United States Association for Energy Economics

USAEE Dialogue

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PRESIDENT'S MESSAGE

Thanks to my predecessor, Len Coburn, for leaving the Association in good shape for the last year of the millennium. Our new officers include Arnie Baker, Vice President for Conferences, Adam Sieminksi, Vice President for Chapter Liaison, and Council members Wilfrid Kohl and Foster Mellen. (Mine Yucel was reelected as Secretary-Treasurer.) Stepping down are Council members Maureen Crandall and Marianne Kah, for whom our thanks. More especially, my gratitude to Shirley Neff, the former Vice President for Chapter Liaison for her work with both the Chapter Development Fund and the Student Scholarship Fund. And of course, Dave DeAngelo is the new president-elect.

The USAEE is reasonably healthy and moving forward in a number of directions. Our membership increased last year by 20 to 985, and we once again earned a profit, raising the Association's assets by about 10%, to $161k.

And yet there is no question that both the profession and the Association face a number of challenges (assuming society survives the Y2K bug and a variety of millennial madnesses). The current oil price weakness is a stark reminder of the uncertainties which pervade the petroleum industry, while the ongoing debate over restructuring and deregulation of the electric and gas industries emphasize the vital importance of economics in policy-making. Both should enhance the role of energy economists.

Under such circumstances, the role of the professional association in providing improved intellectual interaction (and networking) is increased. Yet as a result of the ongoing restructuring of the energy industry, many companies and individuals that have been staunch supporters of the USAEE over the years are under pressure to cut back their financial assistance and personal participation. Some, of course, have ceased to exist as independent entities. Others have seen their planning departments merged, renamed or abolished. And many long-time members have moved into new industries.

This is definitely a challenging year for both the energy industries and our Association. Renewal is our first concern, followed by expansion. I hope that we will be able to convince our members now more than ever of the importance of the Association in their professional careers and to their organizations. We are the only non-profit organization strictly devoted to energy economics and for many of us the premier professional society. As such it is important that the Association provide the maximum services to the members, in quality if not in quantity. Dave Williams at Administrative Management Services does a marvelous job of herding the cats, but he needs our input on the direction to send them. The goal is cats which are contented, not cohesive.

To that end, there are a number of goals for this year, including expanding the membership and increasing sponsorship. Although the organization has received generous support from a number of companies, which is greatly appreciated, this year, it would be good to see others provide at least minimal support in order to broaden our base (and raise our Beta).

And the membership still remains spotty, with heavy representation in a few areas and others only marginally. The North American meeting is being held in Orlando this year in part to increase the low membership levels in the Southeast, and I would urge members to encourage colleagues in that region to make a special effort to attend the conference.

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Editor's Corner

This issue of Dialogue brings you another article by Gerald T. Westbrook on global climate change issues, concentrating on the impact of climate change on ocean levels. Also included is an excellent article

(continued on page 2)

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

by John Cochener of the Gas Research Institute on short-term prices of natural gas.

Please join me in thanking the authors for their contributions to our newsletter.

For more information on global climate change issues, check out the "World Climate Report" at www.nhes.com, the Greening Earth Society at www.greeningearthsociety.org, and www.globalwarming.org and solar-center.stanford.edu/sun-on-earth/glob-warm.html.

Please send new articles (or suggestions for articles) and notices for publication in Dialogue. Include news of chapter events and appropriate press releases. Items can be sent via E-mail (paul-roberts@worldnet.att.net), by Fax (713-207-9962), or by regular mail (Reliant Energy, Incorporated, P.O. Box 1700, Houston TX 77251-1700). If you have questions, comments, or suggestions, I can be reached by phone at 713-207-5059.

Paul Roberts

Conference Proceedings
17th North American Conference
Boston, Massachusetts, October 27-30, 1996

The Proceedings from the 17th Annual North American Conference of the USAEE/IAEE held in Boston, MA, are now available from IAEE Headquarters. Entitled *(De)Regulation of Energy: Intersecting Business, Economics and Policy*, the proceedings are available to members for $65.00 and to nonmembers for $85.00 (includes postage). Payment must be made in U.S. dollars with checks drawn on U.S. banks. To order copies, please complete the form below and mail together with your check to:

Order Department, USAEE/IAEE Headquarters, 28790 Chagrin Blvd., Suite 350 Cleveland, OH 44122, USA.

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Nominations for 1999 USAEE Awards Requested

The USAEE is now receiving recommendations for the Senior Fellow Award and Paul Frankel Award recipients. Below please find a brief description of the awards and their parameters.

Paul Frankel Award

This award is given to an individual or organization for a unique and innovative contribution to the field of energy economics. The award may be given to someone residing outside of the U.S. Presentation is made at the annual North American Conference of the USAEE/IAEE. A plaque and $500.00 stipend is given.

USAEE Senior Fellow Award

The Fellow Award is given to individuals who have exemplified distinguished service in the field of energy economics and the USAEE. Up to three recipients may receive the Fellow Award in any given year. The awards are given to the recipients at the annual North American Conference of the USAEE/IAEE. A small desk clock is given as well as life membership in the USAEE.

The USAEE Council welcomes recommendations from its membership for consideration in bestowing these awards. Please submit a 250-750 word recommendation of the person(s)/organization(s) you feel would be appropriate for receiving these awards to:

Dr. Hillard G. Huntington
Executive Director
EMF, Stanford University
406 Terman Ctr.
Stanford, CA 94305-4023

Recommendations may also be faxed to Dr. Huntington's attention at 650-723-4107.

United States Association for Energy Economics
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UNITED STATES ASSOCIATION FOR ENERGY ECONOMICS
INTERNATIONAL ASSOCIATION FOR ENERGY ECONOMICS

20th Annual North American Conference

THE STRUCTURE OF THE ENERGY INDUSTRY: THE ONLY CONSTANT IS CHANGE

Hilton at Walt Disney World - Orlando, Florida - USA
August 29 - September 1, 1999

Session Themes and Topics

Energy and the Global Economy: S.E. Asia, Russia, Latin America and OECD
New Financial Instruments for the Energy Industries
Incorporating New Technologies for the Energy Industry
North American Energy Integration
The Outlook for Oil Prices
Alternative Transportation: Implications for the Petroleum Industry
Developing Countries: The Status of Energy Development
A New OPEC?
The Climate Change Debate
Natural Gas Markets in the New Century
Electricity Restructuring: Lessons from Natural Gas
The Oil Industry: A Changing Market Structure
Energy vs. Environment in the Gulf of Mexico

*** CALL FOR PAPERS ***

Deadline for Submission of Abstracts: April 21, 1999
(Please included your CV when submitting your abstract)

Anyone interested in organizing a session should propose topics, motivations, and possible speakers to:
Mary Lashley Barcella - 202-429-6670 / mlbarcella@msn.com
Mine K. Yucel - 214-922-5160 / mine.k.yucel@dal.frb.org

Abstracts should be between 200-1500 words and must clearly address the theme of the conference and topics above to be considered for presentation at the meeting. At least one author from an accepted paper must pay the registration fees and attend the conference to present the paper. All abstracts/proposed sessions and inquiries should be submitted to:

David Williams, Executive Director, USAEE/IAEE
28790 Chagrin Blvd., Suite 350, Cleveland, OH 44122 USA
Phone: 216-464-2785 / Fax: 216-464-2768 / E-mail: iaee@iaee.org

General Conference Chair: Michael C. Lynch
Program Co-Chairs: Mary Lashley Barcella & Mine K. Yucel
Arrangements Chair: David L. Williams

NEW THIS YEAR: USAEE Best Student Paper Award ($250.00 cash prize plus waiver of conference registration fees). If interested, please contact USAEE Headquarters for detailed application/guidelines.

Visit our website at www.iaee.org for the latest program announcement

The Incredible Story of the Worlds Oceans: Will Global Warming Have an Impact?

*By Gerald T. Westbrook**

The Magnitude of Nature's Forces

The more one understands the working of our planet in general and it's climate in particular, the more one becomes overcome with awe at the magnitude, complexity and grandeur of the natural scheme of things. Indeed, one can easily adopt a strong religious outlook to this work. So it is appropriate to open this paper with an example that has a strong religious couple.

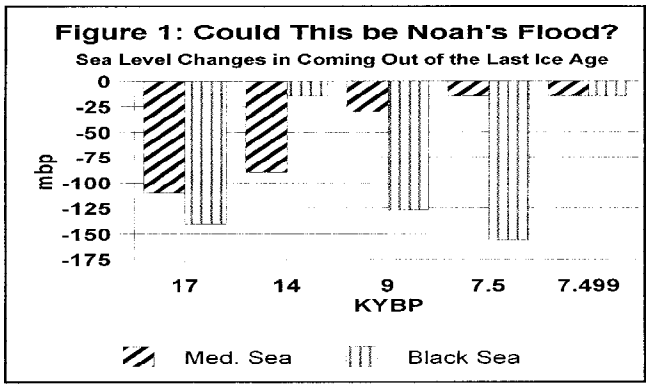
The emergence of the Earth from the Last Ice Age saw repeated warmings and coolings from about 20,000 years ago (20 KYs) to about 8 KYs before present (8 KYBP), when the Earth approached its present temperature. Over the past 20 KYs the oceans underwent about a 120 meter rise (a 400 foot rise) from their lowest levels seen in the Last Ice Age.

Over the interval from 17 to 7.5 KYBP, as the ice sheets melted and the oceans rose, the level of the Mediterranean gradually increased from 110 meters below present (mbp) to 15 mbp. At the end of this period an incredible event[1] occurred in and around the Black Sea, coupled to this sea level rise. The Black Sea started as a lake. And its level oscillated over this 9.5 KY period, from 140 mbp to 15 to 127 to 156 mbp (Figure 1). There was thus a head of 141 meters between the Mediterranean Sea and the Black *Lake* and sea water started to come through around the year 5500 BC. This occurred, first as a trickle, but soon as a torrent, with 1000 times the flow of Niagara Falls. This sea water intrusion would soon turn into an absolute disaster. It is estimated that the sea level rose 15 - 30 cms per day. The inhabitants would have had to retreat as much as one kilometer per day[2] over a period of 100 - 200 days. Shelters would have disappeared rapidly as would most possessions and food, which would soon become the most pressing problem.

Indeed this was an incredible event. Could this have been Noah's flood? We may never know. However legends of a great flood abound in many cultures around the world. If it was not Noah's flood it surely was one of Biblical proportions and helps depict the titanic magnitude of natural events around or connected to the behavior of our oceans.

Background

Global warming, as an environmental issue and as a priority of the Clinton/Gore Administration, has been much in the news with all of the publicity and hype around the Kyoto Treaty.



The global warming issue is based on a gradually increasing level of greenhouse gases (GHGs) in our atmosphere, primarily CO_2, that will increase the energy retained within the Earth's greenhouse system. There is no argument that such a system exists. And GHGs are real as is the global warming phenomenon. (Indeed, without the natural GHGs, the Earth's average temperature would drop as much as 33 ºC. It should be noted in passing that the dominant GHG in this natural global warming is H_2O; not CO_2, not CH_4, not chloro-flourocarbons, but H_2O). The basic questions are how much incremental global warming, if any, will be caused by the incremental increase in CO_2, and what impacts, if any, will result?

There are a large number of forces that influence our climate besides GHGs. These include cosmic, solar, orbital, and Earth based factors — in the atmosphere, biosphere, cryosphere, and the hydrosphere. For those interested in the science of the global warming issue in general, and the complexity involved, references 3, 4 and 5 are recommended.

Objective

Many in industry and in the scientific community believe this treaty is premature. Such skeptics see a need for the debate to be extended, with major improvement required in the quality of the data and depth of the analysis in areas such as the basic global warming science, the general circulation models (GCMs), the alleged climate impacts, and the long-term economic impacts.

An area that this writer believes is of import is an increase in the understanding of the basic science

* Gerald T. Westbrook is with TSBV Consultants in Houston, TX.
This paper was originally presented at the 1998 Offshore Technology conference in Houston, TX, May 4-7, 1998.

behind this issue and the status of that science. That will be the objective of this paper, specifically those parts that are applicable to the oceans. Hence this paper will explore the science in the following areas:

Sea level rise
- Coming out of the Last Ice Age
- The Past Century
- The Coming Century

El Niño

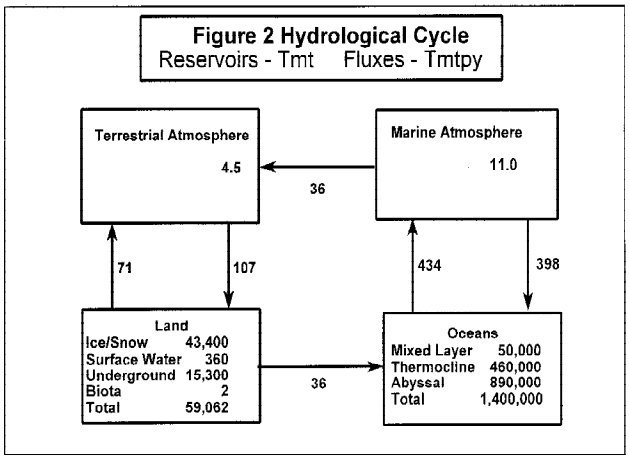
Hurricanes

Ocean thermohaline circulation.

The Hydrosphere

Before starting into the global warming issues, it is informative to look at the structure of the Hydrosphere and the Hydrologic Cycle[6]. With no surprise, the oceans dominate, making up 96% of the Earth's water. The cryosphere and underground water are the only other sectors that contribute significant volumes at roughly 3% and 1% respectively. All other sectors - surface water, atmosphere, and the biosphere add in only trace contributions.

The Hydrological Cycle is illustrated in Figure 2 showing both the reservoir sizes and the annual fluxes between reservoirs. For the ocean sector and even the land sector the annual fluxes are characterized by being very much smaller than the reservoir size. This means that a huge number of years are required to turnover the reservoir. The exact reverse is true for the atmosphere, where many turnovers per year would occur.



In any event the accuracy of many of the numbers is poor, leading to a closure error for the overall cycle of a factor of two.

Sea Level Rise

Coming out of the Last Ice Age.

Non Linear Sea Level Rise Rates. As noted above, the geological record shows the sea level has risen from 120 mbp over the past 20 KYs. This rise was surely non linear[7]. This can be seen, in part, from the data[1] listed in Table 1, with values ranging from 2 to 12 mm/year.

Maximum Rates. A recent graph[8] of estimated sea level rise (SLR) rates, on a 250 year time unit, showed a maximum rate of about 18 mm/year. In addition there are undoubtedly major spikes in the rise rate that occurred due to the existence of what are termed melt water pulses[9].

Table 1 Historical Sea Level Rise Rates - mm/year

Period KYBP	Start mbp	End mbp	Rise m	Time KYs	Average mm/year
7.0-14.0	110	90	20	3	6.7
14.0-9.0	90	30	60	5	12.0
9.0-7.5	30	15	15	1.5	10.0
7.5-0	15	0	15	7.5	2.0

Rates over the past 7,500 years. The last 7.5 KYs have been relatively tranquil showing an average rise rate of 2 mm/year. The rate would have been somewhat higher in the earlier years of this interval, but this average is still a useful frame of reference on this subject.

Sea level changes over the past century.

Sea Level Measurement Challenges. A measurement of contemporary sea levels is confounded by several factors. These include the Earth's crustal rebound and oceanic-atmospheric interactions with the El Niño being the prominent example. The crustal rebound is still underway from the compression applied over the Last Ice Age. This has to be isolated from measurements taken from tidal gauges. And the El Niño can lead to water being pushed substantially higher in parts of the Pacific. Again this must be taken into account.

*Estimates **of** Sea Level Rise Rate.* The IPCC95 report[10] provides a range of sea level rise rate estimates of 1.0 to 2.5 mm/year over the past 100 years. It also noted that there is no evidence for any acceleration of sea level rise this century. Some reports have indicated rates as high as 8 mm/year, but such rates have proven to be erroneous. Still other reports have argued the rate has been no more than 1 mm/year over the last 200 years.

Observed Sea Level Rise. A picture of the sea level rise over this past century, is displayed in Figure 3, with both the observed rise and the estimated rise shown. For the observed rise we see an uncertainty range of 15 cms. This is based on estimates for low, middle and high values of 10, 18 and 25 cms respectively.

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The Incredible Story...*(continued from page 5)*

Estimated Sea Level Rise. The authors of the IPCC95 report ask: can this rise be explained? And their answer is yes and no. With a UN estimated average global temperature rise of 0.3 to 0.6 ºC one might expect some modest response. Consider each of the components of sea level rise as reported in Table 2:

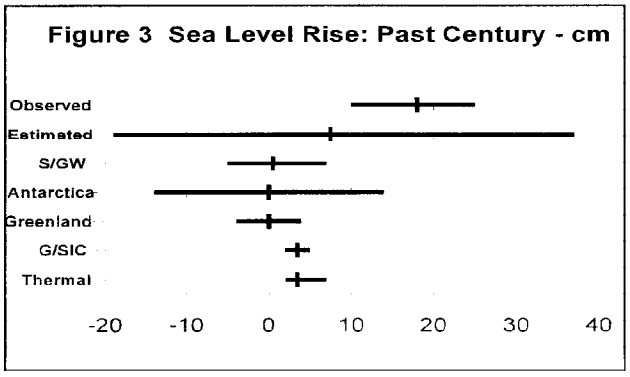


Table 2 Comparison between Estimated and Observed Sea Level Rise over the Past Century - cms

Component	Low	Mid	High	Range
Thermal Expansion	2	4	7	5
Glaciers/Small Ice Caps	2	3.5	5	3
Greenland Ice Sheets	-4	0	+4	8
Antarctic Ice Sheets	-14	0	+14	28
Surface/Ground Water	-5	0.5	7	12
Total Estimate	-19	8	37	56
Observed	10	18	25	15

- Thermal expansion - See a 2, 4 and 7 cm (low, middle and high) estimates. Authors of the IPCC95 report noted "observational data are still too sparse to make global scale estimates", but they still made them. Given the warming over this period some thermal expansion likely occurred.
- Glaciers/Small ice caps - While many of the world's glaciers have retreated, there are mixed signals in the data. Further continuous long-term measurements of the mass balances are very limited. Based on what data is available and simple computer models, an estimate SLR profile of 2, 3.5 and 5 cms was made.
- Greenland ice sheet - There is insufficient evidence from models and from data. Used: -4, 0 and +4 cms.
- Antarctic ice sheet - There is insufficient evidence from models and from data. Used: -14, 0 and +14 cms.
- Surface/ Ground water - The current estimates are very uncertain and speculative. Profile: -5, 0.5 and +7 cms.

The zero values should be interpreted as a measure of the current poor state of knowledge rather than an estimate of the current state of balance. The combined values show that the estimated rise has values of -19, 8 and +37 cms, a range of 56 cms.

Comparison of Observed Uncertainty vs Estimated. Hence there is still major uncertainty both in our ability to measure these recent sea level changes, but also in our ability to analyze the situation and estimate these changes. Indeed the estimate uncertainty is 3¾ times greater than the measurement uncertainty.

Forecasts on sea level changes for the next 100 years.

A History of Sea Level Rise Forecasts. The huge uncertainty seen in the above sea level rise estimates does not bode well for our ability to forecast the future. Indeed, just as global warming forecasts for temperature increases have fallen over time, so have those for sea rise. Forecasts have declined since the early 1980's when a 7 to 8 meter rise was cited (for the year 2130). This level fell to less than 1 meter by 1990 and to less than a half a meter (49 cms) in one of the current UN forecasts, and lower still in other forecasts.

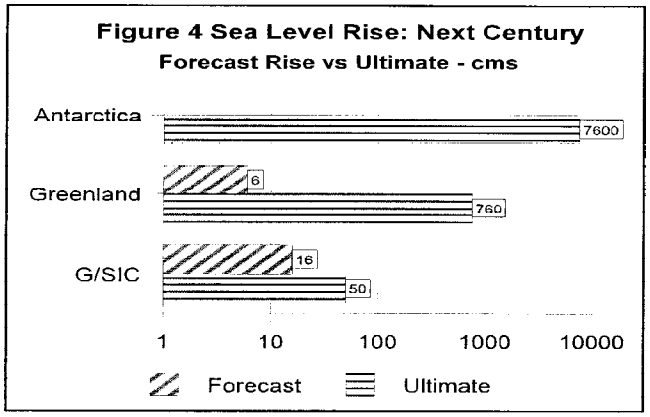
Sea Level Rise Propaganda. In spite of this outlook of lowered rise forecasts and in spite of the huge uncertainties, this alleged global warming impact is perhaps the center of maximum hype, with apocalyptic predictions all over. These include the movie Water World and at least two programs sponsored by the EDF and the Smithsonian Institute. One of these displayed a model of the Washington Monument, at museums all over the country, with sea water flooding half the monument. The question[11] was asked: Why is it necessary to propagandize our children with such non-science?

In a more recent example the EDF/Smithsonian team reported that "by 2075 AD we could expect a 10 - 60 cm sea level rise. This rise, along with a major storm surge would nearly encircle the Washington Monument". They did not mention that a major storm, such as a Level IV hurricane, will have a storm surge of 400 to 550 cms. This surge, along with any normal tides, suggests the monument would be flooded with or without the global warming contribution.

Comparison of Current Forecasts vs the Ultimate Rise. A comparison is made in Figure 4 between the maximum rise, due to the complete melting of the cryosphere, against the current UN forecasts. Such forecasts must be based on a scenario of the future. Here the warming is set at 1.5 to 2.5 to 4.5 ºC. The 2.5 ºC represents the sensitivity of the GCM scenario used, namely the assumed temperature response due to a doubling of the green-

house gas concentration. Analogous sea level rise contributions are reviewed for three components.

- Antarctic ice sheet - A melting of all the ice and snow in Antarctica would lead to a devastating 76 meter rise. Yet the UN prediction for the next century is for a tiny reduction of 1 cm. Others have forecast a somewhat larger reduction.These are based on higher water vapor levels occurring with the assumed global warming, leading to more snowfall. But the higher temperatures involved are insufficient to melt the new precipitation leading to a modest snow accumulation.
- Greenland ice sheet - Similarly for this ice cap the ultimate rise would be 7.6 meters, versus the forecasted rise of only 6 cms. This would be less than one percent of the ultimate.
- Glaciers/Small ice caps - Here the ultimate sea level rise is very small, only half a meter, whereas the forecasted rise is now up to 16 cms.

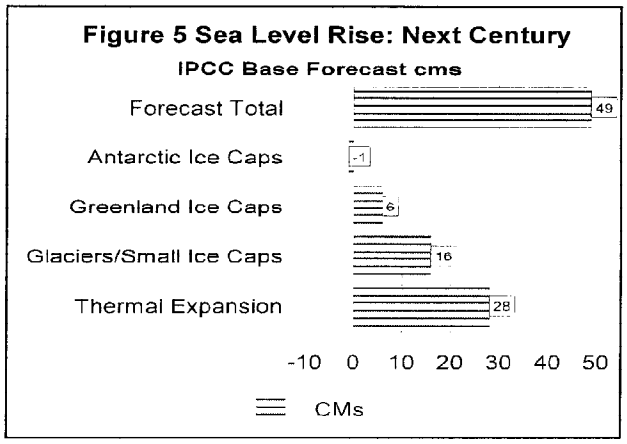


Bringing these three components together (Table 3) we see that the UN forecast for the next century is 21 cms versus the ultimate potential of 84.1 meters. This is less than ¼ of a percent of the ultimate, hardly an apocalyptic outlook.

Table 3 Comparison between UN Forecast for Sea Level Rise Over the Next Century vs the Ultimate Rise

Component	Forecast cms	Ultimate meters	%
Antarctic Ice Sheet	-1	76.0	-
Greenland Ice Sheet	6	7.6	0.79
Glaciers/Small Ice Caps	16	0.5	32.0
Sub-total	21	84.1	0.25
Thermal Expansion	28	-	-
Totals	49	-	-

The Largest Contributor to Sea Level Rise. There is one additional component to be included in the overall forecast and that is thermal expansion. As shown in Figure 5 this is expected to constitute the majority of the forecast, representing 28 cms out of the overall 49 cm forecast.



Uncertainty in Current Forecasts. Forecasts of future sea level rise suffer not only from a very weak understanding of the natural processes involved, but also from a far from perfect picture of the likely future global warming. Hence the 49 cm forecast is highly uncertain. Other forecasts (Table 4) show somewhat lower sea level rise. Titus and Narayanan[12], in a major study using extensive subjective probability analysis came in with a value of 34 cms. Even the IPCC95 report cited a value of 27 cms based on a more conservative climate sensitivity of 2.2 ºC. And the analysis[13, 14, 15] still goes on. Recent reports have noted that the computer model that best reproduces the observed climate has a sensitivity of 1.7 ºC. This is due to the inclusion of some sulfate aerosols along with the greenhouse gases in the model. This reduced sensitivity lowered the sea level rise forecast further, to less than 21 cms.

Table 4 Comparison between Recent Sea Level Rise Forecasts for the Next Century - cms

Component Report Date	IPCC 1996	EPA 1995	IPCC 1996	WCR 1997
Reference[(a)]	10	12	10	13
Climate Sensitivity [(b)]	2.5	-	2.2	1.7
Thermal Expansion	28	21	15	-
Glacier/Small Ice Caps	16	9	12	-
Greenland Ice Sheet	6	5	7	-
Antarctic Ice Sheet	-1	-1	-7	-
Best Estimate	49	34	27	21

(a) See the References and Notes Section above.
(b) Defined as ºC per equivalent CO_2 doubling (per ECD). Each GHG has a unique warming capability. This is used along with the expected composition to calculate the ECD.

Comparison Between Centuries: Observed vs Estimated. It is interesting to compare results of the above analysis between the last century and the coming century. For the last century, we see a middle range sea level rise value of 18 cms, with the

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The Incredible Story...*(continued from page 7)*

upper range extending to 25 cms. For the next century, we see values coming down to 34 or 27 and even down to 21 cms. With the huge level of uncertainty in the data and the analytical methodology, is it just possible that there may not be a statistically significant difference between the observed values for the past century and the estimated values for the coming century? This question/conclusion is consistent with one noted[16] recently that any future global warming will actually slow down rather than accelerate the on going rise in sea levels.

The "DNA" of Climate Change. There is considerable agreement that the Earth has undergone a modest amount of surface warming over the past century. And there is a reasonable probability that this trend will continue. As a result, we should not be surprised at a modest sea level rise. The key question that needs to be answered is what fraction of the observed warming is due to natural forces and what is due to societal or anthropogenic factors? And by extension, what part of any SLR is due to natural warming and what due to anthropogenic warming? Priority research efforts should focus on analyzing the global warming temperature increase and determining what portion is due to natural climate variability and what to anthropogenic factors. The DNA of global warming is the ability to Distinguish between Natural and Anthropogenic warming. Until this DNA ability is well founded and reproducible, until one can detect a societal caused warming above the noise of natural climate variability, we run the risk of wasting vast amounts of scarce societal resources by embracing global agreements prematurely.

El Niño.

The El Niño can be dated back to 1525, but undoubtedly has been around much longer than that. It occurs every 2 - 7 years, with a rather strong one every 5 - 10 years. For some unknown reason, the trade winds slow down, stop or even reverse their normal direction during an El Niño, causing warm Western Pacific surface waters to move east. Dr. D. James Baker, head of NOAA, recently noted[17] that, "the El Niño is a natural phenomenon. We know it is linked to both short term and long term scales. The El Niño is superimposed on some long term fluctuations whose origin we do not know." The El Niño is one example of several key oceanic - atmospheric interactions.

There is little question that the current El Niño is the strongest on record, over the period May through October 1997. And there is also little question that this weather phenomenon has caused severe damage around the world. However, by the end of the year this phenomenon had peaked and indeed fallen below the strength of the 82/83 event. Regardless, its arrival has been exploited by the proponents of the global warming apocalypse with a level of hype that may never have been seen before. The prominent hurricane forecaster, Dr. William Gray, recently commented[18]: "Undoubtedly some will want to interpret this warmest on record El Niño as a partial response to the atmospheric greenhouse gas buildup. We do not subscribe to this view. Rather it is likely due to a peculiar juxtaposition of favorable El Niño enhancing mechanisms. Suspect such events have occurred in prior periods before records were adequate to measure their intensity." Its strength is believed to be due to a build up of the western Pacific warm pool of deep water to a very high level over the past three years.

In spite of all the hype[19] over the last 6 - 9 months, and in spite of missing the strength of the 1997 El Niño there is some good news emerging. That news is that there is definite progress being made in understanding our climate and our weather. We still have a very long way to go, but progress is being made and the early forecast of this El Niño is testimony to that progress.

Hurricanes

Is global warming triggering more hurricanes? Prior to the emergence of the 1997 El Niño, the Atlantic Hurricane activity had been on the increase for 2 - 3 years. Dr. William Gray, recently wrote[20] on this subject as follows: "Some individuals will interpret that recent upswing in hurricane activity... as evidence of climate changes... This may be a logical interpretation, given all the media hype on this topic. But this speculation cannot be accepted. There is no reasonable way such an interpretation can be accepted.

"Anthropogenic greenhouse gas warming, if a physical valid hypothesis, is a very slow and gradual process that, at best, could only be expected to bring about small changes in global circulation over periods of 50 to 100 years. This would not result in the abrupt and dramatic one year upturn in hurricane activity as occurred between 1994-95."

Impact of the 1997 El Niño.

It has been known for some time that strong El Niños will reduce the number of hurricanes in the

North Atlantic. A reversal of the trade winds will lead to stronger wind shear in the upper atmosphere that inhibits strong updrafts thereby ripping apart most embryonic storms. The early forecasts by Dr. Gray and his colleagues called for a slightly above average hurricane season. The result, however, was a year of below normal activity and a busted forecast[18]. This was due to the unexpectedly strong El Niño. Dr. Gray noted that, "The strength of the 1997 El Niño was not anticipated by any prediction models. It just overwhelmed a host of other positive hurricane enhancing factors."

General Circulation Models - The GCMs.

Background. A very major portion of the case for action on greenhouse gas emissions is based on results from computer modeling. This effort has been intensive and global. For example, in 1990, modeling of the global climate was being carried out by at least 14 major groups in the U.S. and about the same number in the rest of the world.

Some of this effort has included coupled models that include both atmospheric and oceanic simulations. By and large the nature of the scientific research and technology developed and the analysis conducted has been striking. This research effort represents the outstanding creativity in the scientific community. But the models are far from perfect. There are many serious concerns[21] on both the models logic and performance:

Logic Concerns.

Model Stability. Several years ago, separate atmospheric and oceanographic models were joined together. The resultant coupled models were less than perfect and in some cases unstable. The expedient solution has been to arbitrarily adjust the amount of heat and moisture flowing between these spheres until the model produces a reasonable representation of our current climate. These fudge factors, have usually been large. Kerr reported[23] in 1994 that, "Most modelers go the tweaking route, adjusting the flow of heat and moisture between the ocean and atmosphere to nudge the model into agreement with the climate. Actually, shove might be a better word than nudge." And Baliunas[24] testified in 1996 that area-by-area flux adjustment of up to 100 W/m^2 could be used in some areas of the coupled ocean-atmosphere simulation. This can be contrasted versus the 4 W/m^2 incremental radiative input to the atmosphere for an effective doubling of the concentration of greenhouse gases.

Role of Water Vapor. The GCMs would not predict very much warming due to CO_2 changes alone. The models rely on a major amplification factor from the estimated H_2O in the atmosphere. The simulation of this feedback is controversial and in general not agreed to by the skeptics.

Performance Concerns.

Exaggeration of the Warming Estimates. Typical model predictions for temperature rise over the past 100 years show a 0.8 to 2.0 ºC increase versus the UN's values, based on surface stations, of 0.3 to 0.6 ºC. If the comparison were made against satellite based data the exaggeration would be worse, as this latter type of data shows no warming at all.

Temporal Characteristics of the Warming. Whatever modest warming that is occurring most is happening in the winter time and at night. This result is not predicted by the models, may well be natural in cause and in any event will be beneficial to society.

Spatial Characteristics of the Warming: High Latitudes. The models have always predicted maximum warming in the Arctic. More recently a flood of articles, essays and letters have declared this is happening. In spite of such press coverage and support, many Arctic surface station records show this is not happening. And satellite based data are even stronger in this conclusion.

Closing Comments on the GCMs. Dr. Gray commented[22] on this subject at a recent meeting. His remarks are paraphrased as follows: The global models can't predict seasonal temperatures or can't hind cast. The reason is the atmosphere is so damned complicated. The models have been superb when used for the next 5-10 days, but when modelers move into the climate area the complexity becomes too damn much.

Hurricane Outlook

Frequency of Occurrence. A major change in the Atlantic Ocean sea surface temperatures (SST) began late in 1994 and has continued to the present. Dr. Gray and his colleagues noted: "We hypothesize that the strong broad scale SST changes are due to a major increase in the strength of Atlantic Ocean Thermohaline circulation (THC). This interpretation is consistent with changes in a number of our global circulation features that have occurred during the last three years. We appear to be experiencing a shift towards a stronger Atlantic Ocean THC and likely will experience greater amounts of hurricane activity in the coming decades than occurred in

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the 1970s, 1980s and early 1990s."

Intensity of Future Hurricanes. If one simply looked at an annual history of the cost of hurricanes one might jump to the conclusion that they are increasing in intensity. However, when this record is examined[25], it is easy to see that such a record is a reflection of more Americans building more expensive dwellings in vulnerable coastal locations, not storm intensity.

With the number of hurricanes forecast to increase this cost trend will continue. However the intensity of these storms is not forecast to increase with any global warming. If there is warming, more of this will occur in the high latitudes than in the tropics. This will reduce the equator to pole temperature gradient, one of the major driving forces behind severe storms.

Ocean Thermohaline Circulation

About 10.7 KYBP another dramatic event occurred[26] as a result of glacial melting. Massive runoff sent trillions of metric tons of fresh water into the ocean, leading to a density reduction in the surface waters of the North Atlantic. When the surface waters could no longer sink, the normal THC was stopped. Without the *conveyor belt* to move the warm Gulf Stream north, the North Atlantic cooled rapidly, more sea ice appeared — with a much higher albedo or sunlight reflecting attribute, thereby amplifying the cooling — and the Northern Hemisphere plunged back into a mini ice age now known as the Younger Dryas.

Fortunately, within a few centuries, the orbital parameters of the Earth's motions about the sun changed sufficiently to offset the THC cutoff, and the Younger Dryas event ended.

The possibility that the ocean conveyor belt could be shut down was not lost on those who thrive off of apocalyptic forecasts. At least twice over the past 20 or so years British TV documentaries have been based on this phenomenon:

The Weather Machine (1976). This warned that the ice age could return again due to the closing off of the Gulf Stream.

After the Warming (1991). This promoted a sudden onset of global warming caused by the conveyor belt.

If one accepted as a fact that anthropogenic global warming is coming, a case might be made for the conveyor belt to be slowed. (Note that this is opposite to the trend reported above in the Hurricane section). If the conveyor were slowed, the warm Gulf Stream surface current would be slowed.This would lead to a cooling[26] that would tend to offset the original warming.

Conclusions

We asked in the title of this paper whether global warming will have an impact on the oceans? The answer to this question is yes, but we just don't know what it will be. For example, it is essentially impossible today to predict whether our seas will rise or fall with any global warming.

Observations on Ocean Phenomena

We have covered four major areas with potential oceanic involvement in any global warming. Two factors stand out:

*Level of uncertainty***.** Efforts have been made in this paper repeatedly to flag the unprecedented levels of uncertainties in our understanding of the subject and our ability to translate that into adequate computer models. This epidemic of uncertainty has been reported elsewhere[24,27] and key examples are summarized in Table 5. It is almost beyond comprehension and surely irresponsible that noted politicians can claim, when faced with this level of ambiguity, "that the science is settled". Nothing could be further from the truth[16].

Table 5 Summary of Uncertainty Levels in the Hydrosphere

Hydrosphere Subject	Specific Issue	Error Factor
Hydrological Cycle	Closure	2
SLR: Past Century	Observed Range	2½[(a)]
SLR: Past Century	Est. vs Obs Range	3¾[(b)]
SLR: Next Century	Forecast History	16[(c)]
SLR: Next Century	Current Forecasts	2
Coupled GCMs	Fudge Factors	25[(d)]

(a) Upper Range/Lower Range.
(b) Width of estimated range/Width of observed range.
(c) Ratio of a 1980s forecast with that for 1995.
(d) Ratio of area-by-area flux adjustment of up to 100 W/m^2 in the ocean-atmosphere simulation vs a 4 W/m^2 radiative input.

Apparent modest level of impacts. The impact of oceanic events, at least as forecast for the next century, tend to be modest (Table 6). Compare the forecasts of 0.21 to 0.49 meters with the magnitude of such natural events as hurricane surges of over 5 meters and earthquake or volcano based tsunamis that can exceed 20 meters. A modern day analog to the Black Sea flood could only result if the Antarctic ice sheet melted. Yet the forecast contribution from this source is actually negative.

Table 6 Relatively Modest Magnitude of Possible Impacts

Phenomenon	Comments
Sea Level Rise	Next century forecasts vary: 21 to 49 cms. These are modest vs hurricane surges, tsu namis, *or Noah's* flood. Antarctic icecap contribution is negative. Comparison of forecast vs ultimate rise is only ¼ of one percent.
El Niño	By end of 1997, weaker than 1982/83 event.
Hurricanes	Intensity of hurricanes is expected to fall, if any global warming develops.

Global Warming Treaty

A global warming treaty was agreed to at the recent Kyoto meeting. President Clinton has not signed this treaty. But the treaty will have to be ratified by the Senate, an action that is unlikely, judging from their previous 95 - 0 vote on this issue. It is believed this ratification will be delayed, possibly up to and even beyond the next two elections. In November, 34 senators are up for re-election and one can expect intense pressure on these individuals to change their position. However such pressure may not be aimed at getting the treaty ratified, but at achieving a better result in the 1998 election, than would otherwise be expected. Since the next meeting of the Council of the Parties was held in Buenos Aires in November 1998, it is expected that the Clinton/Gore Administration will spend much of 1998 striving to bring the Developing Nations aboard the Kyoto Treaty.

Surely there are legitimate concerns in this area and these shouldn't be minimized. There is need for more assessment and debate on this subject and particularly more research.

Nomenclature

DNA -Distinguish between natural & anthropogenic warming.

ECD -Equivalent CO_2 Doubling. See also Table 4, note b.

EDF -Environmental Defense Fund organization.

GCM -General Circulation Models for climate simulation.

GHG - Greenhouse Gas.

G/SIC - Glaciers/Small Ice Caps.

IAEE -International Association foe Energy Economics.

IPCC -Intergovernmental Panel on Climate Change, an organization sponsored by the UNEP & the WMO.

KY -Kilo Years.

KYBP -Kilo Years Before Present.

mbp -meters below present for sea level.

NPRA -National Petroleum Refiners Association.

S/GW -Surface/Ground Water.

SLR - Sea Level Rise.

SST -Sea Surface Temperature.

THC - Thermohaline Circulation.

Tmt -Trillions of metric tons. Tmtpy - Tmt per year.

UNEP -United Nations Environmental Program.

WCR -World Climate Report.

WMO -World Meteorological Association.

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Additional Speakers

Check out these additonal speakers addressing the Orlando North American Conference:

J. Christopher Allen	Reliant Energy Wholesale Group
Mark Bernstein	Rand Corporation
John Boatwright	Natural Resource Economics
Stephen R. Conners	MIT
Herman T. Franssen	Petroleum Economic Limited
Roger R. Hemminghaus	Ultramar Diamond Shamrock Corp.
William W. Hogan	Harvard University
Karl Georg Jechoutek	World Bank
John Jurewitz	Southern California Edison Co.
William L. Leffler	Shell Oil Company
Laney Littlejohn	Consulting Economist
Prakash Loungani	IMF
Onnic Marashian	Platt's McGraw-Hill
Michael L. Telson	US Department of Energy
Barbara Laflin Treat	Bechtel Corporation

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

Speaking of which, the Orlando meeting is shaping up nicely, thanks to the tireless efforts of the Program Co-Chairs Mary Barcella and Mine Yucel. Our featured speakers include Roger Hemminghaus, the chairman of the board of Ultramar Diamond Shamrock and Mike Telson, the chief financial office of the Department of Energy. There are also two innovations: on Sunday afternoon, there will be classes on refining and electricity by Bill Leffler and Steve Connors, respectively, for those members who want to fine-tune their technical knowledge, and the conference will close with three of the oil industry's leading lights, John Boatwright (Exxon USA), Laney Littlejohn (Saudi Aramco), and Onnic Marashian (Platts), all now retired, drawing lessons from their careers. The IAEE website, www.iaee.org, contains the conference program.

Mary and Mine do not however bear responsibility for selecting the site or date, which rests with yours truly. (DRESS IS BUSINESS CASUAL) The motivation behind that was to lower the cost of attendance, making the conference a little more affordable for our members. Substantively, there are also prime reasons to go to Orlando in August. For the environmentalists: August in Orlando offers the perfect opportunity to demonstrate the impact of global warming. For the energy industry: By holding our conference in air-conditioned splendor, the ability to mitigate the effects of global warming should be amply demonstrated.

Needless to say, there are many attractions in the Orlando area, although I can't imagine any of our members straying from the weighty intellectual atmosphere of the conference. The deadline for abstracts is April 21. We are planning a number of special attractions (a dunking booth for the president has been prominently mentioned) and look forward to everybody partying like its 2000-1.

As always, I remain receptive to input of all kinds (wilfrid.mit.edu), but caution that baby lag is lowering my mental acuity. If I don't respond, I'm not being rude, just sleepy.

Mike Lynch

USAEE BEST STUDENT PAPER AWARD APPLICATION/GUIDELINES

USAEE is pleased to offer an award for the Best Student Paper on energy economics. The award will consist of a $250.00 cash prize plus waiver of conference registration fees. To be considered for the USAEE Best Student Paper Award please follow the below guidelines.

- Student must be a member of USAEE or IAEE in good standing.
- Submit COMPLETE paper by April 21, 1999 to USAEE Headquarters.
- Paper MUST be original work by the student (at least 50% of work completed by the student seeking award).
- Submit a letter stating that you are a full-time student and are not employed full-time. The letter should briefly describe your energy interests and tell what you hope to accomplish by attending the conference. The letter should also provide the name and contact information of your main faculty supervisor or your department chair. Also, include a copy of your student identification card.
- Submit a brief letter from a faculty member, preferably your main faculty supervisor, indicating your research interests, the nature of your academic program, and your academic progress. The faculty member should state whether he or she recommends that you be awarded the scholarship funds.

Complete applications should be submitted to the USAEE/IAEE Headquarters office no later than April 21, 1999 for consideration. Please mail to:

David L. Williams, Executive Director, USAEE Headquarters
28790 Chagrin Blvd., Suite 350, Cleveland, OH 44122

NOTE: The recipient of the $250.00 cash prize will receive notification of this award and be presented the award at the Orlando USAEE/IAEE North American Conference. This individual will also receive a complimentary registration to attend the meeting. Please note that all travel (ground/air, etc.) and hotel accommodations, meal costs in addition to conference-provided meals, etc., will be the responsibility of the award recipient.

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

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STUDENT SCHOLARSHIPS AVAILABLE

The USAEE is offering a limited number of student scholarships to the 20th Annual North American Conference of the USAEE/IAEE. Any student applying to receive scholarship funds should:

1) Submit a letter stating that you are a full-time student and are not employed full-time. The letter should briefly describe your energy interests and tell what you hope to accomplish by attending the conference. The letter should also provide the name and contact information for your main faculty supervisor or your department chair, and should include a copy of your student identification card.

2) Submit a brief letter from a faculty member, preferably your main faculty supervisor, indicating your research interests, the nature of your academic program, and your academic progress. The faculty member should state whether he or she recommends that you be awarded the scholarship funds.

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

Completed applications should be submitted to USAEE/IAEE Headquarters office no later than August 13, 1999 for consideration. Please mail to: David L. Williams, Executive Director, USAEE 28790 Chagrin Blvd., Suite 350, Cleveland, OH 44122.

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

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

Producers and the Dynamics of Short-Term Gas Prices

*By John C. Cochener**

Producers have little control over gas prices in the marketplace; however, an understanding of the drivers triggering price swings can improve business decisions.

As the winter heating season ends, gas storage is brimming, markets have come through a belated winter, and the market awaits a fresh tide of Canadian gas from new pipeline expansions. What impact will these events have on the stability of gas prices? For producers, volatile gas prices can make operations difficult since uncertainty often leads to unpredictable cash flows. It is imperative that all portions of the natural gas community understand the driving forces in the natural gas market and the options available to them.

When speaking of the gas market, there are many different regional markets, each having a specific price and location. In addition to the contract and cash markets, there are three gas futures markets. Because of the integrated nature of the North American gas market, prices in one region can be affected by prices and fundamentals in other regions.

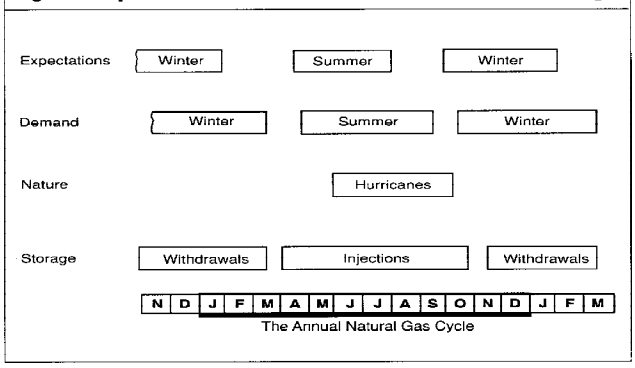
There are many players in these various markets and each can have a different agenda on a given day. This is why prices often move to unanticipated extremes counter to reason and one's intuition. At the end of the day, gas prices reflect the collective attitude of the market players towards the market and their perceptions of real-world fundamentals.

Market transactions occur daily. However, over the years, many buyers and sellers have chosen to defer their pricing until the last minute in what has come to be known as "bid week," typically the last five business days prior to the last two calendar days of the month. Concentrating such intense activity into a single week creates volatility as "unmatched" participants scramble to finalize arrangements for gas to flow the following month. A closely related factor is the expiration of futures contracts about the same time. As preparations are made to close out expiring futures contracts, open interest and liquidity decline which in turn increases volatility.

Unlike most petroleum markets, natural gas trades in near real-time, i.e., other than some limited line pack and storage, gas (similar to electricity) is consumed as it is produced. Supply cannot exceed demand for an appreciable time. For gas to flow, it must have a "home" somewhere down the pipeline. Thus, supply and demand dynamics play out daily through the exchange of phone, fax, and electronic meetings of the minds. What is ironic about the system is that current supply and demand data is not available until after the fact. The weekly estimates of the American Gas Association (AGA) are the closest to real-time volume information that exists. These reports can have substantial impact on cash and futures markets.

The most striking characteristic about the gas market is its classic rising and falling price pattern caused by the changes in nature's seasons. Figure 1 illustrates the timing of the fundamental swings in seasonal gas demand for heating in winter and cooling (through increased electricity generation) in the summer. To meet winter demand peaks, gas must be injected ahead of time and then withdrawn as required over the course of the season.

Figure 1: Expectations And Fundamentals Drive Seasonal Price Change



One "wild card" in the cycle that must be addressed each year is the hurricane season which can cause disruption of key gas supply from the offshore Gulf of Mexico. This can cut over 28 percent of lower-48 gas production hindering both immediate demand and gas storage fill. In recent years, there have been offshore production outages caused by Hurricanes Andrew in August 1992 and Danny in July 1997.

In actuality, expectations and perceptions of fundamentals by market participants lead fundamental events as shown in Figure 1. Because it is uncertain how the fundamental factors will play-out during the course of the seasonal cycle, prices tend to lead demand fundamentals.

Since demand for natural gas is seasonal due to weather factors, prices generally exhibit a similar pattern over time. Gas prices tend to increase in the months of highest consumption as wellhead and

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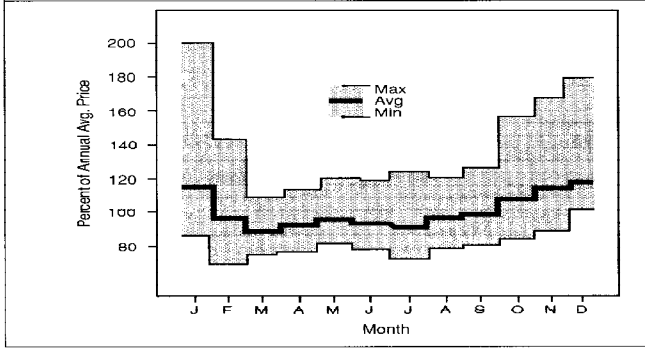
storage supplies are more heavily tapped. Even though prices may be shifted forward in time, a seasonal price pattern still exists.

For example, by February in the heart of winter, when the market can see far enough ahead to determine the remaining course of the supply-demand balance, the market begins "discounting" winter events and focusing on what spring will bring.

Figure 2 illustrates the monthly average seasonal pattern in wellhead gas prices during the 1990s.

Figure 2: Wellhead Price Patterns (1990-1997)



The chart is expressed as percentage factors relative to the annual average price. Also shown for reference are the high and low extremes observed during the study period. In recent years, prices deviated most from the seasonal pattern in 1994 and early 1995 following a series of warm winters. The chart illustrates that the classic 'high in winter- low in summer' price pattern still prevails despite highly publicized daily and weekly price spikes that began springing up in the early 1990s. However, the seasonal price pattern can be skewed short term within the upper and lower range presented in Figure 2.

Principal Price Drivers

Five (5) basic categories of factors having over a dozen outcomes can combine to create extremes in gas prices. These include:

- **Weather-** (1) Colder Winter Weather- Increases gas consumption and gas prices in the Winter, and potentially increases storage injection in the following summer. (2) Hotter Summer Weather- Leads to higher electricity consumption, more use of natural gas, and higher gas prices.
- **Fuel Competition-** (1) Higher Oil Prices- (a) Increase residual fuel and distillate prices, thereby increasing fuel switching to natural gas. (b) Longer term, higher oil prices encourage drilling activity and adds to natural gas deliverability (associated gas) thereby lowering gas prices. (2) Higher Hydro or Nuclear Electric Generation- Higher non-fossil fuel generation leads to less natural gas use for power generation, and lower gas prices.
- **Infrastructure-** (1) Restricted Pipeline Capacity- Tends to depress upstream prices and increase downstream prices. (2) Higher Gas Storage Inventories- Reduces gas prices due to tougher competition with wellhead supplies, and decreased potential for pipeline deliverability constraints. (3) Higher Producer Resource Costs- Lessens incentives to drill and reduces deliverability resulting in higher prices long term.
- **Market Factors-** (1) Market Psychology- Can move prices either direction. Usually acts to magnify and possibly overshoot fundamental factors. (2) Technical Analysis- Provides support or resistance levels to certain price movements depending on historical statistical criteria.
- **Financial-** (1) Higher Short Term Interest Rates- Lead to lower prices as producers are less likely to hoard supplies awaiting higher prices. (2) Higher Long Term Interest Rates- Adds to producer's resource costs and leads to reduced drilling activity and higher gas prices. (3) Value of Canadian Dollar- A falling Canadian dollar adds incentive for Canadian producers to increase exports to the U.S. provided pipeline capacity is available and moderates the potential for increasing gas prices.

How Factors Work Together

The most critical element in determining short term price response, especially in tight markets, is availability of marginal supplies. When additional supplies are readily available, price responses are typically muted as short-term supply and demand dynamics are quickly resolved.

The timing for natural gas supply to enter the market depends on the incremental source. Gas production from existing resources, and gas from storage in producing regions can be made quickly available but must travel for several days to final destination with the risk of delay from pipeline limitations. The same is true for additional Canadian imports.

Other gas stored in line pack, and in market storage areas, can be made available rapidly, but the quantity is limited by physical constraints of pipelines, storage fields, and the volume of working gas in storage.

Combinations of the various factors can occur simultaneously causing the resultant price to exhibit

(continued on page 16)

Weather Cycles in Nature

The 1990s have spawned a frenzy of publicity about the "El Niño" phenomenon. Putting things into perspective, there have been at least 28 El Niño episodes observed over the past 200 years. On average, an El Niño occurs every 3 to 7 years. The most recent El Niño (3/97 to 5/98) was one of the strongest on record. The prior El Niño (12/90 to 4/95), was the longest on record.

Across global weather, the impact of El Niño is second only to the change of seasons. Its appearance (or disappearance) is a signal that weather patterns are about to change. Some regions will warm while others will cool, depending on the location of the jet stream at the time and the occurrence of any splits. The impact of El Niño on the United States is typically warmer winters and less tropical activity in the Gulf of Mexico.

Currently, much is being made of La Niña, the replacement and opposite extreme of El Niño. There is speculation that since the two events are opposites, the coming winter will be colder than normal. However, history does not always support this conclusion. One reason why La Niña does not consistently ensure a colder winter stems from the duration, intensity, and ending date of the previous El Niño along with a multitude of other natural factors transpiring at the time.

Most climate cycles (including El Niño and La Niña) are traceable to solar origins and correlate reasonable well with the basic 11-year solar cycle, even considering possible lag times. The solar influence is indirect and occurs through one or more unknown mechanisms that include geomagnetic disturbances and volcanoes which in turn affect other natural phenomenon in a domino-like chain reaction. Much longer cycles in nature such as planetary alignments can trigger solar flares which in turn affect the earth's upper air circulation and the jet stream. While such phenomenon may appear random at the time, instantaneous events may constitute only a "snapshot" of what is occurring in the grander scheme of nature's cycles.

Short-Term Gas Prices *(continued from page 15)*

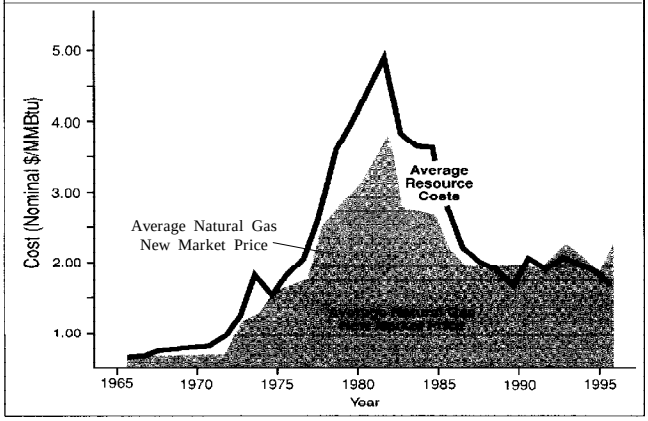
wild spikes and crashes that draw headlines.

Producer Economics

At the end of the day, gas prices reflect a collective attitude towards the market. Producers will drill new wells, recomplete existing wells and enhance production through restimulation or addition of compression only when expected prices are sufficient to justify the investments. Other important long term factors include the expected success rate of the drilling program, anticipated size of new discoveries, recoveries per well, time profile of production, and the future price of crude oil, natural gas, and gas liquids.

These factors translate into oil and gas "resource costs," or the minimum price needed to make an investment worthwhile. Figure 3 shows the long term estimated nominal-dollar resource cost of dry gas for average new gas wells drilled in the United States from 1966 to 1996. The resource costs are calculated using historical costs and engineering parameters (e.g., success rate, recovery per well) and assume a minimum rate of return of five percentage points above an average AAA corporate bond issued in each year. After reaching a high of $4.89 in 1982, the resource cost of new, non-associated gas fell until 1990 and has since averaged about $1.55 per MMBtu of dry gas.

Figure 3: Average U.S. Natural Gas Resource Costs



Also shown in Figure 3 is the average gas price received each year for production from new wells. These prices reflect regulated pricing through 1982 and, thereafter, market prices. As Figure 3 shows, resource costs tend to move in the same direction as prices. This stems from the pattern of producer investment (i.e., producers concentrate on low-cost gas when prices are low but make incremental

investments for more expensive gas when prices are high) and the factor costs to producers (e.g., lease acreage, wells) oscillate with oil and gas prices.

In the early years shown in Figure 3, prevailing market prices were below resource costs indicating that producers were making investments on the expectation of higher future prices. In more recent years, prevailing gas prices have been higher than the estimated resource costs. This indicates that the producers' realized rates of return have exceeded the rate (five percentage points over AAA corporate bonds) used in the resource cost calculation. Producers have been successful in applying technology to lowering finding costs relative to declining gas prices.

Proactive Producers

Much has been written in the trade press about producers periodically curtailing production when gas prices collapse. The most recent instances occurred in February 1992 and July 1995 when plummeting daily prices approached the dollar level. News of gas curtailments by producers probably has more impact on market psychology factors than appreciable changes in volumes delivered into the market.

In reality, production at 100 percent of capacity continuously around the clock is an elusive goal due to the need for periodic maintenance, equipment stream-day treating and processing equipment factors, and bottlenecks in the gathering and transportation system necessitating throttling production. As a practical matter, 95 to 97 percent utilization is probably an optimal level on a sustained basis. During the much publicized "gas bubble," when there was an excess of deliverability overhanging the market, the utilization factor was in the low 80 percent range. There is usually the potential for operators to increase production a few additional percent if the demand pull becomes strong enough. Producers gauge how close to the limit they can produce through feedback gathered in conversations from potential buyers regarding sizes of parcels desired, urgency, and frequency of contact.

Some producers will not flow gas from a property if such production will lead to lower reported stockholder earnings. The price below which losses would be reported on a property is often referred as the "shut-in" price.

The decision to produce or shut in a property is usually made based on the impact to reported corpo-

(continued on page 18)

Gas Futures Markets:
The Role of the Speculator

Since the advent of gas futures trading in 1990, speculators have come to play a significant role in influencing gas prices. The role of the speculator in the market is to turn a profit by anticipating price moves. Although speculators do not hold physical gas, their contribution to the "paper" market consists of liquidity, volume, and volatility.

Most speculators are in the market for only short periods of time. They utilize technical analysis techniques to spot price moves and turning points early. Speculators and other small traders seek to identify trends and set action points (support and resistance) based on past market behavior. Action by the group as a whole often acts as a catalyst to magnify short term trends that can feed on itself and cause intra-day price spikes.

While hedging in the energy industry is the source of fierce theoretical debate, the long and short positions of the commercial hedgers who actually buy and sell futures contracts seldom match up. Thus, speculators provide the incremental liquidity needed for the futures market to operate smoothly and efficiently. In effect, speculators create an additional market and assume the price risk that the commercial hedgers attempt to avoid.

On balance, speculators in natural gas markets have generally preferred to purchase contracts with expectations that prices will increase, rather than selling short anticipating that prices will decline. Typically, the non-commercial traders (speculators) account for about eight percent of all open interest and about four percent of all short positions.

A review of historical futures volumes indicates that speculators tend to substantially increase their open positions during periods of increasing gas prices, and reduce their net open interest during periods of declining prices. The difference between long and short positions held by speculators, known as the net open interest, has the effect of increasing demand for gas contracts during periods of rising prices, and decreasing demand during periods of falling prices, potentially amplifying price swings in the market.

Short-Term Gas Prices *(continued from page 17)*

rate profits, simple marginal costs, or a variety of other intangible factors. In order to show a profit on a property the gas price must cover out-of-pocket expenses, depreciation, depletion, and amortization (DD&A) , operating and maintenance costs (O&M), royalties and severance taxes.

In the typical case, out-of-pocket expenses amount to about $1.18 per MMBtu of dry gas. After subtracting a $0.31 credit for natural gas liquids revenue (variable depending on the LPG market) realized by the producer, this comes to $0.87 per MMBtu at the wellhead or about $1.02 per MMBtu after factoring back in gathering costs. The wellhead shut-in price of $0.87 is much lower than the $1.30 to $1.80 resource cost experienced in recent years because the shut-in price accounts only for capitalized investments and ignores investment costs that are expensed. Capitalized investments include successful wells, lease equipment, leasehold costs on producing acreage while investment costs cover dry holes, leasehold costs on abandoned acreage, geological and geophysical expenses and corporate overhead. Other expenses relate to financing costs including interest on debt and return to stockholders.

Since each producing region and lease is unique, shut-in costs cover a range starting at $0.50 per MMBtu on the low end of the spectrum to over two dollars per MMBtu on the high end. The lower extreme is based on higher than average well productivity (or lower than average costs) with opposite assumptions for the higher end. Because the most productive wells eclipse their less productive counterparts, the vast majority of non-associated gas in the U.S. has short-run economics similar to the lower and middle range with significantly less production requiring prices above two dollars.

Not all gas producers use shut-in prices based on impacts to profit and loss statements in their production decisions. Small producers, for example, may look at only marginal production cost (O&M costs, royalties and severance taxes) and will ignore DD&A in determining a shut-in price either because they have no publicly traded stock or because they have cash flow requirements that must be satisfied regardless of profit impacts. In other cases, an operator might be forced to continue flowing gas even at low prices due to lease requirements or to avoid damaging gas reservoirs. Conversely, some producers might choose to shut in production with expectations that prices will rebound in the short term, although such a strategy is hard to justify except in reservoirs with the fastest decline rates.

The Big Picture

In the short term, prices rise or fall based on perceived shortages or surpluses arising from the interplay of the principal driving factors. How the various market players respond to multiple short term stimuli creates the dynamics of the gas market.

Expectations move gas prices short term. Fundamentals establish the level of gas markets longer term as short term excesses ultimately shift and self-correct. Longer term, prices need to be sufficient to stimulate development of additional natural gas reserves. While short term prices can deviate from long term trends temporarily, any sustained deviation will result in either under or over development of the resource, creating supply imbalances forcing short term markets to again converge with long term underlying trends.

Over the last decade, the long term factors influencing gas prices have largely offset one another. Growth in demand has been offset by development of new resources, reductions in finding and production costs, and improvements in production, transmission, and distribution efficiency. In the long term, natural gas price levels react to the fundamentals driving supply and demand. Producers must recognize that short term prices will continue to oscillate about the longer term equilibrium price.

Portions of this article were adapted from the recently released GRI publication "Short Term Gas Prices: How The Market Adjusts To Changing Fundamentals." For ordering information, please contact Val Megginson at 703/526-7832; FAX 703/526-7808; or via e-mail at vmeggins@gri.org. For questions regarding this article, contact John C. Cochener, Principal Analyst, at 703/526-7834 or via e-mail at jcochen@gri.org.

REFERENCES

Short Term Gas Prices: How The Market Adjusts To Changing Fundamentals, Gas Issues & Trends Report, GRI-97/0375

Cochener, John, 1995. *"The Iceman Cometh?," Hart's Natural Gas Focus,* Vol. 3, No. 5 (October), pp. 20-25.

Cochener, John C., 1992. *"Long-term Cycles in Heating Degree Days- The Impact on Demand for Natural Gas," Cycles,* (July-August), pp. 187-190.

Conference Explores Promise and Problems Of Latin American Energy Market

Western Hemisphere energy cooperation was the subject of the Fourth Annual Energy Policy Conference sponsored by the National Capital Area Chapter (NCAC) of the IAEE, by the Johns Hopkins -Nitze School of Advanced International Studies, and the Energy Council. The conference was chaired by Leonard Levine of TransCanada Pipelines Inc. Session Chairmen were Wilfrid Kohl, SAIS; David South, Energy Resources International, Inc.; and Rafael Quijano, LAPIZ. The conference welcome was presented by NCAC President, Joe Dukert. The conference introduction was presented by Representative Joseph Green, House Majority Leader, Alaska House of Representatives.

David Pumphrey presented the conference address, which summarized the U.S. Government's long standing contribution to Western Hemisphere energy cooperation, with particular emphasis on the need for opening markets and promoting trade and investment.

The proceedings emphasized that the interdependence, long-exemplified by Canada and the United States in the trade of energy and energy products, has spread to the southern part of the hemisphere. Some examples are Mexico and Venezuela's oil exports to neighboring countries and their important trade of petroleum and its products with the United States. More recently, the reliance on imported technology and capital has transformed the electricity markets in several Latin American countries. Also, trade of natural gas and power is now developing among Latin American countries.

Conference panelist Sarah Emerson of Energy Security Analysis Inc., anticipates crude oil imports to the United States from Western Hemisphere countries will eventually supplant Persian Gulf imports—but not those from the North Sea and West Africa, due to their high quality and proximity to the East Coast. She believes that by 2010, the growth in demand for U.S. oil product imports will exceed present capacity, and that this may lead to investments in new Latin American refineries.

Jaime Millan, of the Inter-American Development Bank, discussed the evolving Latin American electricity market. He anticipates the eventual development of integrated regional markets for electricity and gas in the Southern Cone, Central America, and Mexico, from the very limited cross-border trade of natural gas and power that now exists in the Southern Cone.

Chakib Khelil of the World Bank stated that the use of natural gas in power generation has increased rapidly in this decade in Argentina and other countries, following the introduction of combined-cycle gas turbines that sharply reduce the cost. Underlying the growing use of natural gas in the power industry, was the privatization in many countries of previously state-owned and financed energy infrastructure. John Harkins of TransCanada Pipelines Inc., discussed the construction of the TGN pipeline that connects Chile and Brazil with Argentina's gas reserves, and other natural gas pipelines his firm has built in Colombia and Mexico. Frank Langhammer of Taylor-DeJongh Inc., spoke of his company's role in helping finance large infrastructure projects, that previously were financed by host governments. Typically, the sponsor puts up one-fifth to one-quarter of the total cost, and the remainder comes from multilateral banks, export credit agencies, commercial banks, and insurance companies. Chris Goncalves of Pace Consulting LLC, discussed the need for investors to be able to balance their political and financial risks effectively.

The working relationships and common experience built up over the years between the U.S. and Latin American Countries in energy matters are now spurring a cooperative approach to major issues of the Kyoto Treaty, many of which relate to the use of energy. David Pumphrey, of the U.S. Department of Energy, cited several examples of hemispheric cooperation that have come out of the Summits of the Americas: Initiatives on unleaded gasoline, energy efficiency, and clean power technology, as well as agreements on regulatory reform. He foresees agreements to come on market integration and the exchange of climate information.

The Clean Development Mechanism (CDM), a provision of the Kyoto Protocol that permits additional benefits for investments and technology transfers in 2000-2008 for climate mitigation in developing countries, has encouraged a number of U.S. firms to invest in pilot projects in Latin America. Sid Embree, of Clean Commodities Inc., said her firm has considered projects in biomass, solid waste disposal, high efficiency technology, and CNG vehicles. John Palmisano of Enron International, stated that companies like his, when considering an investment to reduce greenhouse gas emissions, would be guided not only by cost but also by whether the project related to its core business, or that of a customer. Duncan Austin of the World Resources

(continued on page 24)

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The Structure of the Energy Industries: The Only Constant is Change

20th USAEE/IAEE Annual North American Conference – August 29 – September 1, 1999
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Announcement and Call for Papers

Economic upheaval, globalization, privatization and regulatory reform are having significant impacts on energy markets throughout the world. All of the major energy industries are restructuring through mergers, acquisitions, unbundling and rebundling of energy and other services. This conference will provide a forum for discussion of the constantly changing structure of the energy industries, with insights into the causes and likely outcomes of the restructuring efforts that are not underway. Some of the major conference themes and topics are as follows:

Oil Industry Restructuring
Natural Gas Markets in the New Century
Global Gas & Power
The Climate Change Debate
Electricity Restructuring
Alternative Fuel Vehicles
The Global Economy and its Effect on the Energy Industry

At this time, confirmed and/or invited speakers include the following:

Kathy Abbott, Columbia Gas (invited)
Joe Foster, Newfield Exploration
Knut Anton Mork (invited)
Matt Simmons, Simmons & Company
Ronald Sutherland, American Petroleum Institute
Steven P. Brown, Federal Reserve Bank of Dallas
Michael C. Lynch, MIT
Adam Sieminski, BT Alex Brown, Inc.
Kyle Simpson, Morgan Meguire, LLC
Scott Woronuik, TransCanada Pipelines

In addition, 25 concurrent sessions are planned to address timely topics that affect all of us specializing in the field of energy economics. Sessions under development or consideration include:

Modeling Competitive Electricity Markets
Environmental Analysis and Regulation
Oil Supply Outlook: International Projections
Evolving U.S. Natural Gas Markets
Latin American Deregulation
Globalization of the Electricity Industry
Energy Modeling: Past, Present and Future
A New OPEC?
The Outlook for Coal and Nuclear Power
Doing Energy Business in the Information Age: Removing the Barriers
Energy Reform in Transition Economies
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U.S. Oil Policy
Global Change: Economic and Energy Policy Implications
Energy Efficiency in a Glutted Market
Market Power in the Transmission Industries – (NG & Electricity)
Distributed Generation
Convergence in the Utility Industries

Anyone interested in presenting a paper or organizing a session should propose topics, motivations, and possible speakers by April 21, 1999 to:

Mary Lashley Barcella - 202-429-6670 / mlbarcella@msn.com or Mine K. Yucel - 214-922-5160 / mine.k.yucel@dal.frb.org

Abstracts should be between 200-1500 words and must clearly address the theme of the conference and topics above to be considered for presentation at the meeting. At least one author from an accepted paper must pay the registration fees and attend the conference to present the paper. All abstracts/proposed sessions and inquiries should be submitted to: David Williams, Executive Director, USAEE/IAEE 28790 Chagrin Blvd., Suite 350, Cleveland, OH 44122 USA Phone: 216-464-2785 / Fax: 216-464-2768 / E-mail: iaee@iaee.org

The 20th USAEE/IAEE Annual North American Conference provides a unique opportunity for leading experts from business, government, universities, and research institutions to discuss and debate the future of energy markets in this era of commodization, decentralization, and internationalization.

The meeting will emphasize the applicability of the most recent, cutting-edge analysis for helping private and public organizations frame decisions and choose appropriate strategies.

In the past, USAEE/IAEE conferences have attracted outstanding speakers. You can be sure that prominent speakers who are on the cutting-edge of energy economic issues will once again address this annual meeting.

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

The Structure of the Energy Industries: The Only Constant is Change

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Conference Explores...*(continued from page 19)*
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Publications

Energy in China, James P. Dorian (1998). Price: $632. Contact: FT Energy Asia Pacific, 159 Telok Ayer Street, Singapore 068614. Phone: 65-323-6373. Fax: 65-323-4725.

Energy Risk Management, Peter C. Fusaro (1998). Price: $70.00 in North America or £ 53.99 in Europe. Order Number 0-7863-1183-3. McGraw Hill Publishing, PO Box 182604, Columbus, OH 43272-3031. Phone: 1-800-2-MCGRAW or Fax: 1-614-759-3644 in the US, and Phone: 44-1628-502-532, or Fax: 44-1628-621-662 in Europe.

Power Systems Restructuring, Marija Ilic, Francisco Galiana, Lester Fink (1998). Price: $145.00. Contact: Kluwer Academic Publishers, Order Department, PO Box 322, 3300 AH Dordrecht, The Netherlands. Phone: 31-78-6392392. Fax: 31-78-6546474. E-mail: orderdept@wkap.nl

Power in China (1998). Price: $225.00. Contact: Asia Law & Practice Publishing Ltd., 5/F, Printing House, 6 Duddell Street, Central, Hong Kong. Fax: 852-2543-7617. E-mail: enquiries@alphk.com

Gas Liberalisation in Europe (1998). Price: £399. Contact: Management Reports, ICBI, 8th Floor, 29 Bressenden, Place London SW1E 5DR, United Kingdom. Phone: 44-171-850-5103. Fax: 44-171-850-5101.

The Future of the European Electricity Market (1998). Price: £399. Contact: Management Reports, ICBI, 8th Floor, 29 Bressenden, Place London SW1E 5DR, United Kingdom. Phone: 44-171-850-5103. Fax: 44-171-850-5101.

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25-26 March 1999, Brazil Energy '99. Miami, FL. Contact: Registration Dept., Center for Business Intelligence, LLC, 500 W Cummings Park, Suite 5100, Woburn, MA 01801. Phone: 781-939-2438. Fax: 781-939-2490. E-mail: registrar@cbinet.com

19-20 April, 1999, Energy & Power Risk. Hyatt Regency, Houston, TX. Contact: ICM Conferences, 303 E Wacker Drive, 20th Flr., Chicago, IL 60601. Phone: 312-894-6416. Fax: 312-894-6358.

20-22 April, 1999, Electric Power '99 - Conference & Exhibition. Baltimore, Maryland, USA. Contact: Electric Power '99, c/o The TradeFair Group, Inc. 1220 Blalock, Suite 310, Houston, TX 77055. Phone: 713-463-9595. Fax: 713-463-9997. E-mail: event@electricpowerexpo.com

4-6 May 1999, IEA International Workshop on Technologies to Reduce Greenhouse Gas Emissions: Engineering-Economic Analyses of Conserved Energy and Carbon. Washington, DC, USA. Contact: John Newman, IEA, Phone: 33-1-40-57-67-15. Fax: 33-1-40-57-67-49. E-mail: johnnewman@iea.org or Jeffery Dowd, US DOE, Phone: 202-586-7258. Fax: 202-586-4447. E-mail: jeff.dowd@hq.doe.gov

17-18 May, 1999, Energy '99 – 8th Annual Latin American Energy Conference. Hilton La Jolla. Contact: Institute of the Americas, 10111 North Torrey Pines Road, La Jolla, CA 92037. Phone: 619-453-5560. Fax: 619-453-2165.

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28-29 September 1999, 1999 Natural Gas Conference. Montreal , Quebec, Canada. Contact: Industrial Gas Users Association. Phone: 613-236-8021. Fax: 613-230-9531. E-mail: igua@igua.ca

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