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The Problem with Natural Gas

7.14.05 *Frank Clemente, Senior Professor of Sociology and Energy Policy, Penn State University*

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In 1997, Joseph Riva, senior geologist writing for the Colorado School of Mines, turned a skeptical eye toward the rapidly emerging dependence of the United States on natural gas (NG). Riva suggested that the rush to embrace NG as the primary fuel to meet incremental electricity and space heating demand was based more on sociopolitical hope than on geological reality. Noting that domestic NG production had peaked at 22.6 tcf in 1973, Riva questioned not merely whether the EIA projected production of 25.5 tcf by 2015 could be met but even whether the then current output of 19.8 tcf could be maintained. Basing his analysis on the level of known reserves and the rate of new discoveries, Riva argued that unless an unprecedented number of large fields were found soon:

"by early next century, natural gas will have become more of an energy problem than an energy solution".

Subsequent events have provided ample support for Riva's grim assessment: (1) domestic NG production only reached 19.7 tcf in 2004 despite an additional 461 rigs in the field—an 82 % increase over 1997; (2) NG well head prices have steadily escalated from $2.10 mcf in 1998 to $ 6.31 mcf in the first four months of 2005 – an increase of $ 4.21 (200 %); and (3) chief U.S. policy makers (e.g., Alan Greenspan) now readily admit the nation cannot meet its NG supply needs and will be increasingly reliant on imports from politically unstable areas – darkly paralleling our current dependence on foreign areas and the entailing socioeconomic costs.

In essence, Riva's foretelling is coming to pass. The present paper takes his concerns as a point of departure to delineate a range of reasons as to how unless the United States begins to take the NG supply / demand situation more seriously, NG is likely to move from the role of energy boon to national liability.

THE SPECTER OF DEMAND SHOCK

Given the status of NG as the cleanest of the fossil fuels, a confluence of environmental regulations, efficiency of combustion and simple convenience has led to an unprecedented build-out of the NG demand infrastructure – particularly through massive construction programs for power plants and new single family homes. Yet, despite this increased dependence on NG to supply electricity and heat our buildings, the casual observer of business news would be hard pressed to find a systematic discussion of the commodity. The price of oil has its own ticker on television business networks but NG may or may not be mentioned in a given day. As a result of this benign neglect there is only dawning recognition that a shortfall of NG may soon reverberate throughout the socioeconomic system – harkening back to the 1970's with the closing of schools and businesses in the dead of winter, reducing manufacturing production and leaving millions of homeowners wondering how they are going to pay their heating bill.

The stunning realization of the NG problem, however, is only a sustained heat wave, hurricane, frigid January, coal strike or nuclear shut-down away. And when that day comes the U.S. will come face to face with a series of NG demand issues looming ever larger on the horizon:

(1) **Construction of NG heated homes** – throughout the 1970's and 80's electricity was the preferred space heating source for newly constructed single family homes. In 1979, for example, 51% of new homes were heated with electricity as opposed to only 39% with NG. Over the past decade, however, NG has clearly become the fuel of choice in 70% of new homes with electricity dropping to 27%. In fact, over the period

2001-2004 over 3.3 million new homes heating with NG have come on line – over 70,000 per month. Further, the construction of new homes is hardly slowing as the most recent housing data indicate that single family homes heating with NG are growing at an annualized rate of over 1.1 million. Finally, these homes are being constructed in regions with harsher winters .The latest American Gas Association data indicate 92% of new homes in the Midwest heat with NG as opposed to only 48% in the South.

(2) **Construction of NG fired power plants**. The NG shortages of the 1970's prompted the passage of the 1978 Fuel Use Act (FUA) effectively banning NG fired electric power plants as well as the use of NG in large industrial boilers. These restrictions on NG consumption led to a substantial decline in demand and the eventual formation of a supply "bubble" – which in turn resulted in chronically low NG prices (See EIA, 2005). In 1987 much of the FUA was repealed setting off a surge in the construction of NG power plants. Indeed, NG consumption for electric generation rose from 2,636 bcf in 1988 to 5,352 bcf in 2004 (a 103 % increase). In fact, since the 1990s virtually all new power plants have been NG units in an historic departure from the traditional fuel diversification strategy of electric utilities:

TABLE 1
New NG Fueled Generation 2000-2004

YEAR	NG FIRED MW ADDED
2000	25,600
2001	40,600
2002	57,100
2003	53,400
2004	25,900

In essence, in just five years we have added over 200,000 MW of NG facilities to the electric power system in the United States – the functional equivalent of 245 Calvert Cliffs Nuclear Units (825 MWe). And the NG beat goes on – in April, Florida Power and Light announced the addition of a new 1,100 MW combined cycle plant at Manatee; in May, Calpine placed a 500 MW unit in operation at Pastoria in California and this summer, utilities in Wisconsin will add almost 1,300 NG fired MW to the grid. Finally, and somewhat amazingly, the EIA projects that over the period 2005 – 2007 we will build an additional 83,000 MW of power stations – of which 73,000 (88%) will be NG fueled.

(3) **Organic Demand Growth**

The population of the United States increases by one person every 12 seconds – or 2.6 million per year. In April of 2005 there were about 650 thousand homes under construction which will heat with NG. Thousands of MWs of new NG fired turbines are being constructed or are in the planning stage. The OMB projects the economy of the United States will grow by over three percent each of the next five years. Each year thousands of cars, trucks and busses join the NG fleet. Stores, swimming pools, apartments, agricultural buildings and many other NG dependent facilities are constructed throughout the Country every single day.

The EIA has projected NG consumption growth along these lines:

TABLE 2
Projected Consumption Growth by Sector (bcf)

Sector	2004	2010	Increase	% Increase
Residential	4,957	5,524	567	11
Commercial	3,103	3,387	284	9
Industrial	8,188	9,046	858	10
Electric Generation	5,226	6,739	1513	29
Other	664	737	73	11
TOTAL	**22,168**	**25,433**	**3,265**	**15**

This relentless pressure from natural increase provides a chronic dynamic of demand growth complementing the potential acute demand from weather or alternative fuel problems.

(4) **Supply constraints on other fuels for electricity**

The United States is the most electric intensive nation in the world. Demand for electricity has steadily increased over the past half century and that growth has accelerated over the last 15 years. In 1991, for example, the U.S consumed about 2,762 billion kilowatt hours (kwh) of electricity. By 2004 demand reached 3,550 billion or an increase of 29%. Coal provided half of this electricity, nuclear 20% and NG 17 %.

Further, the demand for electricity is projected to increase steadily for the foreseeable future. The EIA has projected that 2005-2006 will see a demand increase of 189 billion kwh. To put the magnitude of this bi-annual increase in perspective, an 825 MWe nuclear power plant such as Calvert Cliffs 1 generates about 7.5 billion kwh in a year – or about 4 % of what must be added in 2005/2006 alone – thus, necessitating the construction of the equivalent of over 25 such nuclear power plants (compared to an existing nuclear fleet of 103).

Virtually all of the recent growth in electricity demand , as well as forecasted growth , has been, and must be, met by NG. The construction of NG power plants dominates the electric power situation in the United States.

TABLE 3
New Generation : NG Versus all Other Fuels

Period	New Generation Capacity (MW)	% NG	% All Other Fuels
2000-2001	66,200	95	5
2002-2003	110,500	96	4
2004-2005	29,426	90	10
2006-2010	21,513	86	14
TOTAL	272,429	93	7

In essence then, for the entire decade, new capacity for coal, nuclear, hydro and all other fuels combined will have provided only seven percent of all new power plants – dramatically highlighting the Nation's increasing dependence upon NG. Further, each of these alternative fuels has sufficient problems to question whether they can meet even that meager expectation.

Coal provides about half of our electricity but is faced with (a) stringent environmental regulations, (b) transportation constraints and (c) questions about expanded production. The EIA, for example, has projected that coal production would expand 53 million short tons in 2005 versus 2004 – an increase of 4.7%. Year to

date output, however, reveals that production in 2005 has actually decreased sequentially by 489,000 short tons or 0.1%.

In terms of nuclear power, the 103 existing stations are already operating near maximum capacity (94%) despite their aging status (most over 25 years). The lead time to build a nuclear plant would take us well into the next decade. And in regard to hydroelectric, drought conditions in the western U.S. make each year a touch and go situation. This year, for example, the snowpack melt peaked in late May and rivers in Washington are currently running below normal. Further, not only is there environmental opposition to new hydro facilities but even the relicensing of existing units faces intense scrutiny. Finally, as of this writing, oil is over $60 per barrel. Clearly, the degrees of freedom for fuel switching away from NG to meet incremental , indeed, even existing , electricity demand are quite limited.

THE EMERGING SHORTFALL OF NG SUPPLY

In 2004 the United States consumed 22,424 bcf of NG – virtually all of which came from one of three sources – (1) domestic production [82%], (2) imports from Canada [15%], and (3) imported LNG [3%]. Further, the EIA has projected steady demand increase with consumption rising to 25,433 bcf in 2010 and 29,952 in 2020. Given the increasing demand for NG, continued – and expanded – supply from the three primary sources delineated above is essential to meet growing demand.

Unfortunately, significant and alarming problems with each of these sources threaten to substantially curtail supply and thereby contribute an emerging shortfall of NG. Consider, for instance, in 2004 only three regions accounted for 58% of the U.S. NG supplies – the Federal Gulf of Mexico (18%), Texas (24%), and Canada (16%).

(1) **Declining Production in the Gulf of Mexico**

In 2000 the Federal Gulf of Mexico (GOM) accounted for 24 % of NG production in the United States. Depletion and the exodus of major oil companies, however, have taken a toll:

TABLE 4
Declining production in Federal Gulf of Mexico

Year	GOM Production (bcf)	Y/Y Decline %
2001	5,028	---
2002	4,511	10
2003	4,406	2
2004	4,139*	6

* Adjusted upward 160 bcf to account for Ivan shut-in.

As these data indicate, production in the GOM declined steadily over 2001-2004 by 889 bcf or 18 % and by 2004 the GOM accounted for only 20% of U.S. production. Further, data from January, 2005 indicate this decline is continuing as a further 17 bcf (5%) Ivan adjusted drop occurred relative to January, 2004. And, given the recent drilling patterns in the GOM, it is likely this decline will continue. In 2001 there were 153 rigs drilling in the GOM, by 2003 that number had decreased to 108 – and last week it had slipped to 95.

(2) **Stagnation in Texas**

Texas has been a mainstay of NG production in the United States and in 2004 accounted for 27% of output. But there are real indications that the relentless nature of depletion is beginning to take a toll on Texas production. Indeed, Dietert and his associates (2005) have argued that important NG fields in Texas are susceptible to significant decline rates. While EOG has pegged the overall first year decline rate for new wells at 30% , 2005 Dietert et al have argued that decline rates for particular fields --- Barnett Shale, Bossier Trend and South Texas are now in the 65-75% range. Actual production data from Texas starkly indicate the

treadmill facing the NG industry:

TABLE 5
NG Production in Texas versus Producing Wells

Year	NG production (bcf)	Producing Wells	Production per Well (bcf)
1970	9,450	23,417	.403
1980	6,998	37,345	.187
1990	5,533	49,989	.111
2000	5,645	60,486	.093
2002	5,611	65,686	.085
2004	5,874	69,964 (e)	.084 (e)

In other words, it took three times as many wells in 2004 to produce 62% of the NG produced in Texas in 1970. These data give real meaning to the oft repeated maxims “treadmill” and “the lowest fruit has already been picked”. And the downtrend continues, preliminary data from the Texas Railroad Commission indicate that 71,440 wells as of February, 2005 could not stem a production decline of over 12% versus February, 2004.

(3) **Canada has its own NG Problems**

In a 2003 article I argued that Canada would be unlikely to alleviate NG supply problems in the United States. Specifically, Canada faces many of the same supply issues which plague the U.S. – namely – depletion. In terms of depletion, First Energy (2004) has estimated annual decline rates for western Canadian NG fields :

TABLE 6
Western Canadian NG Decline Rate

Year	Decline Rate for Underlying Production (%)
1991	7
1995	14
1998	18
2001	19
2004	21

Actual production data provide strong evidence of these decline dates. In 2002, there were 9,061 NG wells drilled in Canada and production was 17.4 bcf/d. In 2004, there were 16,000 wells drilled and production was still 17.4 bcf/day. In other words, an increase of 6,939 (77%) wells from 2002 to 2004 was only able to keep production flat. The shocking implications of this pattern are obvious.

This situation is especially disturbing since Canada has been the overwhelming source of NG imports to the U.S. In 1993, for example, Canada accounted for 86% of U.S NG imports and by 2003 that figure was 87%. The Canadian safety net has been crucial as our own NG production declined and demand ramped up.

Unfortunately, based on EIA forecasts the days of increasing NG imports from Canada appear to be over:

TABLE 7
NG Imports From Canada

Year	Imports from Canada (bcf)
1990	1,430
1995	2,789
2000	3,471
2005 (e)	2,998
2010 (e)	2,573

In essence, the rise in Canadian imports in the 90s appears to have peaked and declining imports are projected with a decline of 898 bcf (26%) from 2000 to 2010.

(4) **Drilling and Service at Full Utilization**

In 1980, 3970 rigs were drilling for oil and NG in the United States. As the industry fell on hard times in the next two decades the number of active rigs steadily declined to reach a nadir of only 625 in 1999 – a decline of 3,345 (84 %) rigs in less than 20 years. Idle rigs were sold at pennies on the dollar, left in the field to rust or cannibalized for parts. The rig construction industry came to a virtual standstill as less than ten rigs were built per year. The rig service industry experienced a corresponding decline as workover and service companies simply went out of business or were merged with larger competitors. And finally, the workforce in the oilpatch steadily aged as few young people were willing to risk a career on what many considered a moribund industry.

This chronic underinvestment in our energy supply infrastructure is coming home to roost. Andrew Gould, CEO of Schlumberger, succinctly summarized the situation in the keynote presentation at the Howard Weil Energy Conference in April:

“the industry is dealing with … the lack of investment over the past 18 years … A lot of the rig fleet, and much of the equipment are old. Very little spare capacity exists … [but] the most disturbing shortage by far is the lack of [energy] professionals … skilled people have either been laid off, or have retired from the industry.”

Recent data place Gould’s concerns in bold relief. The U.S. rig count has surged to over 1,358 out of an estimated 1,470 capable rigs. When rig float (units being moved from one site to another) is considered there are apparently only several dozen capable rigs not working.

In fact, Richard Mason at Land Rig Newsletter has indicated the panic to get a rig has propelled huge increases in dayrates because land drillers are “out of rigs for all practical purposes”. Further, Mason notes that even the most optimistic estimates indicate less than 100 newbuilds or refurbishments would be available before 2007 – compared to 325 added from inventory in 2003-2004 alone.

The situation in the GOM is even more alarming --- the rig market is so tight that dayrates have leaped from $24,000 in 2003 to $62,000 or more. Attrition of older rigs and years of outmigration from the GOM have left the region with only a fraction of once available rigs.

Further, the GOM faces the specter of even further outmigration as national oil companies and operators in the Middle East, Far East and North Sea are willing to pay as much as $140,000 per day for a premium rig. And, to add insult to injury, although there are over 30 news builds on order, it appears that none will be available for the GOM. Given a world-wide bidding war, Daniel McNeese at Rowan summed up the risk to GOM production:

“rigs are going to get pulled out of here if rates don’t go up … I mean people are bidding all over the world”.

Equipment and tubular manufactures such as National Oilwell Varco (NOV) and Maverick Tube (MVK) are hard pressed to meet demand and face record backlogs. Thomas Richards at Grey Wolf Drilling recently complained that even simple rig components were taking six months on order and another drilling firm stated that NOV should "double the size of their company". Clearly, the age of the fleet (most rigs are over 25 years old) means that continual refurbishment is exacerbating the already intense pressure on rig suppliers.

And finally, the shortage of experienced personnel haunts the industry at every turn. Guardis Banister, Technical Director at Shell Energy has anecdotally commented that "while the U.S. produces 43,000 lawyers per year we graduate only 430 petroleum engineers." Further, there are simply not enough oil field hands to meet demand, setting off intense competition for skilled workers. In a recent article, Richard Mason offered the following anecdote:

"Contractors are now beginning to cannibalize the existing labor force. A help wanted advertisement in our local Sunday newspaper was run by an Oklahoma City contractor who is moving refurbished rigs to West Texas. The Company was looking for toolpushers … a bonus, was available if toolpushers could bring crews along."

Finally, the lack of new blood in the industry is becoming extremely apparent. Panelists at an Offshore Technology Conference session in May warned that the average age of personnel in the upstream sector is 49.

Restricted Access to Major NG Fields

Environmental and political opposition to drilling new areas greatly constrains potential NG production. Despite our haste to build a huge NG demand infrastructure we do not have the commitment to increase supply. There is a hypocrisy in place here. Recently, Representative Lois Capps (D-CA) expressed her:

"strong support for the long standing bipartisan legislative moratorium on new leasing activity … despite efforts by … the natural gas industry to open up the Outer Continental Shelf to drilling".

Yet Capps represents a state which consumed 2,383 of NG in 2004 but produced only 320 -- an 87 % shortfall. A similar situation exists in Florida, a state which consumed 726bcf in 2004 but produced only three due to offshore moratoria on drilling. Of course, neither of these states hesitates to burn NG produced off the coast of Louisiana or Texas.

The estimated NG reserves which are off limits due to governmental restrictions and moratoria are somewhat staggering:

TABLE 8

ESTIMATED RESTRICTED NG RESERVES

Region	Restricted NG Reserves (bcf)
Offshore – Pacific Coast	21,000
Offshore – Atlantic Coast	31,000
Offshore – Gulf of Mexico	43,000
Onshore – contiguous U.S.	137,000
TOTAL	232,000

Despite the ready availability of these reserves, however, the Nation refuses to initiate the development of this much needed supply. As recently as May 19, the U.S. House defeated by voice vote a proposal to open

sections of the OCS to NG exploration and development.

CAVEAT: DEUS EX MACHINA?

At this point most readers will be contemplating how (a) LNG imports and (b) non-conventional NG production, e.g. coalbed methane and deepwater drilling will alleviate this situation. There is no question both of these sources have great promise – but at this point the argument that they can both offset NG production declines and meet incremental demand is more hypothesis than proposition. Specifically, we are betting much of our energy future on untested assumptions. Recent comments from the energy industry highlight the problems with U.S. production : (1) Lee Raymond , CEO of Exxon, recently told reporters “Gas production has peaked in North America’’ and (2) Energy Security Analysis, Inc. noted the “ steep decline rates of aging fields in Texas, Louisiana and Oklahoma” and the fact that “domestic production will make up a significantly diminished share of U.S. supply”.

In terms of LNG, for example, Andrew Weismann (2005a, 2005b), has raised serious questions regarding LNG (a) availability, (b) price and (c) impact upon both our national and fiscal security. In regard to non-conventional sources, one should recognize that depletion, lack of equipment and environmental regulations impact these sources as well. Overall, the expectation that relatively untested (on a massive scale) sources of NG will offset the issues mentioned here is a high stake gamble. Like the Greek tragedies of old, salvation may arrive from out of the blue but submitting our energy future to a complex and fragile series of unverified assumptions is risky indeed.

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Readers Comments

Date	Comment
Len Gould *7.14.05*	Excellent article. One thin to add to the problem is the approaching competition for natural gas as a hydrogen source for upgrading heavier crudes to market quality. Certainly that market will absorb any potential flow increases through Canada's tar sands. Two questions: 1) How is methane hydrates recovery looking? I've heard that there are deposits undersea off the west coast of Canada which coud theoretically supply all of N America for a very long time. 2) Is there not a huge potential in pyrolysis of bio-materials that should be able to pick up slack, provided the generators can use a liquid bio-fuel substitute (see Orenda). eg. Dynamotive at http://www.dynamotive.com/biooil/ "This is the case for a 30 MWe combined cycle installation where a 20 year plant life was assumed with an equivalent feedstock cost of 3-4 $US/tonne and the COE was estimated to be 0.046 $US/kWhr. As well, there is the potential to reduce the COE further"
Joseph Somsel	So we should be starting construction on 25 Calvert Cliff nuclear reactors a year? Given that current designs have double the output, that would mean 12 reactors a year. Since one is likely to have two

7.14.05 identical reactors at a plant site, that means 6 projects need to begin every year. It the provisions of the Senate energy bill make it to President Bush's desk, only two projects (or four reactors or 6,000 MW) would recieve official support of the federal government - at first.

Each nuclear project needs about 2,000 trained technical people to build throughout the design, fabrication, construction, regulation, inspection, and testing organizations on multiyear commitments. One can assume that maybe 500 of those need some prior experience in nuclear power plants. That's 1,000 experenced nuclear power profesionals committed to just the first round of construction. So what are those thousand experienced people doing today? Watching soap operas? Playing golf? Awaiting their H1B visas?

To meet the 25 Calvert Cliffs a year goal would require 3,000 experienced personnel PER YEAR. US universities are graduating maybe 200 BS/MS nuclear engineers a year. The oil & gas industry is not the only one facing personnel shortages.

Like that popular tune of a couple of decades back said.... "I studied nuclear science; my future's so bright, I gotta wear shades!"

Tom Polikalas *7.15.05* Millions of homes using natural gas for heating should be retrofitted to use ground-coupled heat pumps to tap renewable earth energy. The Dept of Energy's "GeoPowering the West Initiative" suggests 7 million homes in the relatively near future could use "GeoExchange." Our rural electric co-op offers financing for ground-coupled heat pump "GeoExchange" systems. This financing can make the consumer better off financially from month 1--the savings on natural gas can more than offset the cost of the retrofit. I'm proud that my home uses energy produced in the US--the energy in the ground in my own back yard tapped via GeoExchange. Go to intermountainenergy.com, geoexchange.org, www.dmea.com, enlinkgeoenergy.com and dougrye.com to learn why GeoExchange should be much more extensively used for both heating and cooling homes and commercial buildings.

Joseph Somsel *7.15.05* Mr. Polikalas, I too am a fan of ground-source heat pumps. However, increasing their market share would only make a significant dent in natural gas consumption if the electricity that REALLY powers them is generated from plants that do not use natural gas as a fuel, ie coal or nuclear.

Your statement "I'm proud that my home uses energy produced in the US--the energy in the ground in my own back yard tapped via GeoExchange." is puffery at best. One can say the same about typical air conditioners except that the energy to cool your house would come from good ol' American air.

Tighten up your pitch and I'm right behind you.

Rodney Adams *7.16.05* Joseph:

The United States has a HUGE installed base of nuclear trained people that can be brought up to speed without resorting to a four year program in nuclear engineering.

Each year, the nuclear navy trains about 3000 new entry level people for various positions on submarines and aircraft carriers. Only about 10% have 4 year degrees, the rest are the technicians that do most of the work anyway. We train that number to make up for the 3000 or so that leave the Navy with experience and even more training.

During the Great Bandwagon Market of the late 1960s through the mid 1970s Americans managed to build most of the currently operating 103 reactors plus make substantial progress on an equal number of projects that were later cancelled. Obviously many of the people involved during that build up are now retired or dead, but some of them are still in the work force.

The nuclear business has been undergoing "consolidation" for several years. A number of well qualified nuclear technicians and operators have been "downsized".

It is kind of absurd for people to note the number of plants that need to be built to make up for the obvious limitations of other fuel sources and then to use those numbers as an excuse for not considering nuclear power as an integral part of the supply solution.

It is time to start building and time to stop whining to the government for subsidies. Nuclear fission can compete as long as the managers understand the technology and the rules under which they will have to live.

Graham Cowan *7.17.05* To someone who benefits from the special taxation of coal, oil, and natural gas it makes some sense to talk about subsidy for new nuclear construction. It discourages the pipeline-blast-shy, CO-intolerant public from *demanding* that construction. But from that crassly fiscal point of view it would make no sense at all to allow such subsidy actually to go forward.

If Adams does not know of any subsidy chatter that doesn't fit that pattern, he should acknowledge this.

--- Graham Cowan, former hydrogen fan
Boron: A Better Energy Carrier than Hydrogen?

Rodney Adams *7.18.05*

Mr. Cowan:

I am sorry, but you lost me with the multiple negatives.

My point is that the nuclear industry should press forward with construction decisions and not waste its time in Washington waiting for the government to help financially. The important government decision has already been publicly announced; the official policy of the US government is to support the development of clean, safe nuclear power. If nothing else, the President will at least use his very valuable "bully pulpit" to keep his Administration focused on that support.

I acknowledge that the coal, oil and gas industries have all kinds of special taxation and spend a lot of time ensuring that their products are viewed favorably in Washington. I also have very deep, and, at least in my opinion, well founded reasons to believe that some people with financial interests in the continued prosperity of the fossil fuel industry will do everything that they can to slow the development of nuclear power and to add to its costs as much as possible.

What were you trying to say?

Rod Adams Editor, Atomic Insights www.atomicinsights.com

Frank Clemente *7.18.05*

Len --thank you -- good questions but beyond my expertise --I hope another reader can respond to your comments--FC

Henry Dowd *7.18.05*

Mr Polikalas: I am grateful to hear your pronouncement of the efficiency of GeoExchange/Geothermal systems. I have been a strong advocate of these systems for over 20 years, It seems that we are too eager to throw away byproducts of energy production which could be recycled into meaningful thermal energy.In Sweden, the government recycles the thermal energy from powerplants and waste water treatment plants and provides district heat, snowmelting and process heat to its citizens. I was involved several years ago in calculating the thermal output from the MWRA plant in Boston. The energy not recovered was 6-9 MMBTU/hr in 100-200MM gallons per day of outfall. It would make more sense to recover this energy and send people an invoice than planting a windfarm in Nantucket Shoals. The city of Stockholm has a tremendous district heating system, which requires two additional HDPE tubes from the street, a BTU meter and a brazed plate heat exchanger for space heat and domestic hot water. Why are we missing the concept of a positive cash flow from public projects? Sorry for my griping, but I'm a victim of the Big Dig and the Mass. Water Resources Authority (MWRA)

Henry Dowd *7.18.05*

I apologize for my previous calculation of the MWRA plant. The quantity of energy not recovered is 6-9 Billion BTU/hr, not million. These are contained in 100-200 million gallons of treated wastewater per day. Thank you.

Ferdinand Banks *7.19.05*

Everybody - and I mean everybody - says that I am hopeless where computers are concerned, and they are probably right: this is why I have not seen this excellent paper until now. I can therefore only hope that Professor Clemente continues his work along present lines, in the course of which he informs certain of his colleagues at Penn State of the 'real' as compared to the 'fantasized' supply-demand situation with natural gas. Among other things this means that when the natural gas peak is reached, or therabouts, and the price of that resource goes into orbit, there should be relatively plenty of 'inputs' available for nuclear equipment. Of course, I would rather avoid seeing some of those inputs used, but thanks to the irrationality of some influential members of the the anti-nuclear, pro-gas booster club, I don't see thow it can be avoided.

Ken Malloy *7.19.05*

I am appalled that you would raise the specter of “harkening back to the 1970’s with the closing of schools and businesses in the dead of winter” and discussing the tightening supply and demand balance without barely a mention of the role of price. The 70’s crisis was caused by price controls. In the 80’s and 90’s, we did something about. Today the modern gas industry responds to supply/demand imbalance with price fluctuations. THERE WILL BE NO INVOLUNTARY CLOSURE OF FACILITIES BECAUSE OF LACK OF SUPPLY. (Sorry for shouting.) Prices will increase which will have the following salutary effects: supply will go to those who value it most, supply will be increased, and consumption will be reduced. If there is a “natural gas” problem, it is the fact that electric consumers do not see the real implications of their demands for electricity because we hide price from them. If consumers saw peak and off peak electricity prices, we would have a different distribution of consumption, lowered overall consumption of electricity, and less demand for natural gas in electric generation.

Randy Park *7.19.05*

I'm afraid Mr. Malloy falls prey one of the two mythical responses to the approach of hydrocarbon energy peaking - "the market will save us." (The other response being "technology will save us.") But if one

reads Frank Clemente's article carefully, he does not state there will be involuntary closure because of lack of supply, but rather "... the closing of schools and businesses in the dead of winter, reducing manufacturing production and leaving millions of homeowners wondering how they are going to pay their heating bill." This is a quite plausible outcome of the supply/demand price fluctuations Mr. Malloy speaks of. In fact, he says "consumption will be reduced." If not by schools and businesses, by whom? The problem is that supply will NOT be increased, because of the geological reality of depletion of the current fields. Sure, some currently uneconomical fields may be able to yield more at a higher price, but they will not make up for depletion of the existing fields. Nuclear power is the only near term viable replacement - and we'd better get working on it soon.

Santiago Velez *7.19.05*

As a relatively new employee and Nuclear Engineer (5 years) for a large Nuclear Utility I understand first hand the shortage in personnel and expertise required to expand the nuclear industry. As a student in Nuclear Engineering in 1996 through 2000 I was discouraged by academia to join what was considered a dying industry but I understand then and more so now that the need for highly technical people is essential for continued operation and maintenance and further production of nuclear power plants. Like trying to walk a dinosaur with a leash, deregulated utilities are consolidating and downsizing the aging technical workforce by attrition and voluntary severence packages. The intent of this is to reduce the largest cost to a nuclear utility, O&M. A parallel is the reduction in employee benefits that follows when the median age of a nuclear employee is in the high 40's to low 50's with rising medical costs. What is not at the forefront of the leadership at our company or any other large nuclear utility is the 'sustained' performance of nuclear plants as they continue to age. This leaves little to no margin in the area of technical expertise for the construction of new nuclear facilities. The philosophy of the nuclear utilities and moreso steam supply vendors, such as GE, Westinghouse, and AREVA needs to change from one of large scale mammoth construction processes for a new nuclear plant, to modular in-factory production of reactor vessel, steam generators, and large components. This will reduce the construction uncertainties and delays associated with on-site construction and minimize the capital costs for the 1st of a kind plant. It will also allow consildation of human resources when there are multiple units on one site. Ultimately, the supply chain of nuclear fuel is not the driving force in costs, but rather the operation of hardened nuclear facilities and ultimately the disposal of highly radioactive waste. The waste issue needs to be resolved in a timely manner in a multi-stage effort, plutonium disposition, fuel reprocessing, permament and temporary waste storage, etc. Nuclear power has survived to this point and even flurished in a deregulated environment only because of the efforts of it's employees to increase and sustain record braking safety records and plant capacity factors. Only now is it clear to me that the academics were wrong when I chose my career path and this article further proves my point.

Steven Rosenstock *7.19.05*

Other items to consider:

1) The US Congress is having huge arguments over doing an INVENTORY of how much gas and oil we have offshore. Not drilling, but just getting a more accurate assessment of how much we really have.

2) If Congress or EPA mandate a 90% reduction in mercury from coal plants in 2008, there could be a huge shift from coal to electric gas generation, as coal plants may be forced to shut down.

3) In terms of home heating fuels, builders are always looking for the lowest first cost. In January 2006, the minimum efficiency standard for heat pumps goes up from 10 to 13 SEER on the cooling side and 6.8 to 7.7 HSPF on the heating side. This will raise prices for heat pumps by at least $600 or so. Meanwhile, the efficiency standards for furnaces and boilers have been flat since 1992, and efficiency advocates have stated that new standards for furnaces and boilers are 10+ years behind schedule. EIA already did an analysis showing a shift toward gas heating because of the standard.

4) There are many lawsuits and fights over LNG terminals. What if most of them are not built due to local NIMBY movements and politics?

5) China and India are making long term (20 year plus) deals with various gas and oil exporting countries. What kind of impact will that have on LNG prices?

6) In the current energy bill, in response to record oil and gas prices, there will be new effficiency mandates or rulemakings for the following: 14 electric products (or classes of products), 1 natural gas product, and 0 (zero) petroleum products.

Just some more items to think about. I really enjoyed this article.

Frank Clemente *7.19.05*

Thanks to all for good comments--particularly Randy, Steven and Santiago-- In regard to Mr. Malloy's criticism I think an Ivan 75 miles west or a figid mW Jan -Feb --would quickly knock those capital letters down to the smallest line on an optometrist's chart. --FC

Windham Bernie *7.19.05*

One of the biggest problems that has led to the situation described well by Mr. Clemente that has been coming for many years is the failure to take externality cost into account and base decisions on total cost. If these costs were included, there is a huge amount of energy efficiency and energy conservation

	measures that are cost effective at current/projected energy prices that could improve the economy and reduce the pressure on supply choices before rash decisions are made. The U.S. imports over 50% of its oil along with large amounts of natural gas and other energy sources and runs a huge balance of trade deficit, mainly related to this. The U.S. is exporting its economic capital and becoming progressively poorer. Along with weakening the dollar and threatening the stability of the world economy. There is also a huge military cost in trying to protect U.S. access to foreign oil supplies. In addition there are huge externality cost not being taken into account in calculating the value of "energy" negawatt-hours. Global warming, worldwide mercury pollution, climate change including desertification, droughts, stronger storms, changes in Gulf Stream current flow, melting glaciers, melting methane hydrates and tundra methane, etc. have huge costs that are growing rapidly and also have positive feedbacks. Its clear from studies of the economic cost of these externalities that the externality cost is more than the direct cost of energy. Yet its not being taken into account. Even without taking the huge externality cost into account there are a huge number of energy efficiency measures that are cost effective at current/projected energy prices. But taking the huge externality cost into account makes even more energy efficiency measures cost effective. And investing locally in energy efficiency and conservation measures adds to the local economy and keeps economic capital at home, with multiplying effects. Its time that "analysts" start basing decisions on total economic cost, as any competant economist is aware of is the appropratie way to do cost benefit analyses. Amory Lovins was mostly correct and more attention should be paid to his work. Bernard Windham Engineer/Demograper
Thomas Tanton *7.19.05*	First, let me support Ken Malloy's comments above, because they are the only ratinal ones made that I can read. The problem with natural gas is not that we're runniing out--it is all due to the transmission and distribution infrastructure. Just as with the California energy crises, the lack of investment in that critical delivery mechanism naturally causes price fluctuation; but all should note that long term prices, when smoothed on even a six month basis are on continual decline--that is not a reflection of a diminishing resource. There are 'price controls' imposed on nat. gas transmission/distribution and guess what--lack of adequate investment to keep up that infrastructure.
Mark Krebs *7.19.05*	A good discussion folks. Probably the best I've seen on this site. But where to start? I suggest we start with rethinking "energy efficiency." Conventional wisdom of "energy efficiency" is tantamount to professing a belief that energy is somehow created inside of utility meters.
James Spellman *7.19.05*	We have one of the worlds largest reserves of coal. We have already demonstrated that we can burn coal cleanly (installed scrubber capacity) and we have new proven tecnologies like IGCC, to take clean burning coal to new levels. You seemed to have eliminated coal in your article, why?
Frank Clemente *7.19.05*	To James Spellman --totally agree on coal -- my focus was on NG and fact virtually all new pwer plants this decade are NG fired --on into 2007,2008,2009 etc--FC
Frank Clemente *7.19.05*	To Thomas Tanton: With all due respect I do not think you could find one petroleum geologist who would agree that conventional NG supply is not "running out" -- the data on depletion and declining production per well are overwhelming. I do agree plenty of gas in restricted areas but since we do not drill there we are increasingly dependent on unconventional sources and foreign LNG -- FC