsequent FERC orders.

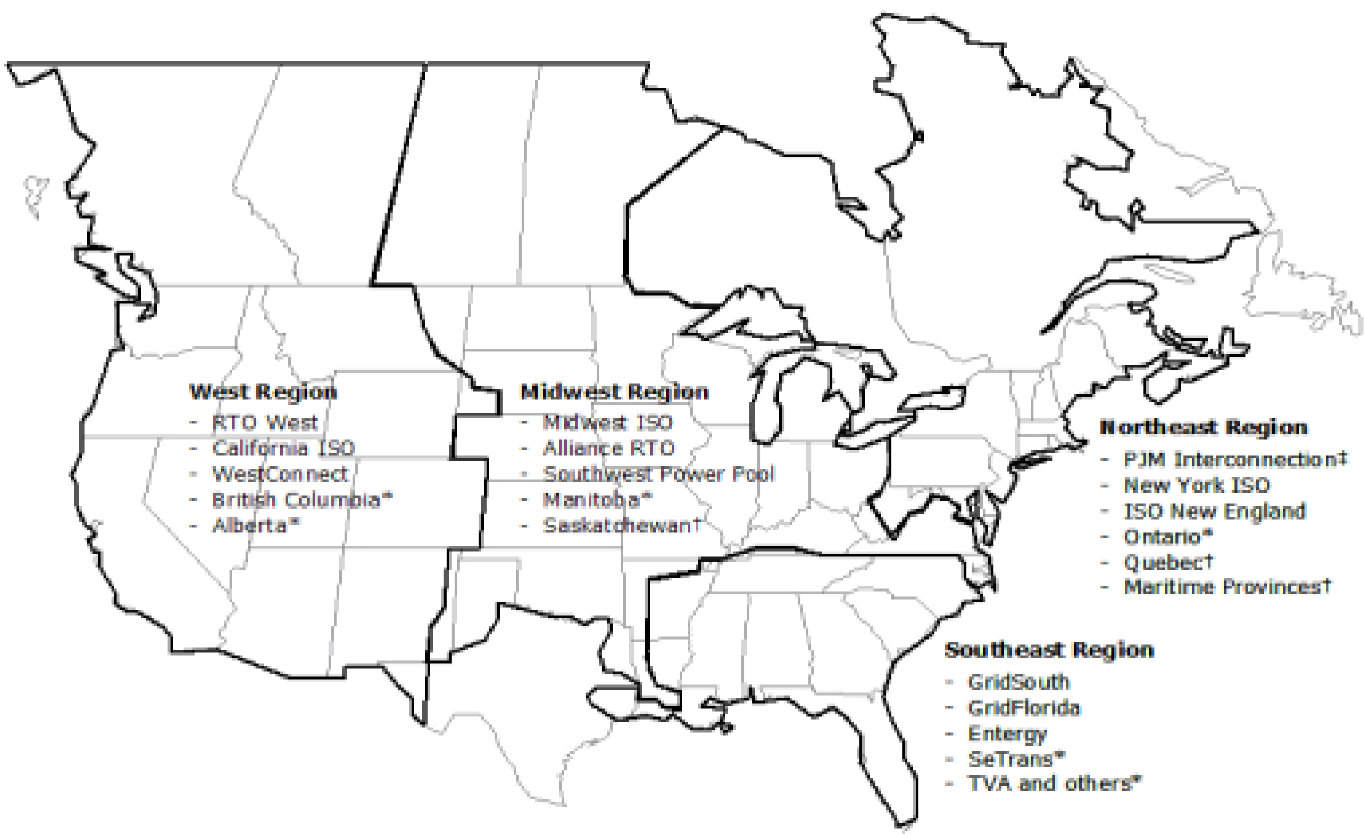
**Configuration/Transition Issues**

Issues along the configuration/transition axis are concerned with the number and location of seams and the process through which seams will likely change over time. Configuration decisions (e.g., where regional market boundaries should be drawn) will determine which seams are internalized into a single region and which seams issues will have to be resolved among neighboring RTOs. A loosely coordinated transition toward RTOs may result in more seams issues and a larger adverse effect on interregional trade. Anticipating and addressing issues will likely result in a smoother transition. Major categories of seams issues along this axis include scope and regional configuration, jurisdiction and governance, super-regional functions, and transition program.

In Order No. 2000, FERC did not prescribe initial boundaries for RTOs, leaving much of this critical *scope and regional configuration* decision up to transmission owners, market participants, and other industry stakeholders. This mode of decision-making contributed to a patchy and disconnected set of 12-15 relatively small proposed RTOs.[7] The number of RTOs is positively correlated with the number of seams and, quite likely, with the number of related seams issues. A lack of early FERC guidance likely increased the time necessary to obtain final RTO approval, as compliance filings were rejected because of inappropriate initial scope and regional configuration. Certain public utilities chose to take advantage of the voluntary nature of the RTO process and defer participation, leaving gaps in the RTO topography and creating seams issues that will be difficult to remedy through interregional coordination initiatives. Since July 2001, FERC has pressed for the development of four large RTOs across North America, one for each of the West, Midwest, Northeast, and Southeast regions.[8] This preference has been further refined through stakeholder consultation and subsequent orders.[9] (Refer to Figure 2 for an overview of potential regional electricity markets in North America and the RTO candidates they would likely encompass).

*(continued on page 16)*

**Figure 2**
**Potential Electricity Markets & Regional Transmission Organizations (RTOs)**




Source: Complied by the authors from various sources, including RTO compliance filings, public Web sites, FERC orders and market reports.
* Entities have expressed an interest in becoming a participant and/or participated in significant proceedings.
† Entities may be eligible to become a participant based on RTO scope and regional configuration criteria.
‡ Includes PJM West.

**Together at the Seams?** *(continued from page 15)*

With Order No. 2000, FERC encouraged Canadian and Mexican entities as well as U.S. public power entities and cooperatives outside its jurisdiction to participate in RTOs. It also required that RTOs perform functions that interface with state regulators' responsibilities. More recently, FERC's efforts to consolidate RTO candidates – i.e., particularly in the Northeast and Southeast – have experienced governance obstacles. Together, these elements represent *jurisdiction and governance* issues to participation in RTOs. International entities face sovereignty and regulatory challenges in order to participate.[10] Likewise, jurisdictional issues will make it difficult for important public power entities such as Tennessee Valley Authority (TVA) and Bonneville Power Administration (BPA) to participate. Uncertainty surrounding the allocation of authority and working relationships between RTOs and state regulators may also hamper the development of RTO capabilities, particularly in the area of transmission planning and expansion. Finally, differences of opinion on questions of governance (e.g., composition of the RTO's board of directors and role of the for-profit transmission companies) could lead to delays or outright failure of the RTO to be formed. If left unresolved, these jurisdiction and governance issues may adversely affect the overall transition to such an extent that few benefits of large regional markets and RTOs are realized.

In Order No. 2000, FERC did not require each RTO to perform all of the minimum functions directly. In some cases, RTOs may satisfy functional requirements by coordinating to jointly perform *super-regional functions*. Such arrangements may be justified in terms of minimum efficient scope and/or scale (e.g., market monitoring) or consistent application of business practices across regions (e.g., transmission planning and expansion). If development and implementation efforts for these functions are not coordinated, they may fail to meet RTO requirements. Alternatively, each RTO may not invest enough time and resources because of a lack of incentive to carry the effort. Questions also remain about whether super-regional functions will actually lead to duplication of effort and resource allocation and whether they are appropriate for larger, more complex functions. If super-regional functions are pursued as part of the RTO development strategy but fail to be implemented for the reasons provided above, the transition program will ultimately suffer and some RTO benefits will likely be lost.

The *transition program* refers to the RTO implementation timeline and potential challenges arising from the "open architecture" provision of Order No. 2000. FERC outlined an aggressive implementation timeline, requiring public utilities to make compliance filings by late-2000 or early-2001 and RTOs to be operational by December 15, 2001. This implementation timeline proved to be overly optimistic, especially for RTO candidates not emerging from an existing FERC-approved ISO.[11] FERC has since indicated that December 15, 2001 is now the date by which all jurisdictional entities should identify the RTO candidate they plan to join.[12] In Order No. 2000, FERC also allowed a staggered implementation timeline for certain functions.[13] Such an approach may lead to greater coordination challenges if neighboring RTOs move ahead with these functions at different rates. Finally, the open architecture provision gives RTOs the flexibility – subject to FERC approval – to improve their organizations in terms of structure, geographic scope, and market offerings. This provision is intended to ensure that RTOs do not preclude natural and reasonable evolution; however, vagueness around its interpretation and potential uses may result in seams issues. Taken together, these issues cast uncertainty on the transition program.

**Structure/Operation Issues**

Issues along the structure/operation axis represent perhaps the most obvious examples of seams problems and generally lead to increased transaction costs and reliability challenges. In contrast to configuration/transition issues, seams issues on this axis are generally related to specific market characteristics or business practices. Major categories include market design and structure, market operations, power system operations, and market facilitation.

Each wholesale electricity market developed to date possesses a unique *market design and structure*. The resulting regional differences tend to increase transaction costs and may create problems related to power system reliability. One

**Table 1**
**Select Northeast Market Design Attributes**

| | ISO New England† | New York ISO | PJM Interconnection | Ontario IMO* |
|---|---|---|---|---|
| Day-Ahead Energy | N/A | Auction | Auction | N/A |
| Real-Time Energy | Auction | Auction | Auction | Auction |
| Regulation | Auction | Auction | Auction | Procurement |
| 10-Minute Spinning Reserve | Auction | Auction | Procurement | Auction |
| 10-Minute Non-Spinning Reserve | Auction | Auction | Procurement | Auction |
| 30-Minute Operating Reserve | Auction | Auction | Procurement | Auction |
| Installed Capacity‡ | Deficiency | Auction | Auction | N/A |
| Congestion Management | Uplift | Full LMP | Full LMP | Partial LMP |
| Transmission Rights | Right/Obligation | Right/Obligation | Right/Obligation | Option |

† Capabilities to support day-ahead energy market, locational marginal pricing (LMP), and financial congestion rights (FCRs) are under development.
* Scheduled to become operational in May 2002; information reflects structure planned for market commencement.
‡ Product definitions for installed capacity vary widely between markets.

of the underlying assumptions of efficient wholesale electricity markets is that price differences between regional markets are removed by participants transacting across regions. Unfortunately, misalignment between products, services, and business practices has resulted in high transaction costs, inefficient use of operating reserves, reliability events, and unnecessary price volatility.[14] Specific problems related to divergent business practices are addressed in the sections below. To illustrate some of the more obvious differences in market design, Table 1 provides a comparison of select market design attributes of wholesale electricity markets in the Northeast.

The overall set of electricity trading arrangements and market rules (i.e., permitted market participants and modes of transacting) can also exacerbate seams issues. Structural rigidities and overly restrictive market rules can lead to efficiency and reliability problems to the extent that they constrain interregional trade and delivery.

Differences in *market operations* business practices (e.g., transaction management, market clearing, financial risk management, settlement and billing, and market information) continue to exacerbate the negative impacts of seams issues. In Order No. 2000, FERC required RTOs to operate an imbalance energy market and encouraged them to adopt market-based mechanisms for congestion management and the provision of ancillary services. In recent months, FERC has sent mixed signals as to whether the RTO should operate additional markets (e.g., day-ahead energy and/or installed capacity). Aside from this high-level guidance, RTOs retain significant latitude to develop and implement market operations business practices that are inconsistent or incompatible between regions. For example, one need only compare prevailing timelines and procedures governing transaction management and settlement and billing in existing wholesale electricity markets to demonstrate this point. Additional evidence to this effect illustrates how market operations business practices may diverge and how efficiency and reliability benefits may be eroded as a result.[15] Considerable disagreement remains as to the appropriate business practices for several of the major market operations areas.[16]

Similarly, differences in *power system operations* business practices (e.g., forecasting and availability, transmission services, ancillary services, scheduling and dispatching, security and reliability, and metering and measurement) also present obstacles to the elimination of seams issues across regional markets. In Order No. 2000, FERC outlined several RTO requirements in this area but did not address preferred business practices or procedures. Even within the reliability guidelines established by the North American Electric Reliability Council (NERC) and regional transmission groups, RTOs may develop and implement divergent power system operations business practices. For example, one need only examine differences in the calculation and application of total transmission capability (TTC) and available transmission capability (ATC) in existing wholesale electricity markets to demonstrate this point. As with the market operations business practices discussed above, much additional evidence points to divergent power system operations business practices, losses of efficiency and reliability benefits, and disagreement as to the most appropriate business practices.

Finally, divergent business practices in *market facilitation* (e.g., tariff design and administration, market monitoring, market development, transmission planning and expansion, interregional coordination, dispute resolution, and market governance) also contribute to seams issues, albeit to a lesser extent. In Order No. 2000, FERC indicated that RTOs should play a role in designing and administering its own open-access transmission tariff, monitoring and developing its markets, enhancing the power system, and coordinating with neighboring RTOs. Based on experience with existing electricity markets, one can also postulate that RTOs will also require some capabilities to provide customer services such as dispute resolution and ongoing market governance.[17] Some progress has been made to develop consistent and compatible business practices in these areas, but a substantial amount of work remains to resolve existing and potential seams issues. Of particular concern are business practices related to transmission planning and expansion, tariff design and administration, and market monitoring because of their relative importance in supporting market operations.

## Policy Responses

To the extent practicable, policy responses for seams issues should leverage the work and expertise of existing regional coordination efforts and groups. This will require coordination among several entities, including FERC, RTO candidates, market participants, energy industry standards authorities, federal departments, state regulators, relevant Canadian and Mexican entities, and other industry stakeholders. The discussion below covers objectives, key players, policy instruments, and execution for each major category of seams issue.

### Configuration/Transition Issues

Configuration/transition seams issues generally require policy responses involving coordination at the highest levels, broad stakeholder participation, and a "front-loaded" effort. In most cases, the appropriate policy response will require contributions by FERC, RTO candidates, state regulators, relevant Canadian and Mexican entities, market participants, energy industry standards authorities, and other industry stakeholder groups.

The most pressing *scope and regional configuration* seams issues include the size and shape of desired regional wholesale electricity markets and respective RTOs, the manner in which FERC evaluates each RTO candidate to determine appropriateness, and the extent to which promised efforts to resolve seams issues are acceptable as substitutes for appropriate scope and regional configuration. These issues are best addressed by representatives from FERC, RTO candidates, state regulators, market participants, and Canadian and Mexican entities, with input from energy industry standards authorities and other industry stakeholder groups. In the July 12th Orders and subsequent issuances, FERC took an important step in this area by outlining its preference for one RTO in each of the West, Midwest, Northeast, and Southeast regions. It remains to be seen whether FERC will maintain this policy direction, especially for the Western and Southeastern regions which have expressed perhaps the greatest level of discontent.[18] FERC should also continue to involve state regulators in discussions on appropriate RTO scope and regional configuration and

*(continued on page 18)*

**Together at the Seams?** *(continued from page 17)*

take steps to analyze the technical feasibility of implementing large-scale RTOs.[19]

The policy response for *jurisdiction and governance* issues should be tailored to meet the coordination, agreement, and participation needs of international, public power and cooperative (i.e., non-jurisdictional), and state entities. RTOs with international members will require clarification on shared jurisdiction between two or more regulators and contractual and other agreements to facilitate cross-border participation. FERC should work with regulators and other authorities in Canada and Mexico to expedite negotiation of the necessary legal and regulatory agreements.[20]

FERC should also work with federal and state agencies to help remove legal and regulatory obstacles and press for enabling legislation where necessary. Finally, state entities and RTOs should continue to seek agreement on shared responsibilities, with support from FERC and energy industry standards authorities.

With respect to *super-regional functions*, FERC could sponsor a technical conference to address the costs, benefits, risks, and feasibility of pursuing super-regional functions for ancillary services, market monitoring, transmission services, and other relevant functions. Considering the potential impact of these issues on RTO evolution, FERC should act quickly to help ensure that any findings may be included in regional market designs and RTO implementation efforts. FERC could also provide detailed guidance on any super-regional functions that are included in RTO candidates' compliance filings so that others may benefit from their insight.[21]

With respect to the *transition program*, FERC should provide clear guidance on new RTO implementation deadline(s), along with contingency plans and consequences of not meeting the new deadline(s). Second, FERC and energy industry standards authorities should provide ongoing monitoring, assessment and reporting on the potential impacts of staggered implementation timelines – i.e., for market-based congestion management (one year) and both parallel path flow and planning and expansion (three years) – and coordinate efforts to overcome common implementation challenges. Finally, with respect to open architecture, FERC should provide ongoing monitoring and assessment of the potential impact of open architecture on market certainty and confidence.

### Structure/Operation Issues

FERC provided the primary policy response for structure/operation seams issues by including interregional coordination as a minimum RTO function. Working groups established by RTO candidates, market participants, and energy industry standards authorities have already started to identify and address seams issues and will likely evolve into the interregional coordination mechanisms required by Order No. 2000. However, despite substantial effort devoted to address structure/operation seams issues, little progress has been made to implement necessary market enhancements. In most cases, making the desired changes will require a focused effort by FERC, RTO candidates, energy industry standards authorities, market participants, state regulators, relevant Canadian and Mexican entities, and other industry stakeholder groups.

Resolving *market design and structure*, *market operations*, and *power system operations* will continue to involve a balancing act, requiring contributions from FERC, RTO candidates, market participants, energy industry standards authorities, state regulators, and other industry stakeholders. To address market design and structure seams issues, FERC should continue to work with energy industry representatives to develop guidelines for a standard market design based on best practices.[22] To address market operations and power system operations seams issues, FERC should also work with the U.S. Department of Energy to encourage the creation of a North American energy industry standards authority and define its role in this area. The North American Electric Reliability Council (NERC) continues to provide guidance in these areas and has recently expressed an interest in expanding its current role – as has the Gas Industry Standards Board (GISB) – to serve in the capacity of an energy industry standards authority.[23] If properly designed and implemented, such an organization would likely provide the most appropriate avenue to collect input from and build consensus among key industry stakeholders to resolve seams issues in these areas.

Policy responses for *market facilitation* – encompassing both regional development and customer services areas of RTO operations – will likely require contributions from FERC, state entities, RTO candidates, market participants, energy industry standards authorities, and a variety of industry stakeholder groups. High-level policy questions – perhaps leading to legislation – may be addressed by the U.S. Department of Energy's Electricity Advisory Board.[24] To address transmission planning and expansion seams issues, FERC should continue to work with state regulators to define the allocation of responsibilities between state regulatory commissions and RTOs.[25] To address seams issues related to interregional coordination and ongoing market governance, FERC should require that RTOs file agreements and plans on how they will participate in working groups and provide estimates of time and resources required to resolve outstanding seams issues in these areas. Finally, to address market monitoring and tariff design and administration issues, FERC should provide guidance through a revised *pro forma* open-access transmission tariff (OATT) that is based on the upcoming standard market design rulemaking.

## Conclusions

The purpose of this paper was to assess whether North American electricity markets are converging toward a seamless electricity trading and transmission environment – i.e., whether these markets are still "coming together at the seams" – and to stimulate a policy discussion on what should be done to facilitate the transition. To do this, we defined seams issues as *impediments to interregional trade in and delivery of electricity and related products and services which result in economic inefficiency and/or a threat to reliability.* We then proposed an analytical framework comprised of two axes – configuration/transition and structure/operation – and applied it to eight categories of seams issues. Along the configuration/transition axis, we examined scope and regional configuration, jurisdiction and governance, super-regional functions, and transition program. Along the structure/operation axis, we examined market design and structure, market operations, power system operations, and market facilitation. We then reviewed current policy efforts and suggested additional responses to help facilitate the transition. Our analysis and review drew on current activities in the ongoing transition toward RTOs encouraged by FERC's Order No. 2000 and related issuances.

Seams issues are the bane of electricity markets and the situation will likely worsen before it improves. It is widely acknowledged that these issues threaten efficiency and reliability, the objectives of most industry restructuring programs and wholesale electricity markets. Not surprisingly, the focus of most analysis performed to date has been biased toward tactical issues, along what we have labeled the structure/operation axis. Relatively little work has been done to address the long-term configuration/transition challenges whose impact on the industry in coming years will be less obvious but probably more profound. FERC's RTO initiative presents us with an opportunity to re-focus analysis and debate to develop a more balanced view of the transition toward regional markets, one that explicitly acknowledges interrelationships between configuration/transition issues and structure/operation issues. Our analysis indicates that seams issues along the configuration/transition axis represent a significant threat to long-term convergence and the evolution of regional markets into a seamless environment. Seams issues along the structure/operation axis, while no less menacing, are better understood and may be more easily addressed.

So, are North American electricity markets still coming together at the seams? Much has been done to identify and address seams issues in the past few years. However, the remaining work to address issues along both axes is significant. In some regions RTO candidates have already taken steps toward implementing the interregional coordination function. In other regions, questions remain about various types of seams issues, from scope and regional configuration to market operations. There can be little doubt that initiating the transition toward larger regional markets and greater participation is a positive and necessary first step. But it is merely the first step in a journey. FERC, RTO candidates, energy industry standards authorities, market participants, and other industry stakeholders must take a more active role in defining the policy responses to issues raised here. Several of the required policy instruments are available, but relevant players have been slow to take up the charge. So far the response has been moderate but encouraging; from FERC's clarification of its preferred scope and regional configuration to industry stakeholders' call for increased discussion on seams issues. Our primary concern is that the coming years of frenzied RTO formation will exacerbate the seams problem to such an extent that the overall transition program will suffer. Nevertheless, based on current evidence and despite some misgivings, we believe markets are converging toward a seamless environment and we remain cautiously optimistic that it will be achieved within the next few years.

**Footnotes**

[1] For example, the mid-Atlantic region (PJM), California, the New England region, and New York in the United States and Alberta in Canada have all established bid/offer- or auction-based wholesale electricity markets within the past five years.

[2] Refer to Federal Energy Regulatory Commission (FERC), Investigation of Bulk Power Markets – Northeast Region, Washington, DC, November 1, 2000 (available at www.ferc.gov/electric/bulkpower/).

[3] FERC, *Regional Transmission Organizations, Order No. 2000*, Docket No. RM99-2-000, Washington, DC, December 20, 1999 (available at www.ferc.gov/electric/rto/post_rto.htm). With Order No. 2000, FERC encouraged electric utilities and independent system operators (ISOs) under its jurisdiction to participate in an approved regional transmission organization (RTO). This order outlined four minimum RTO characteristics – i.e., independence, scope and regional configuration, operational authority, and short-term reliability – and eight minimum RTO functions – i.e., tariff administration and design, congestion management, parallel path flow, ancillary services, open-access transmission administration, market monitoring, planning and expansion, and interregional coordination. It also specified guidelines for open architecture, ratemaking, and filing and implementation timelines.

[4] *Supra* notes 2 and 3.

[5] North American Electric Reliability Council (NERC), *2001 Summer Assessment: Reliability of the Bulk Electricity Supply in North America*, Princeton, NJ, May 2001 and *Reliability Assessment 2001-2010: The Reliability of Bulk Electric Systems in North America*, Princeton, NJ, October 16, 2001 (both available at www.nerc.com/~filez/rasreports.html).

[6] See, for example, Richard Stavros, "Transmission 2000: Can ISOs Iron Out the Seams?" *Public Utilities Fortnightly*, May 1, 2000, pp. 24-33, ISO Memorandum of Understanding (MOU) Business Practices Working Group, *Draft Seams Issues Matrix*, January 4, 2001 (available at www.isomou.com/working_groups/business_practices/documents/general/), and FERC, *In the Matter of RTO Interregional Coordination*, Docket No. PL01-5-000, Washington, DC, June 19, 2001 (available at www.ferc.gov/electric/rto/post_rto.htm).

[7] For example, entities in California, New York and Florida filed to seek approval for single-state RTOs, entities in New England and the mid-Atlantic sought approval for RTOs which represented current or slightly expanded geographic market regions, and entities in the Carolinas and the Southeast sought approval for RTOs with relatively small geographic footprints.

[8] Together commonly referred to as the "July 12th Orders" (available at www.ferc.gov/electric/rto/post_rto.htm).

[9] For example, FERC's RTO Week held in Washington, DC (October 15-19, 2001), the establishment of state-federal regional panels to consider RTO issues (November 9, 2001), and orders related to the emergence of a single Midwest RTO (December 20, 2001). Details on these items are available at www.ferc.gov/electric/rto/post_rto.htm.

[10] *Supra* note 3.

[11] Efforts to develop and implement comparable power system and market operation infrastructure for the mid-Atlantic region (PJM Interconnection), California (California ISO and California Power Exchange), the New England region (ISO New England), and New York (New York ISO) have spanned several years. At the time of writing, only a few candidate RTOs had obtained FERC approval and were ready to initiate operations.

[12] FERC, *Order Providing Guidance on Continued Processing of RTO Filings*, Docket No. RM01-12-000, Washington, DC, November 7, 2001 (available at www.ferc.gov/electric/rto/post_rto.htm).

[13] *Supra* note 3. The original implementation deadline for a market-based congestion management was December 15, 2002 while the deadline for a functional parallel path flow regime and planning and expansion capabilities was December 15, 2004. These deadlines will presumably be updated (deferred) based on the new

*(continued on page 20)*

**Together at the Seams?** *(continued from page 19)*

target RTO operational date.

[14] For example, FERC has indicated "…[t]he lack of 'universal' products in the northeast as well as the lack of harmonized or standardized procedures for buying and selling power across the region is a loss to the efficient functioning of the market," *supra* note 2 at 85.

[15] *Supra* notes 2 and 3.

[16] For example, refer to FERC, *Administrative Law Judge Mediator's Report to the Commission*, Docket No. RT01-99-000, Washington, DC, September 17, 2001 and *Business Plan for the Development and Implementation of a Single Regional Transmission Organization for the Northeastern United States* (available at www.ferc.gov/electric/rto/post_rto.htm).

[17] Note that "ongoing market governance" here refers to the process through which decisions are made by the RTO and its constituents on a regular basis. In contrast, "governance" in the Jurisdiction & Governance section above refers to the nature and characteristics of the RTO's organizational components and formal decision-making structures.

[18] See, for example, FERC, *Mediation Report for the Southeast RTO*, Docket No. RT01-100-000, Washington, DC, September 10, 2001 (available at www.ferc.gov/electric/rto/post_rto.htm).

[19] On state regulator involvement and the need for an analysis of technical feasibility, refer to FERC, *Order Announcing the Establishment of State-Federal Regional Panels to Discuss RTO Issues, Modifying the Application of Rule 2201 in the Captioned Documents, and Clarifying Order No. 607*, Docket Nos. RT02-2-000 *et al.*, Washington, DC, November 9, 2001 and *supra* note 16, respectively (both available at www.ferc.gov/electric/rto/post_rto.htm).

[20] At the time of writing, provincial entities in British Columbia, Alberta, Manitoba, and Ontario have expressed an interest in participating in a candidate RTO and/or participated in significant proceeding while Mexican entities have been less involved in the proceedings. For examples of progress in this area, refer to proposed arrangements by British Columbia and Alberta to enable Canadian entities to participate in RTO West (available at www.rtowest.org) and the recent Coordination Agreement between the Midwest ISO and Manitoba Hydro (available at www.midwestiso.org).

[21] For an example related to coordinated market monitoring in the Midwest region, refer to FERC, *Order Granting RTO Status and Accepting Supplemental Filings*, Docket No. RT01-87-000 *et al.*, Washington, DC, December 20, 2001, pp. 31-36.

[22] For background, refer to FERC, *Electricity Market Design and Structure: Staff Summary of Discussions*, Docket No. RM01-12-000, Washington, DC, October 22, 2001 and FERC, *Concept Discussion Paper for an Electric Industry Transmission and Market Rule*, Washington, DC, December 17, 2001 (both available at www.ferc.gov/electric/rto/post_rto.htm). Additional guidance should be provided in a FERC Notice of Proposed Rulemaking (NOPR) scheduled for issuance in January 2002.

[23] For details on each organization's proposal, refer to NERC, *Proposal for NERC to Develop and Operate the Wholesale Electric Standards Model (WESM)*, Princeton, NJ, December 4, 2001 (available at www.nerc.com) and GISB, *Strawman 2: In Consideration of An Energy Industry Standards Board*, Houston, TX, February 19, 2001 (available at www.gisb.org).

[24] Refer to announcement at www.energy.gov/HQPress/releases01/decpr/pr01205.htm.

[25] FERC's establishment of State-Federal Regional Panels to Discuss RTO Issues should facilitate this dialog (refer to note 19 above). Refer also to FERC, *Letter Inviting State Commissioners' Views on RTOs in the Northeast*, Docket Nos. RT01-2-001 *et al.*, Washington, DC, December 10, 2001 (available at www.ferc.gov/electric/rto/post_rto.htm).

# Restructuring and Dynamics of Competition in Mexico's Natural Gas Industry: An Evaluation Using the Competitive Forces Approach

*By Alberto Elizalde Baltierra**

## Introduction

With the intent of moving towards a more efficient and competitive natural gas industry for the benefit of consumers, the process of restructuring started in Mexico in 1995. The May 1995 amendment to the Regulatory Law of Constitutional Article 27 on Petroleum opened the downstream activities (transportation, storage and distribution) to domestic and foreign private investments. Exploration and production of petroleum and gas continue to be exclusive prerogatives of *Petróleos Mexicanos* (Pemex), the national oil company, which also has considerable market power in gas transportation and sales. The October 1995 Law of the Energy Regulatory Commission (*Comisión Reguladora de Energía* or CRE) strengthened the CRE as an independent agency of the Energy Ministry and extended its jurisdiction to include natural gas. The Natural Gas Regulatory Law (*Reglamento de Gas Natural*) issued in November 1995 developed in detail the regulatory provisions needed to set the framework for the new operations of the Mexican natural gas sector. New issues are thus introduced: open access to pipelines and secondary capacity trading; unbundling of transportation, storage and gas purchase and sales activities; free trade in gas across international boundaries; price regulation based on incentives and a more flexible approach; and franchises for gas distribution. The March 1996 Directive contains the methodologies which must be used by regulated businesses when setting prices and rates in the natural gas industry. The activities regulated by this Directive include first-hand sales of natural gas by Pemex in Mexico, and the provision of natural gas transportation, storage and distribution services. In order to replicate a competitive market price, the formula for setting Pemex's first-hand sales linked the regulated price with that of the Houston Ship Channel. For transportation and distribution prices, the CRE has adopted a more traditional price cap methodology system that minimizes regulatory intervention and provides incentives to improve efficiency and throughput. In addition, the Natural Gas First-Hand Sales Directive issue from February 2000 establishes the criteria and guidelines that Pemex must observe when carrying out sales of domestic natural gas.

The dynamics of competition describe not only the various players in the market, but also the characteristics of the market itself and how those characteristics dictate the behavior of players in the market and their interactions with one another. How have the dynamics of competition in the Mexican natural gas value chain evolved since the beginning of the restructuring process in 1995? In order to examine this question, we propose a model based on the "Five Competitive Forces that Determine Industry Competition" (Porter, 1980).

## Methodology

We make use of the "five forces" model to study changes in the dynamics of competition after restructuring in the Mexican natural gas industry. According to this approach, the state or dynamics of competition in an industry depends on five basic forces: (1) the threat of new entrants, (2) the threat of substitute products or services, (3) the bargaining power of suppliers, (4) the bargaining power of buyers, and (5) the rivalry among the existing competitors. The five competitive forces determine industry profitability because they shape the prices firms can charge, the costs they have to bear, and the investment required to compete in the industry. Buyer power influences the prices that firms can charge, for example, as does the threat of substitution. The strength of each of these forces is a function of industry structure, or the underlying economic and technical characteristics of an industry, and can change as an industry involves. The threat of entry, for example, depends on the strength of barriers to entry, such as economies of scale and government policies. Industry structure is relatively stable, but can change over time as an industry evolves. Structural change can cause shifts in the overall and relative strength of the competitive forces, and can thus positively or negatively influence industry profitability. Firms, through their strategies, can also influence the five forces for better or for worse. According to Porter (1980), for purposes of analysis it is usually more illuminating to consider how government affects competition through the five competitive forces than to consider it as a force in and of itself.

Porter's approach is used in this work for three main reasons. First, it allows us to analyze simultaneously competition in three phases of the natural gas value chain (production, transportation and distribution). Second, as competition is being introduced for the first time in the Mexican natural gas industry, this model is more appropriate for our study because it examines extended competition (potential entrants, substitutes…) rather than just competition among existing rivals. Third, it is relatively easy to use and widely accepted.[1]

As the determinants of the five competitive forces change with time, the intensity of these forces also varies with time. We studied post-restructuring changes in the forces that drive Mexico's natural gas industry following the gas value chain (Figure 1). The participants involved in the Mexican gas market are shown in Figure 2. The major player in the market is Pemex. As part of the drive to streamline and make it more competitive, Pemex was reorganized in January 1992. Pemex assets, personnel, and financial resources are now divided between four subsidiaries or operating companies: Pemex Exploration and Production (PEP), Pemex Gas and Basic Petrochemicals (PGBP), Pemex Petrochemicals (PP) and Pemex Refining (PR).

## Results

For the three industry segments studied (production, transportation an distribution), the three most significant determinants of each competitive force were analyzed in detail. Table 1 shows the influence of these determinants on the competitive forces before and after restructuring. The detailed analysis of the influence of each determinant can be obtained from the full text of the paper (elizaalb@hotmail.com).

*(continued on page 22)*

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[1] See footnotes at end of text.

**Figure 1**
**Forces Driving Industry Competition in the Mexican Natural Gas Market.**
**(Based on Porter's "Five Forces" model)**

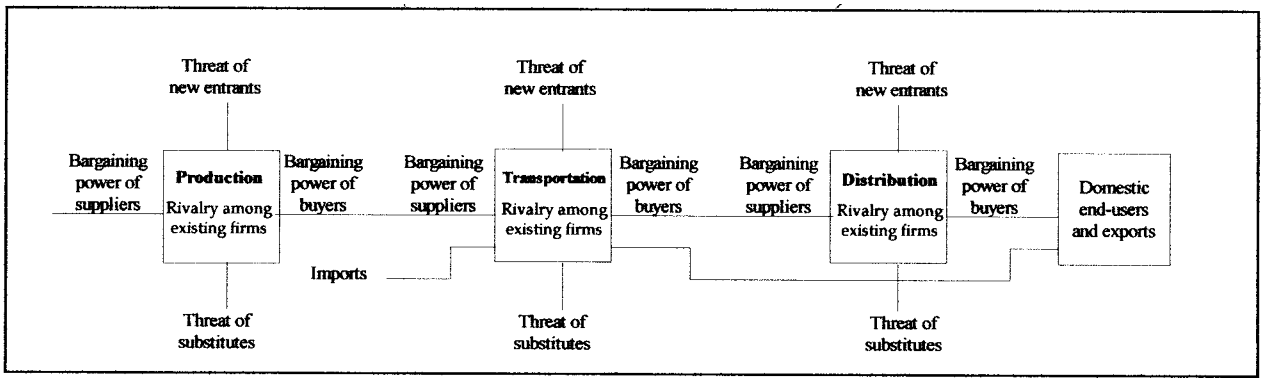
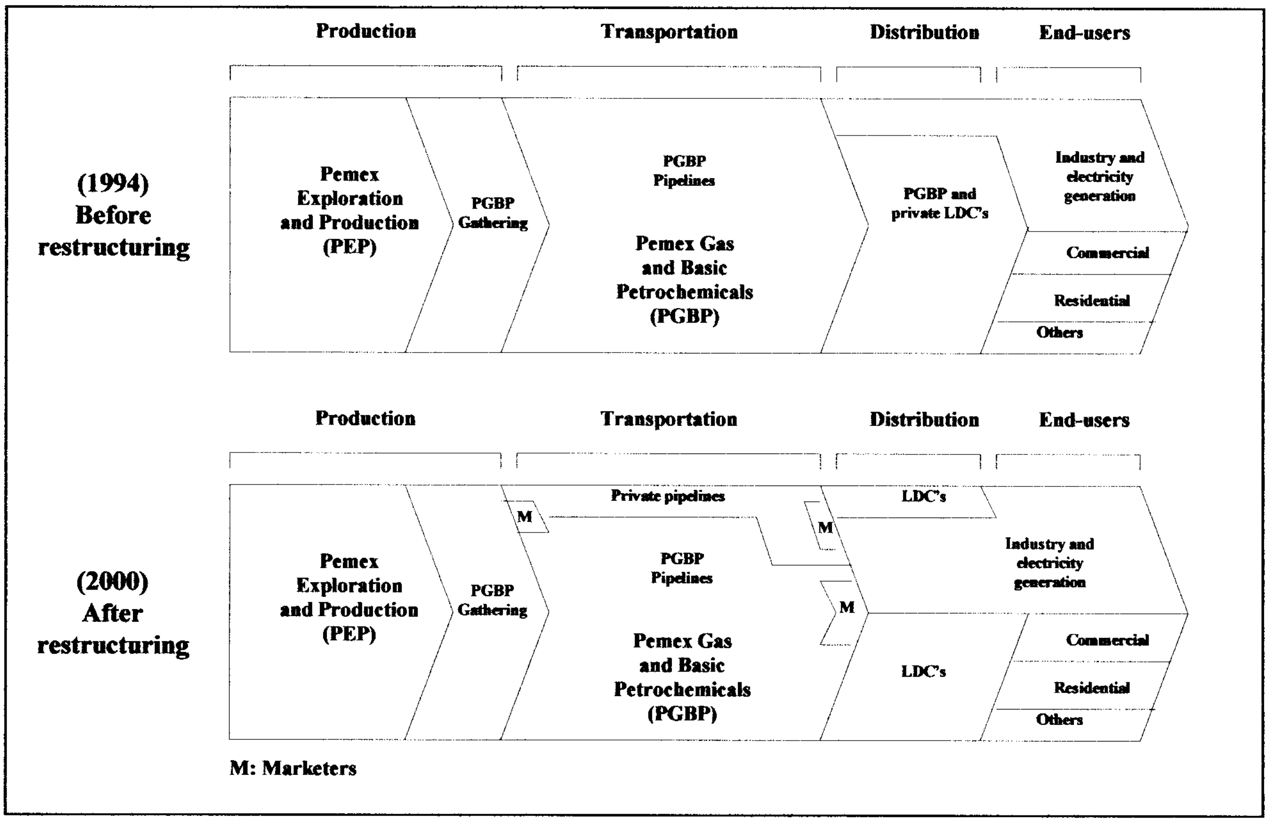



**Figure 2**
**Participants in the Mexican Natural Gas Value Chain.**




**Mexico's Natural Gas Industry** *(continued from page 21)*

**Conclusions**

We have analyzed changes occurring in the dynamics of competition in the Mexican natural gas value chain since the beginning of the restructuring process (1995). From this analysis we made using the "five forces" approach, some conclusions have been drawn.

- As shown in Table 1, the five forces have in general evolved towards a more competitive natural gas industry in those portions of the natural gas value chain that have been opened to competition through government policy.
- Rivalry among existing competitors has been the force experiencing the most change since the appearance of new competitors and expectations of high growth in the industry for the next 10 years. According to the Energy Ministry (SE, 2000), it is expected that domestic gas demand and production, respectively, will increase at 10 and 7 percent per year between 2000-2009. Imports of gas will be required to grow unless Pemex is able to expand natural gas production commensurate with demand. The threat of new entrants has radically increased in strength since 1995 regulations allowed new private firms to participate in midstream and downstream operations. Under recent environmental regulations encouraging gas use, the pressure from substitute products has decreased mostly in urban zones. For other regions, the current high natural gas prices create pressure from competing substitute fuels. A

**Table 1**
**Dynamics of Competition in Mexico's Natural Gas Industry:**
**Competitive Forces Before and After Restructuring.**

| Determinants of five forces | | Influence on competitive forces in the natural gas industry value chain* | | | | | |
|---|---|---|---|---|---|---|---|
| **Forces** | **Determinants** | **Production** | | **Transportation** | | **Distribution** | |
| | | **1994** | **2000** | **1994** | **2000** | **1994** | **2000** |
| **1. Rivalry among existing Competitors** | Number and diversity of competitors | - - - | - - - | - - - | + | - - | - |
| | Industry growth | + | + + + | + | + + + | + | + + + |
| | High fixed costs | + | + | + | + | + | + |
| **2. Threat of new entrants** | Capital requirements | - | - | - | - | - | - |
| | Economies of scale | - | - | - - - | - - - | - - - | - - - |
| | Government policy | - - - | - - - | - - - | + + + | - - - | + + |
| **3. Pressure from substitute products** | Relative price performance of substitutes | - - - | - - - | + | + + | + + | + + + |
| | Switching costs | - - - | - - - | - | - | - - | - - |
| | Government policy | - - - | - - - | - | - - - | - | - - - |
| **4. Bargaining power of suppliers** | Supplier concentration | - | - | - - - | - - | - - - | - |
| | Importance of inputs to the buyer's business | - | - | - | - | - | - |
| | Threat of forward integration | - | - | - - - | + | - - - | + |
| **5. Bargaining power of buyers** | Buyer concentration | - - | - | - - | - | + | + |
| | Price sensitivity/total costs | - - | - | - - | - | - - | - |
| | Threat of backward integration | - - - | - - - | - - - | + + | - - - | + |

* "+" means that the determinant strengthens the competitive force in question. "–" means that the determinant weakens the competitive force in question.

smaller supplier and buyer concentration has reduced its bargaining power, while the threat of forward and backward integration increases it.

- Transportation and distribution have been the segments experiencing most changes, as these segments and natural gas storage are the components of Mexico's natural gas system that were opened to private ownership and investment. For these sectors, all the competitive forces have changed. Gas production has remained the activity showing very low competitive forces even though it has a considerable profit potential. This is because the regulatory law of Article 27 of Mexico's constitution continues to protect Pemex as the only entity with the rights to explore for and produce natural gas (and petroleum) resources.
- For the future, the Mexican natural gas industry must still follow a long restructuring process if it wants to be a competitive industry. The most significant step to be taken will be, however, to allow new competitors in the production segment. We believe that the current changing times in Mexico are a propitious opportunity to make this decision. In making this crucial decision, the Mexican government, as the representative of Mexican people, will decide between continuing to give to the property of hydrocarbons a sovereignty and political cachet or to inject more economic sense. Another issue to be considered is the emergence of crucial innovations, like natural gas market centers and hubs that facilitate price discovery, transportation and ancillary services and, importantly, price risk management.[2] Whatever the decision, the future of the Mexican natural gas industry remains very exciting to study. Many industry analysis studies, such as this work, will be necessary to support decision makers.

**Acknowledgements**

This research has been supported in part by the corporate sponsors of the Energy Institute, Bauer College of Business, University of Houston; IFP and University of Paris-Dauphine; and TotalFinaElf.

**Footnotes**

[1] Its (relative) ease of application inspired numerous companies as well as business schools to adopt its use. A survey by the consulting firm Bain suggested a 25% usage rate in 1993 (Rigby, 1994 cited by Ghemawat et alii, 1999).

[2] From public comments submitted by Dr. Michelle Michot Foss on behalf of the Energy Institute to the Comisión Reguladora de Energía (CRE), January 31, 2001 (www.cre.gob.mx).

**References**

Contact the author.

## Green Certificates and Emission Permits in the Context of a Liberalised Electricity Market

*By Stine Grenaa Jensen**

### Introduction

In Denmark a comprehensive legislative restructuring of the electric power industry was completed in 1999 ("Elreformen", 1999). This Danish Electricity Act provides a fast schedule for liberalisation including a restructuring of the organisation of the Danish power sector.

As the power market is being liberalised, additional markets are introduced. This includes a framework for a separate green market for renewable electricity production. The main objective of introducing this type of market in Denmark is to secure the development of renewable energy technologies, including contributions to greenhouse gas reductions. Finally, a green market will enable these renewable technologies to be partially compensated for environmental benefits which they generate compared with conventional power production. According to Danish electricity reform a share of 20 percent of total electricity consumption has to be covered by the end of 2003. (See the burden sharing within the EU in COM(2000),2000)

Furthermore, to assist Denmark in complying with commitments under the Kyoto-protocol, tradable $CO_2$ permits are introduced in a bubble consisting of the power industry. The targets for $CO_2$ emission are set according to the agreed burden sharing within the EU, where Denmark has agreed to reduce emissions by 21% compared to an import adjusted 1990 emission level. (See the burden sharing in Boots et. al., 2000, page 20).

Increased use of renewably based power production will also lower thermal production on the power market and thereby decrease total emissions arising from power production. Therefore, besides ensuring a desired percentage of renewable energy, the green quota has the positive effect that a smaller percentage of power production emits green house gasses, thereby achieving the goals in the Kyoto agreement. The green quota will, therefore, to some extent, lower the emission level and consequently indirectly work as the emission quota.

Likewise, introduction of an emission quota would favour renewably based power, since it would increase the cost of thermally based power. As a result, renewably based power would become more competitive on the common power market and thereby lead to higher sustainability in power production.

Based on the Danish regulation set up, this paper analyses the equilibrium effects of introducing emission permits and green certificates as regulatory mechanisms, to reduce emissions and ensure a certain deployment of renewable energy, respectively. The analyses in this paper will be based on a small System Dynamics model and they will be theoretical only. Simulations will show the equilibrium effects of letting the planner use both the green quota and emission quota at the same time in order to reach the two goals. The quotas are thus the regulation instruments, whereas the certificates and permits are the means used by the market to fulfil the quotas.

### Tradable Green Certificates

The main idea of a market for green certificates is to ensure a politically planned deployment of renewable energy technologies, with the idea of a liberalised energy framework and maintaining low consumer prices. Compared with other methods of promoting development and deployment of renewable energy, green certificates deal with energy that is actually produced and not merely capacity that is available. Each time a green power producer sells electricity to the grid, he receives a corresponding number of green certificates. These certificates are financial assets and tradable. In addition to the physical power market, they can be sold in an organised, financial market established for green certificates thereby providing an additional payment to the producer for each unit of electricity generated. As a result of this, the price obtainable by the producer of the renewably based electricity will be the sum of the market based settling prices for physical electricity and the price of a green certificate.

The demand for green certificates is determined politically. It can be, for example, a purchase obligation on the production side like in Italy or on the consumer side as in Denmark. In any case, a desired share of renewable electricity can be obtained by setting the appropriate quantity of green certificates that will be issued. This quota is called the green quota. (see Morthorst, 1999, Schaeffer et. al., 1999 (1) and Schaeffer et. al., 1999 (2) for more information on the green certificate market.)

### Tradable Emission Permits

Another regulation instrument in the new Danish electricity reform is the tradable emission permit scheme. As part of the Danish Electricity Act, tradable $CO_2$ emission quotas have been introduced in the power sector. If the $CO_2$ quotas are violated a penalty of approximately 5,5[1] Euro per ton $CO_2$ emitted must be paid. If the fine is set too low producers will pay the fine rather than actually reduce emissions. Thereby the emission quota will have the effect of an emission tax. The target in Denmark is to reduce emissions by 21% compared to an import adjusted 1990 emission level.

Emission permits are issued based on the emission source and ignore the effect emissions may have on different receptor points. Permits issued to electricity generators allow them to emit up to a specified level of emission, with the total number of issued permits equal to the national limit on emissions. Generators that reduce emissions below their allowed level can sell excess emission permits, which can be purchased by other generators for whom it is more cost-effective to purchase permits at the prevailing market price than to reduce emissions.

In the Danish system, $CO_2$ emission permits are expected to co-exist with a green certificate market, thereby presenting an interaction between the two markets. But while tradable emissions permits will influence the emissions of greenhouse gases directly, the certificate market will only indirectly

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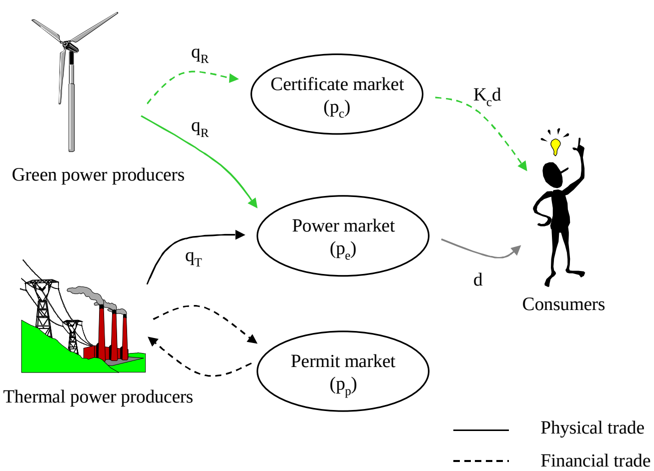
[1] See footnotes at end of text.

influence emissions. Counterwise the green certificate market will influence renewable electricity production directly, while the emission permit system affects it indirectly.

**Model Description**

The model used to carry out the analyses is a small System Dynamics model, which involves the market participants, illustrated in Figure 1. The renewable producer is acting on the power market and the green certificate market. The thermal producer is acting on the power market and the emission permit market. And finally the consumer is acting on both the power market and the green certificate market.

**Figure 1**
**Actors in the Different Markets.**




The consumer will purchase physical power on the power market and certificates on the certificate market. The green producers deliver certificates to the green certificate market corresponding to the amount of electricity produced, which is sold at the power market. The thermal producers likewise deliver physical power to the power market, but they are also obliged to obtain a number of emission permits corresponding to the amount of emissions accompanying their electricity production. These emission permits can be purchased in the permit market when there is a need for additional permits, and sold in the case of a permit surplus.

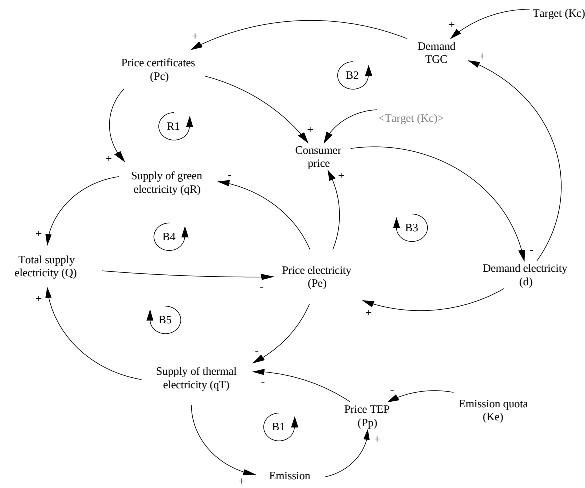
This leads to a model, where all three market participants deal on the power market and one additional market. These interconnections lead to an interaction between the different price determinations, and a change in market conditions on one market will thereby indirectly affect all three markets.

Figure 2 below shows the major feedback loops in the model, i.e., the connections between the three markets and their entrants. The figure provides an overview of the components in the model, incorporating equilibrium assumptions. In the diagrams, the arrow linking any two variables, x and y, indicates a causal relationship exists between x and y. The sign at the head of each arrow denotes the relationship between the two variables as follows:

$$x \xrightarrow{+} y \Rightarrow \partial y / \partial x > 0 \quad \text{and} \quad x \xrightarrow{-} y \Rightarrow \partial y / \partial x < 0$$

The description of the interconnections assumes that all other variables are constant. The description thereby illustrates the reaction pattern in the model, without saying anything about the final simulation results.

**Figure 2**
**Feedback Loops in the Model**




Loops connecting demand and supply exist through both of the supply functions. The balancing loop (B4) indicates that an increase in green production leads to a decrease in the power price, which again leads to a decrease in green power production. This case corresponds to the loop showing the thermal case. These loops illustrate the adjustment between the two suppliers of power in response to the power price, in order to bring total power supply in line with demand.

The balancing loop (B1) represents the market clearing mechanism in the emission permit system. An increase in supply leads to an increase in emissions, which yields an increase in the emission permit price. This way the supply level declines and production is balanced, leading to an equilibrium price for emission permits. Likewise the balancing loop (B2) illustrates the market clearing mechanism in the green certificate system and the equilibrium price on green certificates.

The market clearing mechanism loop in electricity price determination (B3) could by initialised by unfulfilled demand. Unfulfilled demand generates an increase in prices, which again leads to further production to fulfil the demand, and when this level is reached the price level returns to normal.

The only major reinforcing feedback loop (R1), in the model, is the one able to raise demand again and again. This is the loop showing the renewable producer's advantage, when the green quota is raised. When the supply of green electricity rises, the price of electricity decreases, the demand for electricity increases, and thereby the demand for certificates increases. This leads to an increase in the green certificate price and finally the supply of green electricity raises to a new level. This could generate a spiral, where the part of the market allocated to the green producers keeps rising, if no other effects follow to stop it.

**Model Assumptions**

This section describes some of the assumptions made in the model in order to carry though the simulations. The

*(continued on page 26)*

**Green Certificates and Emission Permits** *(continued from page 25)*

determination of demand is based on consumer elasticity[2] for electricity and the expected consumer power price. The elasticity is set to 0.01 and is, therefore, quite inelastic, according a smaller variation in demand than in price.

The price determinations of the green certificate price and the power price are found through the supply and demand differences in order to set equilibrium prices. An increase in price is caused by excess demand and likewise a decrease in price is caused by excess supply. This leads to an equilibrium situation in the long run, where demand equals supply at equilibrium price.

The green quota is set at 20 percent. No additional consumption of green certificates is allowed, i.e., demand for certificates has to equal one fifth of total consumption. The model omits both upper- and lower price-bounds of certificates.

The emission quota in the model is set subjectively at 9 million tonnes $CO_2$. This corresponds roughly to a decrease of 50 percent from the 1990 level in the Danish electricity industry. The price determination of emission permits is through the disparity of the actual emission level and the emission quota, which will lead to an equilibrium emission permit price.

### Simulation Experiments

Three different situations will be considered in order to illustrate the effect of either an emission quota or a green quota:

- Reaching an emission goal
  - Emission quota: 9 million tons $CO_2$
  - Green quota: NONE
- Reaching a green quota
  - Emission quota: NONE
  - Green quota: 20% renewable energy
- Comparison of co-operative versus non co-operative decisions
  - Non co-operative
    - Emission quota: 9 million tons $CO_2$
    - Green quota: 20% renewable energy
  - Co-operative
    - Emission quota: NONE
    - Green quota: 30% renewable energy

The first case shows the different effects of using an emission quota or a green quota in order to reach an emission goal. In the second case the goal is to get sustainable electricity production in the form of renewable produced electricity. The third and last case has the objective of illustrating the difficulties of using two instruments to reach two different goals without co-operation, when the instruments interact through the power market.

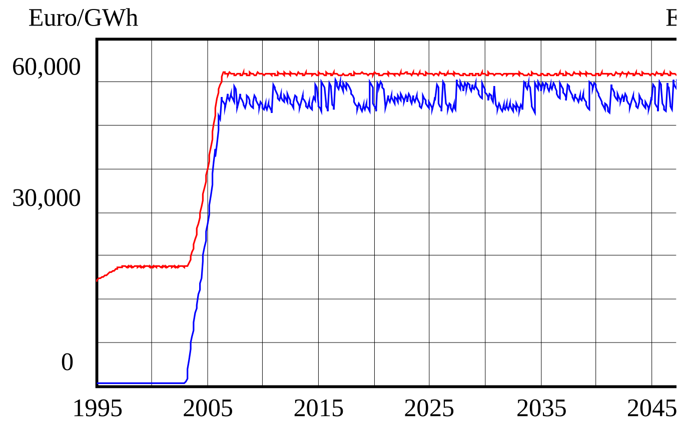
The simulations should show different implications, when introducing one or several mechanisms in order to reach different goals, with respect to the long run equilibrium case.

### Reaching an Emission Goal

The emission goal can be reached either by the use of an emission quota, a green quota or by a combination of both. One needs to regulate if the emission goal is lower than the amount of emission that occurs without regulation.

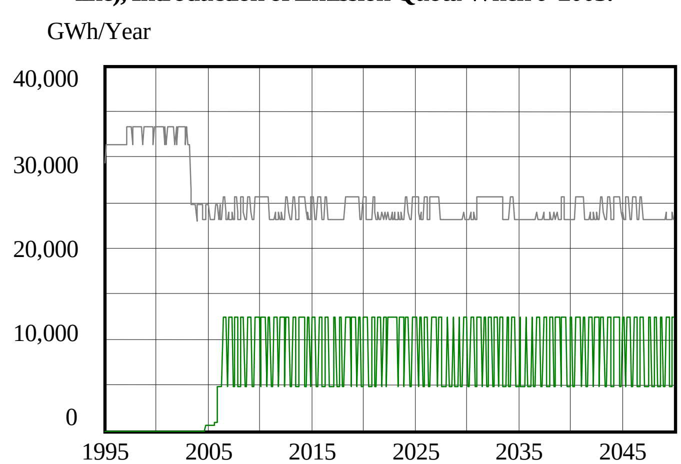
If the planner uses only the emission quota and not the green quota, the result will be a positive equilibrium price for emission permits at a level that illustrates the cost of reducing one unit of emission. The price of certificates will be zero, provided that there is no binding green quota (Figure 3).

**Figure 3**
**Power Price (top) and Emission Permit Price (bottom), Introduction of Emission Quota When t=2003.**



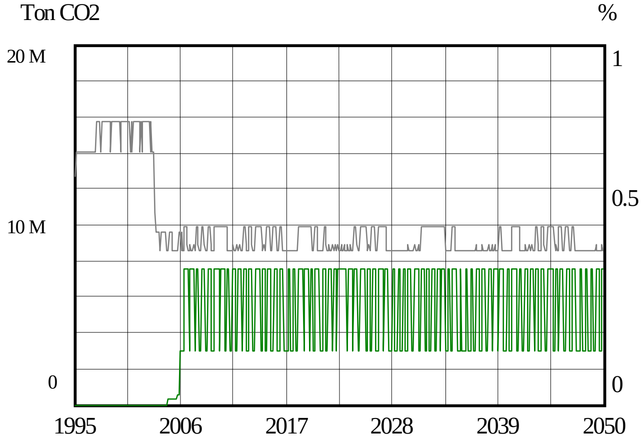

With an increase in the emission permit price and an increase in the electricity price, the producers of renewably based electricity will get better market conditions and the production of “green” electricity, therefore, increases; counterwise thermal production decreases resulting from the additional costs from the emission permits (Figure 4).

**Figure 4**
**Power Production (Thermal-top line and Renewable-bottom line), Introduction of Emission Quota When t=2003.**




The effect of the emission quota is, of course, seen on the actual emission level, which falls to the desired level of 9 million tonnes $CO_2$ on average over a year (upper line in Figure 5). At the same time the percentage of renewable produced electricity increases to 23 percent on average as a result of the power price effect following the introduction of the emission quota (lower line in Figure 5).

**Figure 5**
**Total Emission and Percentage of Renewable Electricity, with Introduction of Emission Quota When t=2003.**




At the same time the emission goal could be reached using the green quota, as the introduction of more renewably produced electricity would replace the thermal production, which leads to a decrease in emissions. It is, however, much more difficult to find the exact green quota in order to reach an exact level of emission, not knowing the direct effect caused by the price and demand change.

It is also possible to use both instruments in order to reach one desired emission goal. It is, however, difficult to use several mechanisms to reach one goal, when it is possible to use only one. The use of several instruments also requires an insight into the interaction between the two instruments as well as insight into the separate markets. The fact that the emission permit market, the green certificate market, and the power market are coupled has an important effect. This exact case will not be simulated in this paper, but the results are similar to the case of co-operative decisions. (See Jensen and Skytte, 2001 (2) for more detail on the interactions.)

### Reaching a Goal of Renewable Energy

In the following section the focus is on the green quota, and there are no direct considerations of emissions. This could correspond to the objective of developing sustainable electricity production. Like the emission goal, this goal can be reached either by the use of one of the markets separately or by a combination of both.

If the planner uses only the green quota to regulate, the green certificate price will reach a level that illustrates the value of a percentage of sustainable power production. The emission permit price will be non-existant. The power price has a negative correlation with the green certificate price, which is why the power price falls with introduction of a binding green quota (Figure 6). An example of an analytical model of the interaction between the power market and the green certificate market can be seen in Jensen and Skytte, 2001 (1) and Jensen and Skytte, 2001 (2).

With a decrease in the power price and a positive certificate price the producers of renewably based electricity will get improved market conditions and the production of "green" electricity, therefore, increases. At the same time the lower power price weakens thermal producers and, therefore, thermal production decreases (Figure 7).

**Figure 6**
**Power Price (bottom) and Green Certificate Price (top), Introduction of Green Quota When t=2003.**

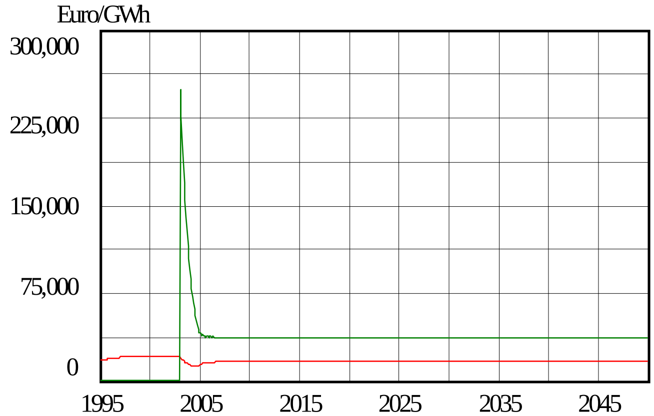
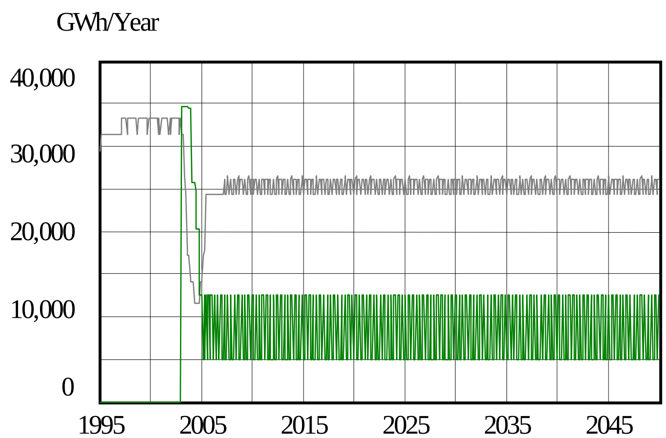



**Figure 7**
**Power Production (Thermal-top line and Renewable-bottom line), Introduction of Green Quota When t=2003.**




The effect of the green quota is seen directly on the percentage of renewable electricity production, which averages 20 percent a year (lower line in Figure 8). At the same time emissions decrease to a level just above 10 million tonnes $CO_2$ per year. It should be noted that a green quota of 20 percent is not enough to reach the desired level of emissions below 9 million tonnes $CO_2$ per year (lower line in Figure 5).

Of course, it is still possible to use the emission quota or both instruments in order to reach a desired renewable energy goal, with the same reflections as in the former case.

### Comparison of Co-operative Versus Non Co-operative Decisions

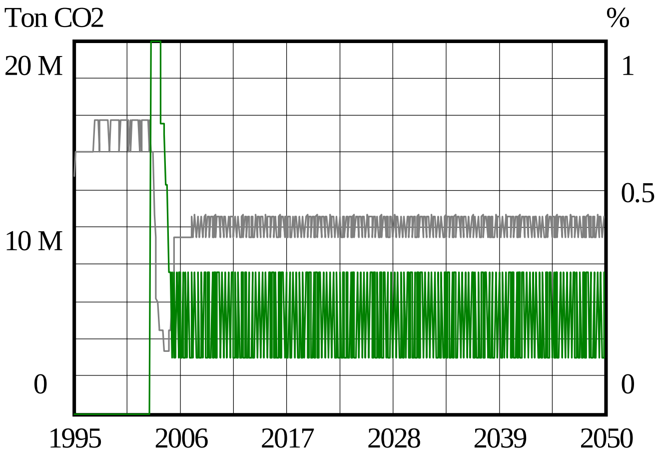
In this section two different scenarios will illustrate the difference between co-ordinating the decisions and trying to reach the goals without co-ordination. If the state has both an emissions goal and a renewable energy goal, with two different offices administrating one instrument each, we would get the case without co-ordination. The emissions quota and green quota will both be operating, and all three

*(continued on page 28)*

**Green Certificates and Emission Permits** *(continued from page 27)*

markets are then interacting.

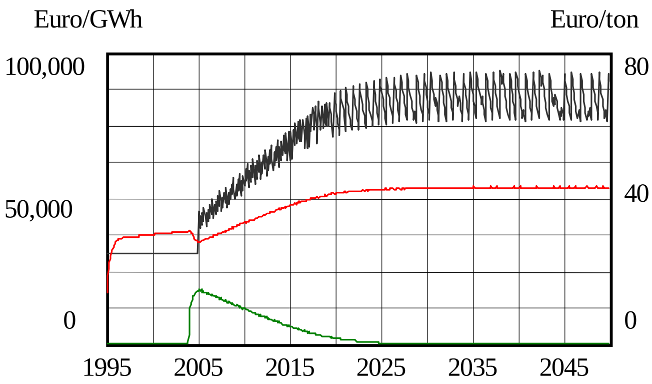
**Figure 8**
**Total Emission (top) and Percentage of Renewable Electricity (bottom), with Introduction of Green Quota When t=2003.**




Assume that one office determines an emission quota of 9 million tonnes of $CO_2$ in order to reach an emission goal. At the same time another office determines a green quota at 20 percent to reach a renewable electricity production. This case is the non co-operative situation illustrated in Figure 9 and partly in Figure 10. It is seen that the green quota is unnecessary to reach a deployment of renewable produced electricity, i.e., the equilibrium certificate price equals zero after a while, but the emission permit price remains positive (Figure 9). This could indicate that it is unnecessary to spend time and money to implement a green certificate system, since the green quota is reached anyway by using only the emission quota.

The power price in the middle of Figure 9 rises caused by the positive correlation to the emission price.

**Figure 9**
**Emission Price (top), Power Price (middle) and Green Certificate Price (bottom) in the Non Co-operative Case.**

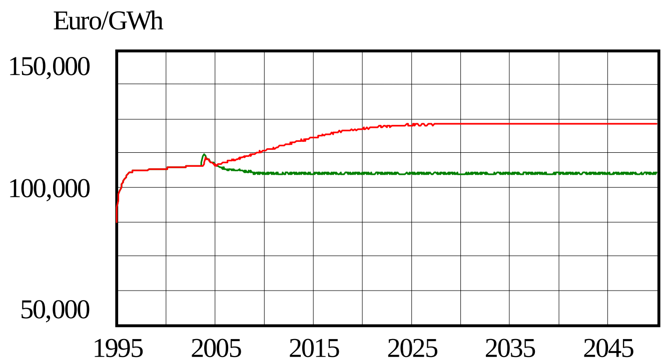



In the co-operative case the offices could, however, consider the correlation between all three prices in the determination of the two quotas. This gives not only a correlation between the power market and the two regulating markets, but also a correlation between the emission permit price and the green certificate price. This correlation exists through the power market and is thereby highly affected by it. The correlation is negative; i.e., an increase in one indirectly leads to a decrease in the other. This negative correlation explains why the two regulatory mechanisms can be used as substitutes for each other. (See Jensen and Skytte, 2001 (2) for more about this correlation.)

The quotas should be set by optimising the social surplus or consumer surplus with respect to the correlations and the desired goals. The simulation shown here does not illustrate an optimised situation, but it does show a combination of quotas that reaches lower consumer prices and thereby lower consumer surplus.

If the planners from the two offices co-operated in the determination of the quotas, they could set the green quota at 30 percent and no emission quota. They could thereby reach a lower consumer price than in the non co-operative solution, and both the goals would still be reached (Figure 10). As a side effect it would only be necessary to implement one additional market, saving the cost of introducing two markets. It should, however, be mentioned that other circumstances, not included in this model, could influence the indirect effect on the emissions, and thereby eliminate the advantage of having only one regulatory mechanism.

**Figure 10**
**Example Consumer Prices in the Co-operative (bottom) Case and Non Co-operative (top) Case.**




## Discussion and Conclusions

In the light of the recent deregulation in most European countries and the following introduction of market based regulation methods, it has been shown in this article that the interaction between the different coupled markets has impact on the equilibrium results of an implementation of regulatory mechanisms. In order to analyse the considerations to be made, when two regulatory mechanisms are used in combination with a liberalised electricity market, this paper illustrates some of the problems in the coupled markets and separate goals.

A simple System Dynamics model was used to simulate different effects of introducing emission permits and green certificates as regulatory mechanisms. The simulations show how interactions between the green certificate market, the emission permit market and the power market can influence prices and the attainment of desired goals. Due to this interaction the political planner (the state) can use both instruments in order to reach an emission goal or a goal of a certain percentage of renewable energy in electricity production.

The simulations show the importance of knowing the interaction of the different markets, if the plan is to introduce both an emission permit market and a market for green certificates, as in the case of Denmark. Of course, the goal can be reached without co-ordination, but it was shown that it could be reached at lower consumer prices and thereby larger consumer surplus with some form of co-ordination. Further work will look at the effects on the social surplus, to determine the effect from the producer side in the model and find the actual goals in the optimal situation.

It was shown in several simulations, that it is possible to reach an emission goal using green certificates as the regulatory mechanism and likewise using the emission permit system to reach a green quota. Having both an emission goal and a renewable electricity production target does, therefore, not necessarily lead to an implementation of both additional markets, or the planners should at least co-ordinate the quotas in order to reach the most optimal situation for society or consumers.

Quite a large number of problems remain to be investigated on the effect of interactions in regulated and coupled liberalised markets, e.g., effects of uncertainty and the actual development for the present situation. Furthermore, it will be very interesting to watch the actual implementation of the green certificate market in the forthcoming years, and observe if one of the two regulatory mechanisms is unnecessary to achieve the goals, like the simulations in this paper would indicate.

**Footnotes**

[1] Calculated with an equivalence of 1 DKK = 7,46 EURO.

[2] Price elasticity: $\varepsilon = \frac{-\Delta d}{d} \Big/ \frac{\Delta p}{p}$, where $d$ is the demand and $p$ the price.

**References**

Contact the author.

## *Conference Proceedings on CD Rom*
## *24th International Conference*
## *Houston, Texas, USA April 25-27, 2001*

The Proceedings of the 24th International Conference of the IAEE are available from IAEE Headquarters on CD Rom. Entitled *2001: An Energy Odyssey*, the price is $85.00 for members and $105.00 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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## Publication

**Annual Review of Energy and the Environment, Volume 26.** Robert H. Socolow, Ed. (2001). Price: (US/Int'l) Print and Online $80 / $85. Contact: Annual Reviews, 4139 El Camino Way, Palo Alto, CA 94306 USA. Phone: 800-523-8635 or Worldwide 650-493-4400. Fax: 650-424-0910. Email: service@annualreviews.org URL: www.annualreviews.org

## Calendar

**11-12 February 2002, New Dynamics of Scandinavian Gas & Power at Hotel Bristol, Oslo, Norway.** Contact: Emma Woodward, Customer Services Representative, IBC Global Conferences, The Bookings Department, Gilmoora House, 57-61 Mortimer Street, London, UK, W1W 8HS, England. Phone: +44(0) 1932 893851. Fax: +44(0) 1932 893893 Email: cust.serv@informa.com URL: www.ibcenergy.com/em1178/?source=lr627

**11-12 February 2002, The commercial opportunities in the gerneration of power from nuclear energy at St. Regis Grand Hotel, Italy.** Contact: Patricia Besa, Marketing Manager, CWC Europe Limited, 3 Tyers Gate, London, SE1 3HX, England. Phone: +44 (0) 20 7089 4200. Fax: +44 (0) 20 7089 4201 Email: pbesa@thecwcgroup.com URL: www.thecwcgroup.com

**11-12 February 2002, The Commercial Opportunities in the Generation of Power from Nuclear Energy: Commercial Viability Driving Investment at Rome, Italy.** Contact: Patricia Besa, Marketing Manager, CWC Europe Limited, 3 Tyers Gate, London, SE1 3HX, England. Phone: +44 (0) 20 7089 4200. Fax: +44 (0) 20 7089 4201 Email: pbesa@thecwcgroup.com URL: www.thecwcgroup.com

**15-15 February 2002, Malta Complimentary Symposium: Exploration Promotion at Carlton Towers, Knightsbridge, London, UK.** Contact: Babette van Gessel, Group Managing Director, Global Pacific & Partners, 2nd Floor, Regent Place, Cradock Avenue, Rosebank, Johannesburg, 2196, South Africa. Phone: 27 11 778 4360. Fax: 27 11 880 3391 Email: info@glopac.com URL: www.petro21.com

**20-21 February 2002, Recent Developments in the Italian Power Exchange, ENERCON ITALY 2002 at Starhotel Business Palace, Milan.** Contact: Registration, Italy. Phone: 39-02-83847-627. Fax: 39-02-83847-262 Email: info@iir-italy.it URL: www.iir-italy.it

**22-22 February 2002, Wind Energy and Rural Development in North Dakota III at Alerus Center - Grand Forks, ND.** Contact: Deb Haley, Associate Director, Energy & Environmental Research Center, PO Box 9018, Grand Forks, ND, 58202, USA. Phone: 701-777-5000. Fax: 701-777-5181 Email: dhaley@undeerc.org

**25-26 February 2002, CBI at Four Seasons Hotel, Houston, Texas.** Contact: Conference Manager, CBI, Registration Department, 500 W Cummings Park, Ste 5100, Woburn, MA, 01801, USA. Phone: 800-817-8601 / 781-939-2438. Fax: 781-939-2490 Email: kimh@cbinet.com URL: www.cbinet.com

**26-27 February 2002, Energy Security: Safeguarding Our Nation's Power at Sheraton Crystal City, Arlington, VA.** Contact: Registration Dept., Strategic Resource Institute, USA. Phone: 888-666-8514/646-336-7030 Email: info@srinstitute.com

**27-28 February 2002, 2nd Annual African Insiders Strategic Briefing 2002 at Rosebank Hotel, Johannesburg, South Africa.** Contact: Babette van Gessel, Group Managing Director, Global Pacific & Partners, 2nd Flr, Regent Place, Cradock Ave, Rosebank, Johannesburg, 2196, South Africa. Phone: 27 11 778 4360. Fax: 27 11 880 3391 Email: info@glopac.com URL: www.petro21.com

**27-28 February 2002, Gas to Liquids - Challenges facing the next generation of plants at Crowne Plaza London, St James'.** Contact: Emma Woodward, Customer Services Representative, IBC Global Conferences, The Bookings Department, IBC Global Conferences, 57-61 Mortimer Street, Gilmoora House, London, uk, W1W 8HS, England. Phone: +44(0) 1932 893851. Fax: +44(0) 1932 893893 Email: cust.serv@informa.com URL: www.ibcenergy.com/em1178/?source=lr621

**27-28 February 2002, 7th Asia LNG & Natural Gas Markets 2002 at Singapore.** Contact: cynthia@cmtsp.com.sg, Event Manager, CENTRE FOR MANAGEMENT TECHNOLOGY, SINGAPORE. Phone: 65 345 5701. Fax: 65 345 5928 URL: www.cmtevents.com

**February 27, 2002 - March 1, 2002, DistributTECH 2002 at Miami Beach, Florida.** Contact: Jennifer Lindsey, Conference Manager, PennWell. Phone: 918-832-9313 Email: jenniferL@pennwell.com URL: www.penwell.com

**5-5 March 2002, Euroheat & Power Annual Conference: Power to the Heat - Energy Efficiency for Europe Made by Combined Head and Power at Brussels, Belgium.** Contact: Simona Basiu, Communications Officer, Euroheat & Power, Av. du Diamant 26, Brussels, 1030, Belgium. Phone: 32-2-7402110. Fax: 32-2-7402119 Email: simona.basiu@euroheat.org URL: www.euroheat.org

**6-8 March 2002, World Sustainable Energy Day 2002 at Stadthalle Wels, Austria.** Contact: O.O.Energiesparverband, Landstrabe 45, A-4020 Linz, Austria. Phone: 43-732-6584-4380. Fax: 43-732-6584-4383 Email: office@esv.or.at URL: www.esv.or.at

**11-12 March 2002, Caspian Energy Retreat Summit at Mandarin Oriental Hotel London.** Contact: Patricia Besa, Marketing Manager, CWC Associates Ltd, 3 Tyers Gate, London, SE1 3HX, England. Phone: +44 (0)20 70894150. Fax: +44 (0) 20 7089 4201 Email: pbesa@thecwcgroup.com URL: www.thecwcgroup.com

*(continued on page 32)*

**Calendar** *(continued from page 31)*

**18-19 March 2002, 2nd Annual Latin Gas 2002 at Sheraton Rio Hotel, Rio de Janeiro, Brazil.** Contact: Babette van Gessel, Group Managing Director, Global Pacific & Partners, 2nd Flr, Regent Place, Cradock Ave, Rosebank, Johannesburg, 2196, South Africa. Phone: 27 11 778 4360. Fax: 27 11 880 3391 Email: info@glopac.com URL: www.petro21.com

**19-21 March 2002, Electric Power 2002, St. Louis, MO, USA at America's Center.** Contact: The TradeFair Group Inc, 1220 Blalock Road, Suite 310, Houston, Texas, 77055, USA. Fax: 713-463-9997 URL: www.electricpowerexpo.com

**25-26 March 2002, CBI's Safety and Security in the Electric Power Industry at Houston, Texas.** Contact: Registration Office, CBI, USA. Phone: 800-817-8601. Fax: 781-939-2495 Email: cbireg@cbinet.com

**25-26 March 2002, Australia's Outlook for Power Generation at Melbourne, VIC, Australia.** Contact: Cathy Lloyd, IBC Conferences Australia, Level 2, 120 Sussex St, Sydney, NSW, 2000, Australia. Phone: +61 (0)2 9080 4300. Fax: +61 (0)2 9290 3844 Email: enquiries@informa.com.au URL: www.ibcoz.com.au/generation

**1-1 April 2002, Renewable Energy Conference at London.** Contact: Alex Gerber, Marketing Manager, Global Business Network, 9 Wimpole Street, London, W1M 8LB, UK. Phone: 0044 (0)207291 1030. Fax: 0044 (0)207291 1001 Email: gerber@gbnuk.com

**4-5 April 2002, Africa Regional Farmout & Exploration Promotion Forum 2002 at Sheraton Suites, near the Galleria, Houston, USA.** Contact: Babette van Gessel, Group Managing Director, Global Pacific & Partners, 2nd Floor, Regent Place, Cradock Avenue, Rosebank, Johannesburg, 2196, South Africa. Phone: 27 11 778 4360. Fax: 27 11 880 3391 Email: info@glopac.com URL: www.petro21.com

**7-9 April 2002, 10th Middle East Petroleum & Gas Conference at Doha, Qatar.** Contact: The Conference Connection Inc, PO Box 1736, Raffles City, 911758, Singapore. Phone: 65-226-5280. Fax: 65-226-4117 Email: info@cconnection.org

**8-9 April 2002, 6th Annual Asia Upstream 2002 at Holiday Inn, Park View, Singapore.** Contact: Babette van Gessel, Group Managing Director, Global Pacific & Partners, Private Bag X61, Saxonwold, Gauteng, 2131, South Africa. Phone: 27 11 7784360. Fax: 27 11 8803391 Email: info@glopac.com URL: www.petro21.com

**8-9 April 2002, Russian Oil & Gas Investment Summit at Langham Hotel London.** Contact: Patricia Besa, Marketing Manager, CWC Associates Ltd, 3 Tyers Gate, London, SE1 3HX, England. Phone: +44 (0)20 70894200. Fax: +44 (0) 20 7089 4201 Email: pbesa@thecwcgroup.com URL: www.thecwcgroup.com

**10-10 April 2002, Asia Regional Farmout & Exploration Promotion Forum 2002 at Holiday Inn, Park View, Singapore.** Contact: Babette van Gessel, Group Managing Director, Global Pacific & Partners, 2nd Floor, Regent Place, Cradock Avenue, Rosebank, Johannesburg, 2196, South Africa. Phone: 27 11 778 4360. Fax: 27 11 880 3391 Email: info@glopac.com URL: www.petro21.com

**10-12 April 2002, 11th Annual Mineral Economics and Management Society (MEMS) Professional Program and Meeting at Montreal, Quebec, Canada.** Contact: Dan Paszkowski Email: dpaszkow@mining.ca (or) space@mines.edu URL: www.mines.edu/Outreach/Cont_Ed/mems.html

**15-16 April 2002, 2nd Fujairah Fuel Oil and Bunkering Forum (Fujcon 2002) at Fujairah, United Arab Emirates.** Contact: The Conference Connection Inc, PO Box 1736, Raffles City, 911758, Singapore. Phone: 65-226-5280. Fax: 65-226-4117 Email: info@cconnection.org


## *IAEE Newsletter*

## Volume 11, First Quarter 2002

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.

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