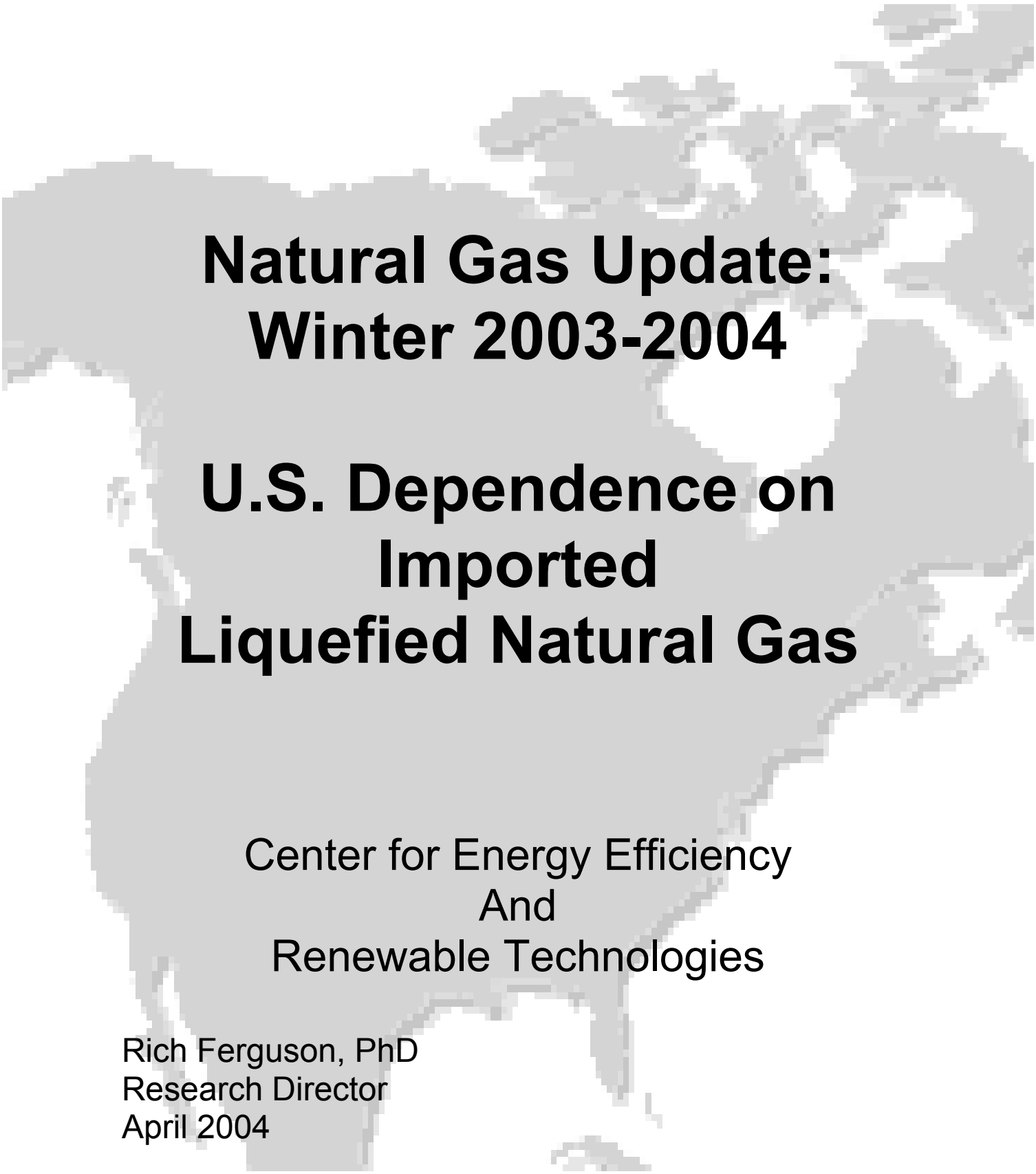

Natural Gas Update: Winter 2003-2004

U.S. Dependence on Imported Liquefied Natural Gas

Center for Energy Efficiency
And
Renewable Technologies

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Research Director
April 2004

EXECUTIVE SUMMARY
Natural Gas Update Winter 2003-2004

A Declaration of Independence

The U.S. arguably has become dependent on imports of liquefied natural gas (LNG). At the end of winter heating seasons, natural gas in storage is drawn down to the lowest levels of the year. What is remarkable about this year is the fact that were it not for recent imports of LNG, storage now would be virtually exhausted.

2003 LNG imports were at record levels but still contributed less than 3% of the total U.S. natural gas supply in 2003. Nevertheless, the North American gas supply situation is so tight, even this relatively small amount kept prices from skyrocketing. Even with the LNG, prices were more than double those seen in the 1990s. Without it prices would have been much higher. We are forced to conclude that the U.S. is now dependent on LNG to prevent the price of natural gas in North America from reaching levels that cause economic and social disruptions.

In the 1970s, the U.S. became similarly dependent on imports of foreign oil. This April, the U.S. must declare its dependence on shipments of natural gas from other continents as well. Shall the nation stand by and allow this dependence to grow, as it did with petroleum, or shall we do something about it?

This report, the third in a series on North American natural gas issues, describes the developments that occurred in 2003. As projected in earlier reports, natural gas prices remained well above those seen in the 1990s. In response, drilling activity increased 25% in the U.S. and 50% in Canada. The results were dismal. Production increased less than 1% in the U.S. and actually declined in Canada. There is now consensus among the experts that North American natural gas production has peaked and will gradually decline.[1]

U.S. consumption declined in 2003 due to higher prices and the weak economy. The small increase in production and weak demand helped gas storage levels recover from historic lows seen at the end of the 2002-2003 heating season. What has escaped attention is the role that LNG has played in maintaining adequate supplies.

Four terminals to receive shipments of LNG were built in the U.S. in the 1980s when imports first appeared necessary. When prices remained low these were uneconomical and were mothballed. They are all now back in operation, and although the amounts of gas imported as LNG are still relatively small these imports made the difference between having average levels of storage and having none.

Projections of supply and demand show that today's storage levels nearly equal the gas imported as LNG since the beginning of 2002. Without LNG imports, U.S. gas in storage

[1] See, for example, "Balancing Natural Gas Policy – Fueling the Demands of a Growing Economy," National Petroleum Council, www.npc.org.

would be virtually exhausted and prices astronomical. April 2004 marks the time at which the U.S. becomes dependent on LNG imported from other continents to keep prices even moderately affordable.

Energy is a vital resource for any nation, and especially for the U.S., which uses far more per capita than any other. Dependence on foreign oil and gas is fundamentally different from dependence on imported manufactured goods. Every politician pays lip service to "reducing dependence on foreign oil". Natural gas is a useful fuel, the least polluting of all the fossil fuels. But now is the time for the nation to think twice before becoming as irreversibly dependent on imported gas as it is on oil. Developments in the Middle East have tragically demonstrated how vital energy is to our national security. By declaring our new dependence on foreign gas, perhaps we can muster the determination to do something about it.

With sufficient determination the U.S. can refuse to remain dependent on LNG. The highest priority must be given to improving the efficiency with which natural gas is used. The next step is to reduce the need for gas-fired electric generators by investing in renewable energy resources such as wind, geothermal and solar. Business as usual has led ineluctably to dependence on foreign gas. Only by investing adequately in efficiency and renewable energy *as a nation*, can we live within our domestic natural gas supplies.

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NATURAL GAS UPDATE: WINTER 2003-2004
A Declaration of Independence

Introduction

In response to the high price of natural gas over the last year, producers in the United States and Canada have been drilling like crazy. Unfortunately, we have very little to show for it. U.S. gas production in 2003 was less than one percent higher than in 2002, despite a 25 percent increase in new wells drilled and completed.[1] Production in Canada, despite a 50 percent increase in new wells, actually dropped. These dismal returns are not an aberration. They reflect a continuing trend that the Center for Energy Efficiency and Renewable Technologies (CEERT) described in two previous reports[2] and other industry experts have recently confirmed:[3] North American natural gas resources are seriously depleted; production has peaked and is now in permanent decline.

In fact, all that kept us from running out of gas in late March or early April 2004, at the end of the 2003-2004 winter heating season, were our imports from overseas, primarily from natural gas fields in Trinidad and the Middle East.

The high prices of 2003 spurred not only domestic drilling but also an increase in shipments of liquefied natural gas, or LNG. (This is natural gas cooled until it becomes liquid and can be transported overseas in specially constructed ships.) The four American LNG terminals built in the 1980s to receive and regasify LNG proved uneconomical back then when prices were low, and only one stayed open, trickling a small amount of LNG into the country year after year. But since the beginning of 2002, with importers seeing nothing but high prices ahead, the remaining terminals have come out of mothballs. Our calculations indicate that from the beginning of January 2002 to the end of March 2004, the United States imported about 900 billion cubic feet (bcf) of natural gas from overseas.[4]

This is roughly the same amount of natural gas that was left in storage at the end of March 2004.[5] Indeed, the 2003-2004 heating season is ending with very close to an average amount of gas in storage and thus a reasonable chance of building up sufficient supplies over the coming months to get us through next winter. But without the LNG imports we would have had neither.

Thus, after 30 years of dependence on foreign oil, the United States now stands at the threshold of a new kind of energy dependence. The choice we face is whether we should continue on our present course of reckless consumption and let ourselves become as irreversibly dependent on overseas gas as we are on overseas oil, or should we start using our own resources more efficiently and wisely, so that we don't have to rely on somebody else's. Given the costs of natural gas dependence -- the vulnerability of the American economy to price and supply shocks orchestrated overseas and the

further entanglement of American foreign policy in the Middle East -- this should not be a hard choice to make.

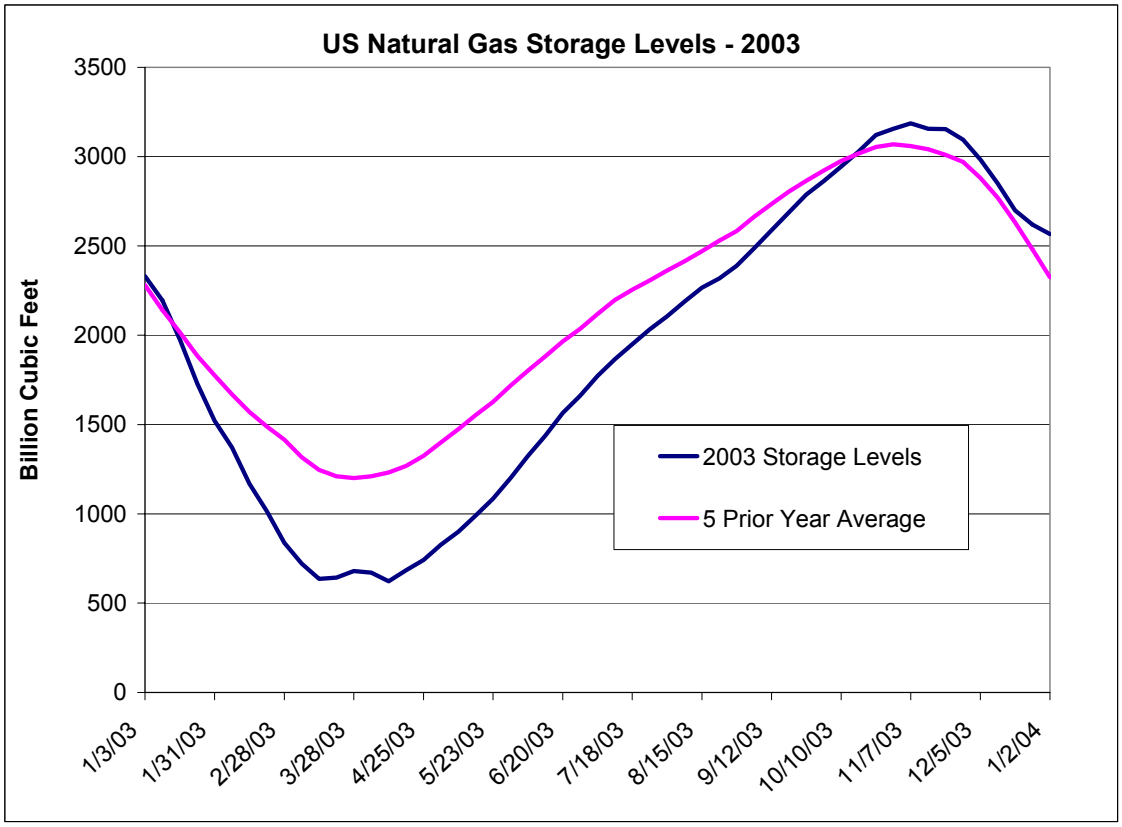
Unfortunately, the Bush administration's reaction to the looming natural gas crisis has been to try to get more gas produced domestically while doing nothing to improve the efficiency with which these resources are consumed. It is a policy that will not change our dwindling domestic supplies or our growing dependence on others. However, it is not our only option. We could, in fact, maintain our natural gas independence into the foreseeable future just by reducing demand. And we can make the required reductions in our demand for natural gas simply by improving the efficiency with which we use it and by increasing our reliance on renewable energy resources (in place of gas) to produce electricity.

But, first, an update on the U.S. natural gas situation.

Natural Gas Supplies in 2003

Last March, at the end of the 2002-2003 winter heating season, natural gas storage was down to its lowest level in a decade, and storage remained low through the summer and fall of 2003, when it should have been building up again in preparation for the next winter. Market participants started anticipating possible winter supply shortages, and they bid prices up an average 50 percent over 2002 levels.

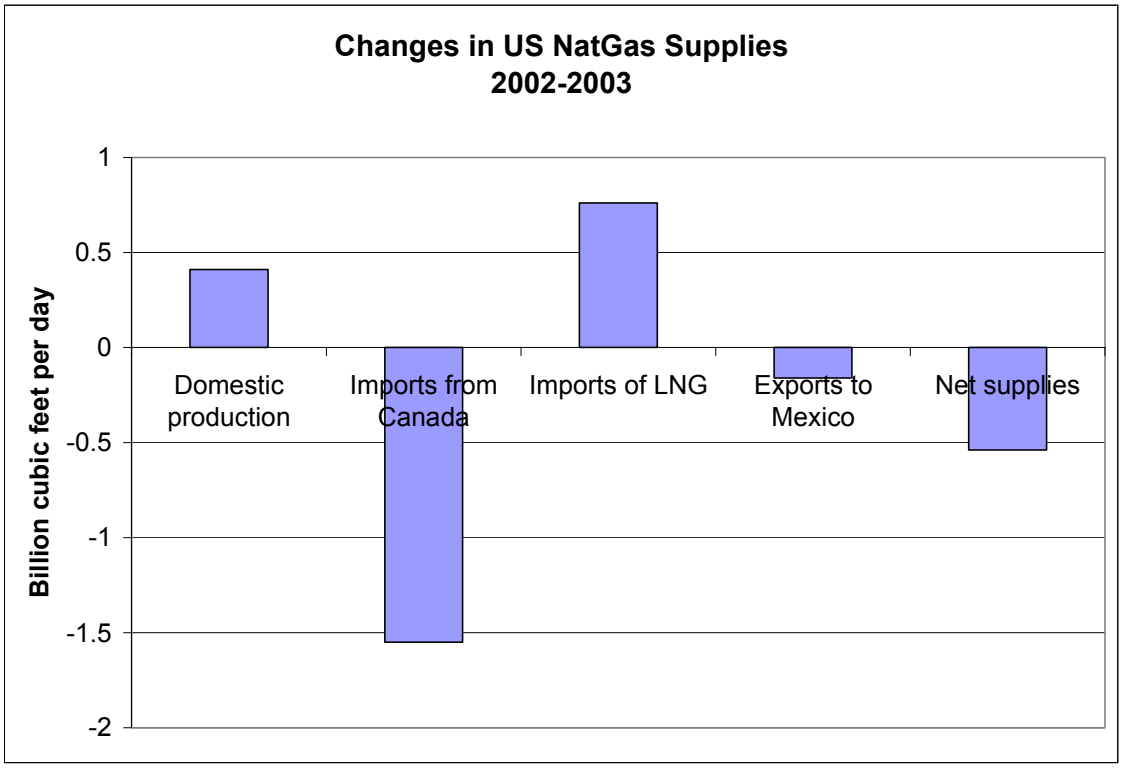
Figure 1



In response to those high prices and a weak economy, U.S. consumption of natural gas declined. But even with reduced consumption, natural gas supplies in 2003 had trouble meeting demand. Until mid-October, the amounts of gas in storage lagged behind historical averages (the average levels of the previous five years). In mid-October, there was at last a turnaround. As a result of weak demand and burgeoning imports of LNG, gas storage levels finally caught up to historical averages, and for a few months even exceeded them. But prices remained stubbornly high.[6] 2003 was a year of diminishing North American production, and the markets remained uneasy about it.

Natural gas supplies available for consumption in the U.S. are obtained from domestic production and from net imports (imports minus exports). Figure 2 shows how each component changed from 2002 to 2003.

Figure 2



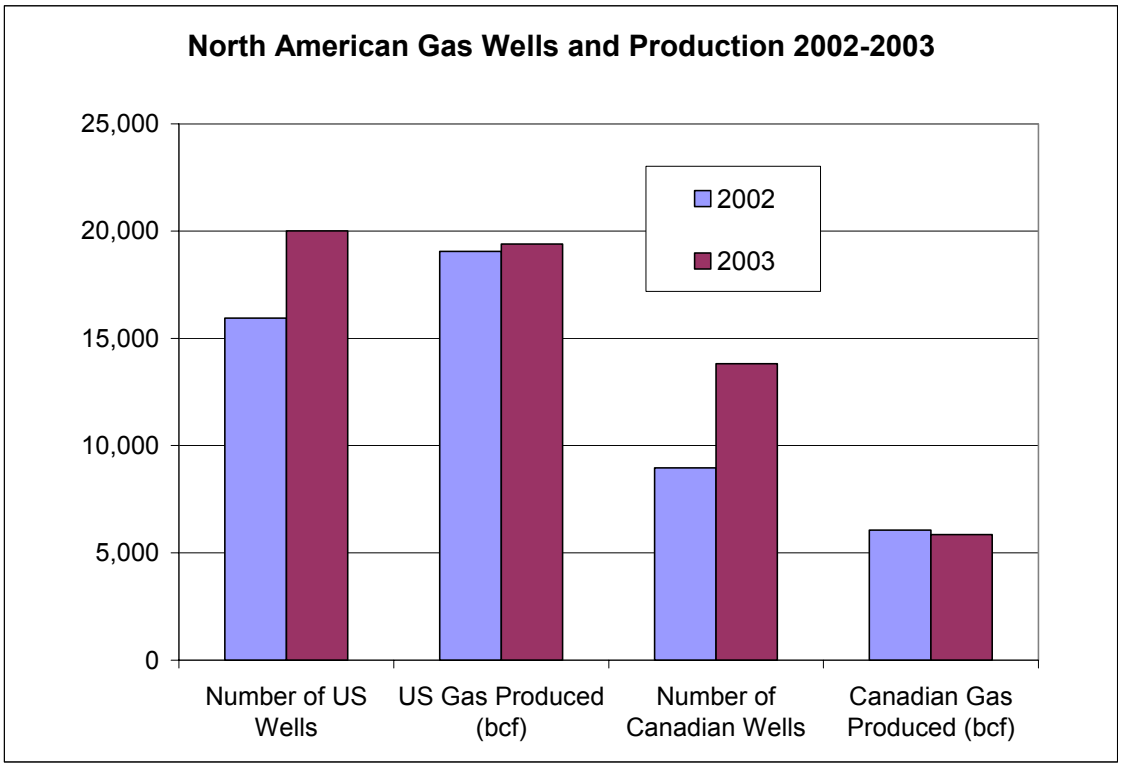
(Note that decreased imports from Canada and an increase in net exports to Mexico both reduced the supplies available to the U.S.)

As Figure 2 shows, a large decrease in supplies from Canada, together with increased exports to Mexico, resulted in a small net decrease in U.S. natural gas supplies of 0.54 bcf/d (down 0.9%). In the absence of LNG imports, however, supplies available to the U.S. would have decreased 2.69 bcf/d, a serious 4% of total demand.

Theoretically, of course, domestic production might have increased to fill such a gap, but in fact, domestic production was already going flat out. There was little, if any, more domestic production to be had at 2003 prices. Indeed, as Figure 2 shows, the 0.76 bcf/d increase in LNG imports (to levels nearly double those in 2002) was nearly twice the increase in domestic production, despite the year's vigorous drilling activity.

The 2003 numbers highlight a troubling trend. Approximately 20,000 new gas wells were drilled and completed in the United States last year. This was an increase of about 4,000 (25%) over 2002. Yet the effort produced an increase in production of only 0.4 bcf/d (0.8%).[7] Meanwhile in Canada, nearly 14,000 new gas wells were completed in 2003, a whopping 54% increase over 2002. Canadian production, however, *decreased* by 3%, or 0.6 bdf/d.[8] Canadian gas available for export to the United States dropped considerably more, by an estimated 1.5 bcf/d (15%).

Figure 3



Sources: U.S. Energy Information Administration (USEIA) and Natural Resources Canada

As Figure 3 dramatically illustrates, greater efforts to find and extract natural gas in North America met with diminishing returns. In the industry, moreover, there is now widespread consensus that these 2003 results are not an anomaly. Rather they are seen as evidence that the region's large and easily reached gas reservoirs have been depleted.[9]

Supply Outlook for 2004

The U.S. Energy Information Administration (USEIA) predicts that domestic production will increase again "modestly" in 2004, while prices will average about $5 per million BTUs of energy ($5/MMBTU), which is somewhat lower than the average price in 2003. The USEIA prediction appears to be optimistic. As mentioned above, there does not appear to be much, if any, additional U.S. gas available for production at $5/MMBTU. Unless prices increase substantially above this level, domestic production may remain flat or even decrease as it did in Canada last year. Markets appear to agree with this more pessimistic view, as the average futures contract price for delivery during the remainder of 2004 is over $6/MMBTU.[10]

The wellhead prices that we saw in 2003 were the highest ever in this industry, and they resulted in only a tiny increase in U.S. production. Independent analysts now predict that spending on oil and gas exploration will decrease slightly in 2004 and production levels will fall.[11] Unless prices jump substantially above $5 per MMBTU and are sustained for some time at that level, the independent predictions are far more likely to pan out than the optimistic USEIA forecast.[12]

For the same reasons, independent analysts predict that natural gas production in Canada also will continue to decline. If, in addition, 500 natural gas wells are shut in next year to protect pressure in Alberta's Athabasca oil sands, as a Canadian court recently ordered,[13] the drop in production could be quite dramatic. And since Canada must retain enough gas to meet its own rising demand, exports to the United States from Canada will probably decrease further in 2004.

As for Mexico, its officials expect its gas consumption to keep growing by leaps and bounds,[14] which means that U.S. net exports to Mexico will probably increase again in 2004.

In other words, unless aggressive policy measures are taken to reduce U.S. consumption, additional LNG will be needed in 2004 -- to meet demand and offset further declines in supplies from North American sources.

If prices remain at or above $5/MMBTU, that LNG should be available. Existing LNG terminals have the capacity to add as much as 319 bcf (0.87 bcf/d) to last year's LNG import level.[15] With prices at or above $5/MMBTU -- high enough to attract the additional LNG, keep domestic producers drilling, and limit demand – supplies should indeed be adequate for the remainder of 2004. (And it is likely that prices *will* remain at

that level, because if they were to fall below $5/MMBTU, drilling activity and imports would slow, drying up supplies and driving prices back up.)

But at $5 or more per MMBTU, natural gas in America will also be far more expensive than in countries with an abundance of natural gas. American industries, as a result, will suffer competitively. Meanwhile, the American economy's dependence on overseas suppliers of natural gas and gas-derived products such as fertilizer will continue to grow. The outlook beyond 2004 is not comforting.

Storage

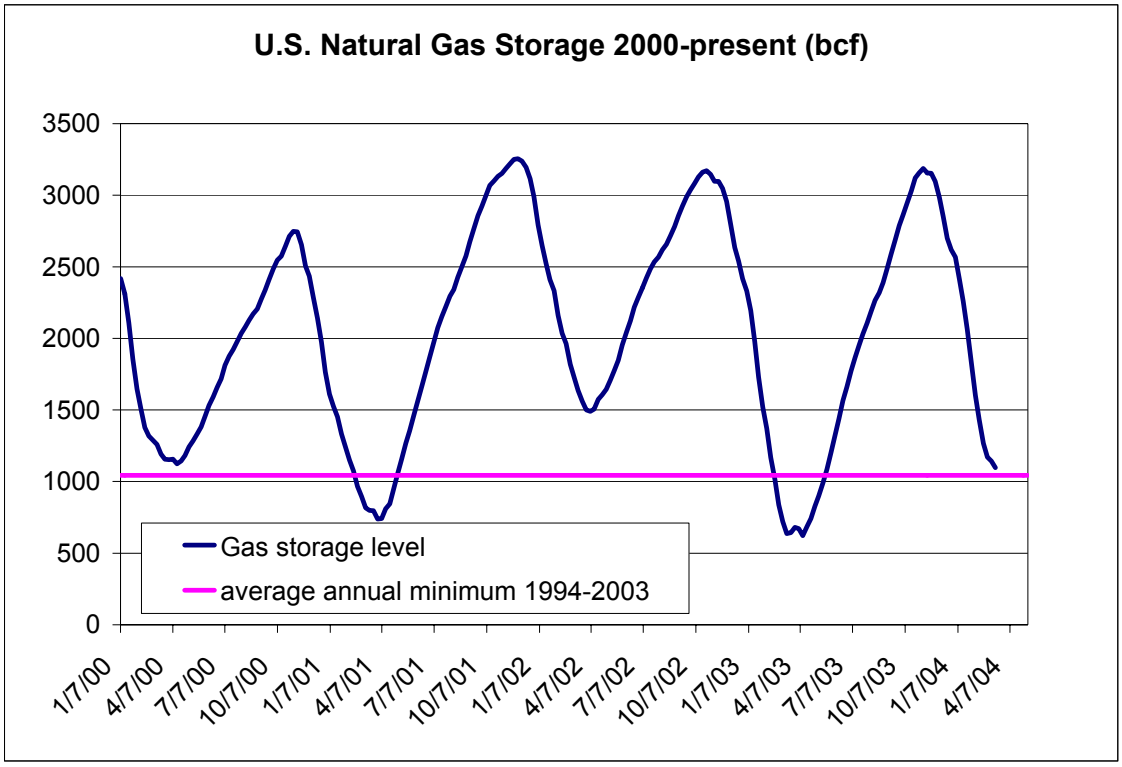
Back in the days when no one was worried about domestic gas supplies – when whatever the U.S. demand, market participants expected domestic suppliers to be able to meet it – prices were driven almost entirely by storage levels. When the only concern was about the possibility of short-term flow disruptions, storage numbers provided the best predictor of supply problems. Storage numbers also were, and remain, the most accurate and timely data available concerning the country's natural gas situation. (USEIA's direct estimates of supply and demand come out several months after the fact and are notoriously fuzzy.[16]) Thus, in the past, the movement of natural gas prices has tracked changes in storage levels, and this is why there was such great surprise in 2003 when that consistent pattern seemed briefly to end.

The fact that prices continue to be high in the face of apparently adequate storage levels is a good indication that market participants are no longer confident about domestic gas producers' ability to meet demand. Reasonably enough, they are now concerned about not just the short-term flow of gas, but also its mid- and long-term availability. They no longer seem to be relying on storage figures alone to make their supply predictions. (See discussion below of Natural Gas Prices 2003.)

Storage, however, is still the main driver of prices and the most current and descriptive information available about the U.S. natural gas situation at any time. It remains the critical factor to examine to understand what's going on in this sector. And it remains a difficult factor to make sense of.

As Figure 4 illustrates, storage levels vary greatly from month to month as well as from year to year. The fluctuations are determined by changes in both supply and demand, while supply and demand, in turn, both influence and reflect changes in prices. Demand is also determined by the weather and the robustness of the economy, and supply, of course, by the availability of resources and the cost of bringing them to market.

Figure 4

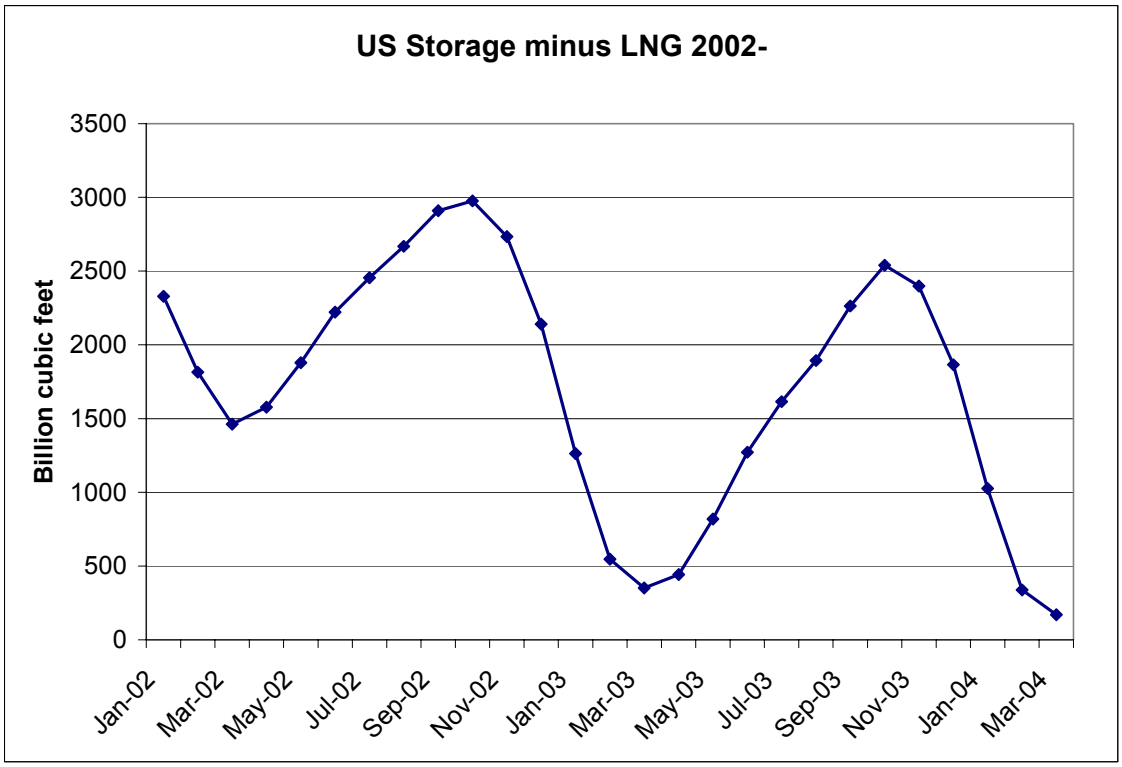


Consider, for instance, storage in 2003. It followed the usual month-to-month pattern of getting used up over the winter and replenished over the rest of the year. But beyond that, it also reflected less predictable aspects of the natural gas market. In response to price increases in 2001, U.S. production expanded and consumption contracted, leading to higher–than-average storage levels in 2002, which then depressed prices. Faced with those lower 2002 prices, production contracted and demand increased, which resulted in the record low levels of storage in 2003. This can be confusing. What is clear, however, is that the recent trend has been to disturbingly low low-points. Moreover, absent the recent surge in LNG imports, the situation would be ominous.

LNG Dependence

Figure 5 provides a vivid illustration of the new U.S. energy dependence by plotting U.S. storage levels minus cumulative LNG imports since the beginning of 2002.[17] It suggests how critical LNG has been this year and is likely to remain.

Figure 5



Important as the LNG increment turns out to be, the amount of LNG imported in 2003 is still too small to have displaced any domestic production. Indeed, domestic producers were going all out all year. The LNG imports *added* to U.S. supplies. Thus, if LNG imports were now to cease, there is no reason to expect that North American supplies could make up the difference, without dramatic increases in prices.

The industry's behavior also seems to be based on an assumption that LNG dependence will continue and grow in the future. The United States currently has four LNG receiving terminals located at Everett, MA, Cove Point, MD, Elba Island, GA, and Lake Charles, LA.[18] All but the Everett facility were taken out of service as receiving terminals in the 1980s, but all are now back in service and planning to expand in 2005. Their existing and planned sendout capacities – the amount of gas they can generate from LNG shipments and deliver to users -- are shown in Table 1.

Table 1

Existing LNG Receiving Terminals and Planned Expansions		
Location	Annual sendout capacity, 2004 (in bcf)	Planned annual sendout capacity, 2006 (in bcf)
Everett, MA	159	334
Cove Point, MD	274	365
Elba Island, GA	163	294
Lake Charles, LA	230	438
Annual Totals (bcf/yr)	826	1431
Daily Average (bcf/day)	2.26	3.92

USEIA reports that LNG imports for all of 2003 were 507 bcf. In 2004, utilizing the full capacity of the existing terminals, imports could increase by as much as 319 bcf for the year or .87 bcf/d for an addition of 1.5 % to total supplies. This will probably be sufficient to meet the year's expected increase in demand and decrease in domestic supplies.

For the future, many additional receiving terminals have been proposed, with new initiatives appearing regularly. Four new LNG terminals are under consideration in California and three in Baja California. There is even a proposal for a terminal in the Bahamas that would serve Florida via undersea pipeline. Not all these schemes will come to fruition, of course, at least not in the near term.[19] But the large amount of interest demonstrates that U.S. gas prices are widely expected to stay in or above the current range and make importation of LNG a profitable enterprise.[20]

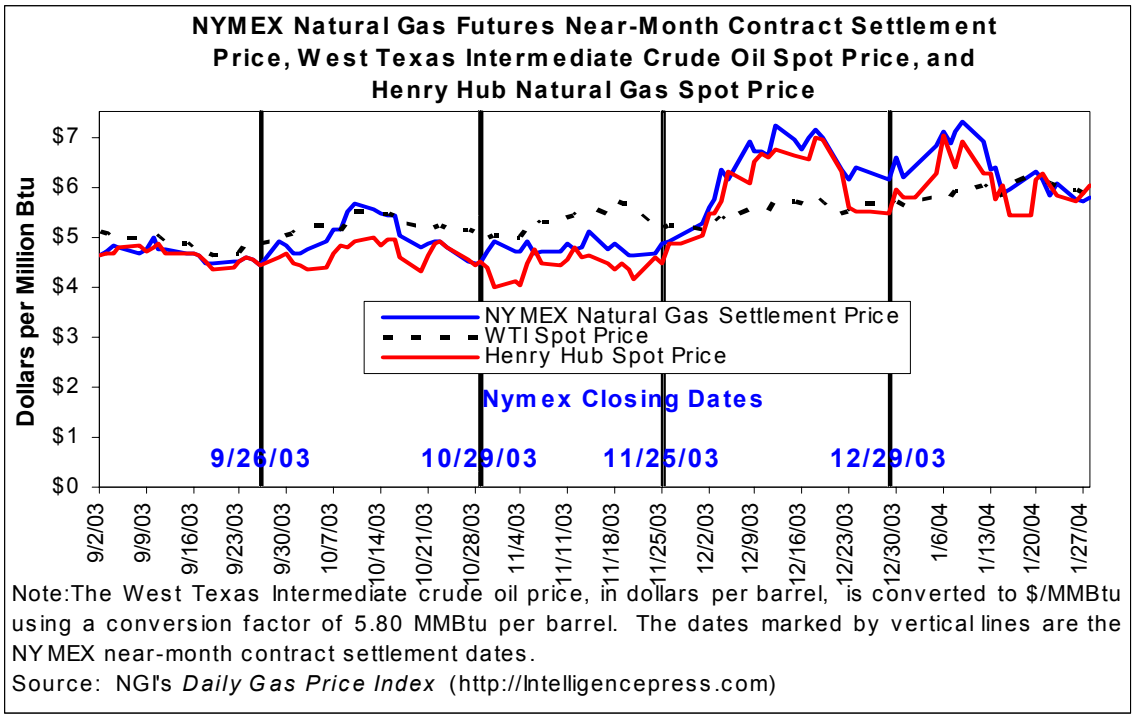
In the 1970s, a similar situation developed in North American crude oil markets. The availability of imported crude oil prevented U.S. prices from increasing dramatically, but without increasing prices, domestic production began to fall as domestic resources were increasingly depleted. Consumption could thus keep growing, but the U.S. became increasingly dependent on imports from overseas. Unless U.S. energy policy is quickly revised to ensure natural gas is used more efficiently, the country is going to become just as deeply dependent on imported LNG as it is on imported oil.

Natural Gas Prices in 2003

As discussed above, to a great extent the source of future gas supplies, as well as the amount of future demand, will depend on price. But what determines price? Generally,

the fear of future shortages is what prompts buyers to bid up prices in order to ensure they have supplies. Thus, in the past, weather forecasts and changes in storage levels were the key determinants of the price movement in natural gas futures contracts traded on the New York Mercantile Exchange.[21] But the course of 2003-2004 prices suggests something rather different. The behavior of recent natural gas prices is shown in Figure 6. Recent U.S. gas storage levels are shown (once again) in Figure 7, together with the average storage levels for the five prior years. As noted above, even when storage levels rose above the historical average in mid-October, prices refused to decline. This surprised many observers

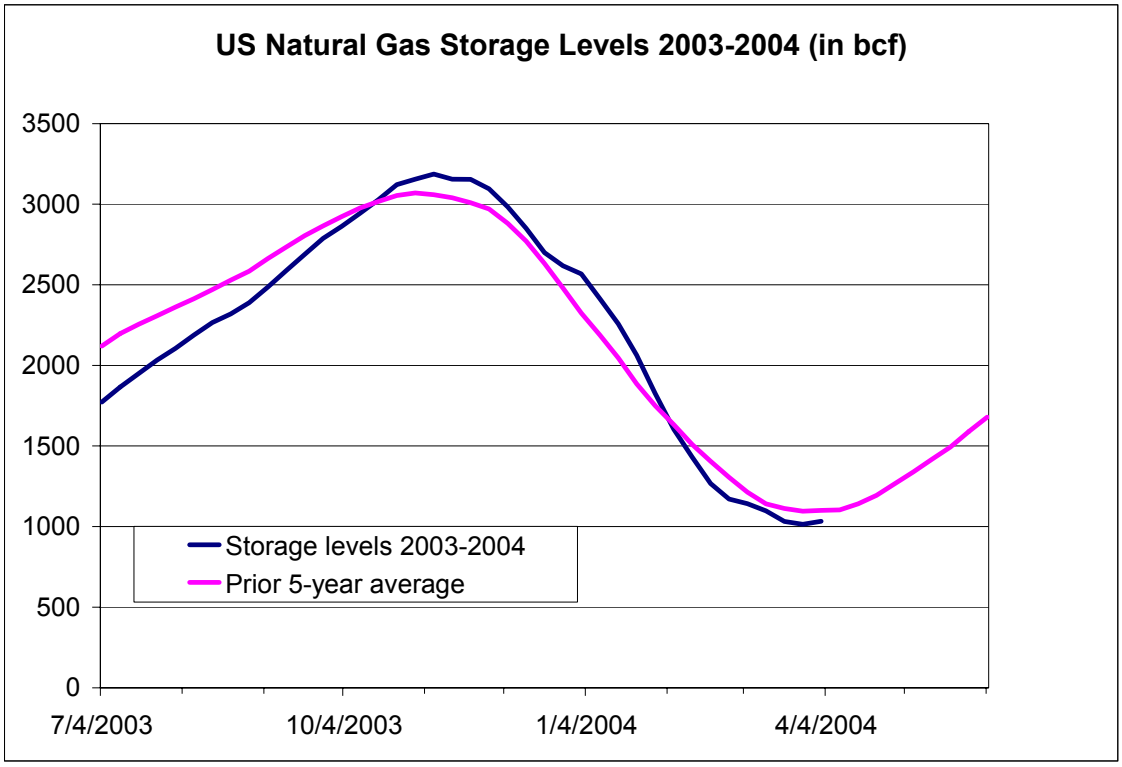
Figure 8



Note:The West Texas Intermediate crude oil price, in dollars per barrel, is converted to $/MMBtu using a conversion factor of 5.80 MMBtu per barrel. The dates marked by vertical lines are the NYMEX near-month contract settlement dates.
Source: NGI's *Daily Gas Price Index* (http://Intelligencepress.com)

Note that the red and blue lines are natural gas prices. The broken line charts oil prices..

Figure 7



In fact, even after stored gas began to be withdrawn for winter heating in 2003, the levels of gas in storage remained comfortably above historical averages. At the beginning of 2004, gas in storage was 10% above the five-year average for the same date. As shown in Figure 6, however, prices remained 20% above those seen in the fall of 2003, which people had thought were high because of storage concerns. Not until February 2004, with storage levels down to the historical average, did prices fall back into the $5-$6 range.

The apparent explanation of this unexpected price behavior is that the market is beginning to understand the longer-term nature of U.S. gas supply problems. Storage levels which in the past would have promised adequate supplies, now don't. And buyers remain concerned about being caught short in the future. Thus they are willing to continue paying high prices to ensure future supplies.

Another factor that seems to be pushing natural gas prices upward is the rising cost of crude oil in the United States. Power plants and some industrial facilities can use either natural gas or petroleum as fuel, and which fuel is chosen is determined by their relative prices. As can be seen in Figure 6 above, the price of energy from gas in December 2003 exceeded the oil energy price by 40%. It is quite likely that fuel switching occurred as a result and reduced demand for gas.[22] However, as Figure 6 also shows, the price of oil increased substantially in December and January, becoming approximately equal to the price of gas on an energy basis. If the price of oil continues

to rise relative to the price of gas, fuel switching will go the other way -- from oil to gas – and increase the demand for natural gas. Thus, concern over rising oil prices may now be putting upward pressure on gas prices.

Price Outlook for 2004

The current heating season is ending with storage levels near average, and prices above $5/MMBTU. Average futures prices for the remainder of 2004 are about $6/MMBTU. Prices can be expected to moderate somewhat if confidence in supply adequacy improves. But the market will remain unsettled and jumpy in the face of any unexpected changes in consumption or in weekly storage reports.

USEIA projects 2004 natural gas spot prices to *average* $5/MMBTU (thus, to be as often below that figure as above) and domestic production to increase.[23] But it's unlikely that prices would drop below $5 for long, since lower prices would quickly reduce supplies and drive prices back up. Thus the USEIA price estimate appears to be a best-case scenario for gas consumers. The factors putting upward pressure on prices are strong, and several reasonable scenarios could be developed in which prices reach very high levels. It seems likely that gas prices will remain above $5, perhaps well above, for most of the year.

Prices, however, are unlikely to go through the roof, and that's because of imports from overseas. As in 2003, it will be LNG imports that prevent the gas supplies available to the U.S. from decreasing dramatically and thus prevent prices from skyrocketing. This is another aspect of American dependence on overseas gas. The U.S. was dependent on LNG to keep 2003 gas prices more or less affordable, and this dependence can be expected to grow in 2004 and beyond, unless the U.S. takes steps to reduce prices by changing the way it uses this resource and reducing demand..

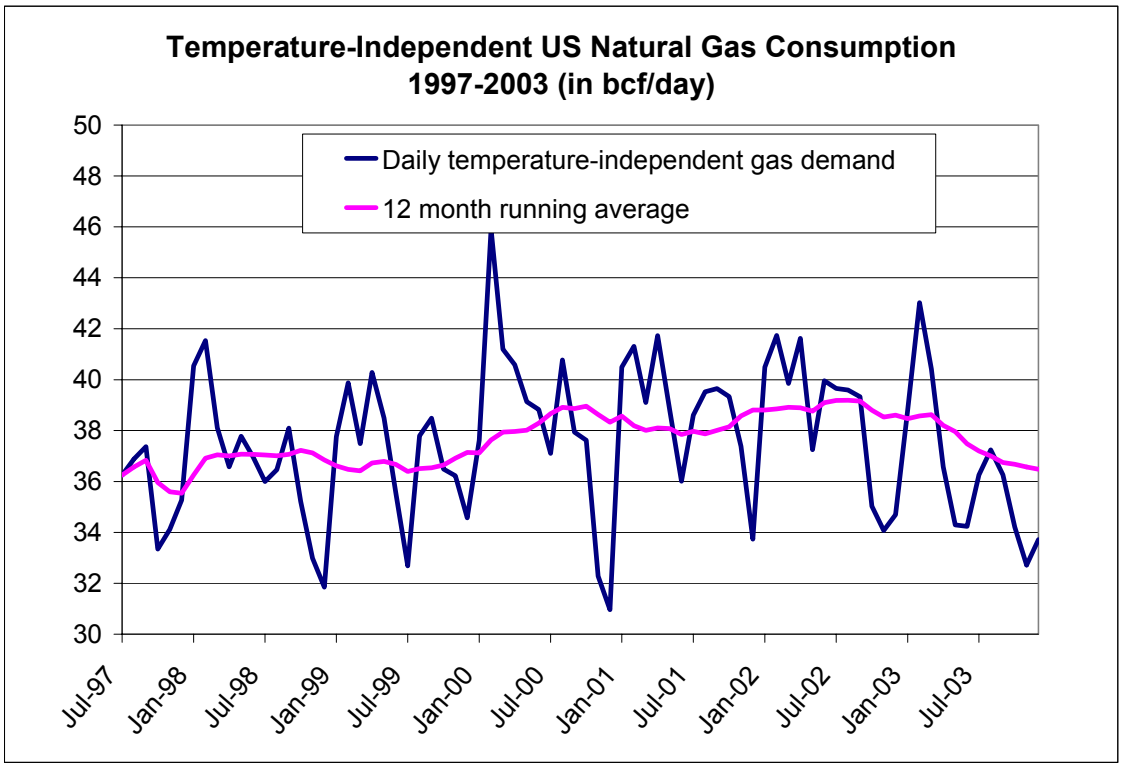
Natural Gas Consumption

We know that consumption in the U.S. declined 2.2 bcf/d (3.5%) in 2003 compared to 2002, in response to sharply higher prices and a weak economy. It is far less clear what that drop implies for the future. With the economy gaining strength, USEIA projects that demand will increase in 2004 by 1.56 bcf/d (2.6%),[24] recovering more than half the 2003 decline. This projection, however, is predicated on increased supplies and lower prices, which appear unlikely, as discussed above.

One key reason that trends in demand are difficult to discern is that the weather-dependent part of the demand for natural gas swings around so dramatically. Natural gas in the U.S. is not used predominantly for heating and cooling, as the press suggests whenever the weather gets particularly hot or cold, but the effects of weather have tended to obscure whatever *is* going on. CEERT recently developed a model to estimate gas consumption for heating and cooling purposes in any week.[25] This model shows that temperature-dependent consumption accounts for about 40% of total demand.

Over the course of 2003, the CEERT model estimates that cool weather created a 173-bcf increase in demand compared to 2002. This is particularly interesting because USEIA data show *total* U.S. gas consumption *decreasing* by 797 bcf in 2003. The CEERT model therefore estimates that temperature-independent consumption decreased by almost one trillion cubic feet in 2003, a drop of 3.66 bcf/day. This can be seen in Figure 8.

Figure 8



Source = CEERT Natural Gas Model. Temperature- independent demand is obtained by subtracting the model's estimates of monthly temperature-dependent demand from USEIA monthly total demand figures.

Temperature-independent uses of natural gas -- for cooking, for water heating, for electric generation, for industrial and commercial operations and as feedstock in the manufacture of fertilizers and other chemicals – dropped significantly. Apparently, the price of natural gas in 2003, and the weak economy, took a greater toll on natural gas consumers than USEIA's figures alone suggest. Thus the fact that prices are likely to remain in the same range for some time should give us pause. Consumers appear to have more than one urgent reason to hope for improvements in the efficiency with which gas is used.

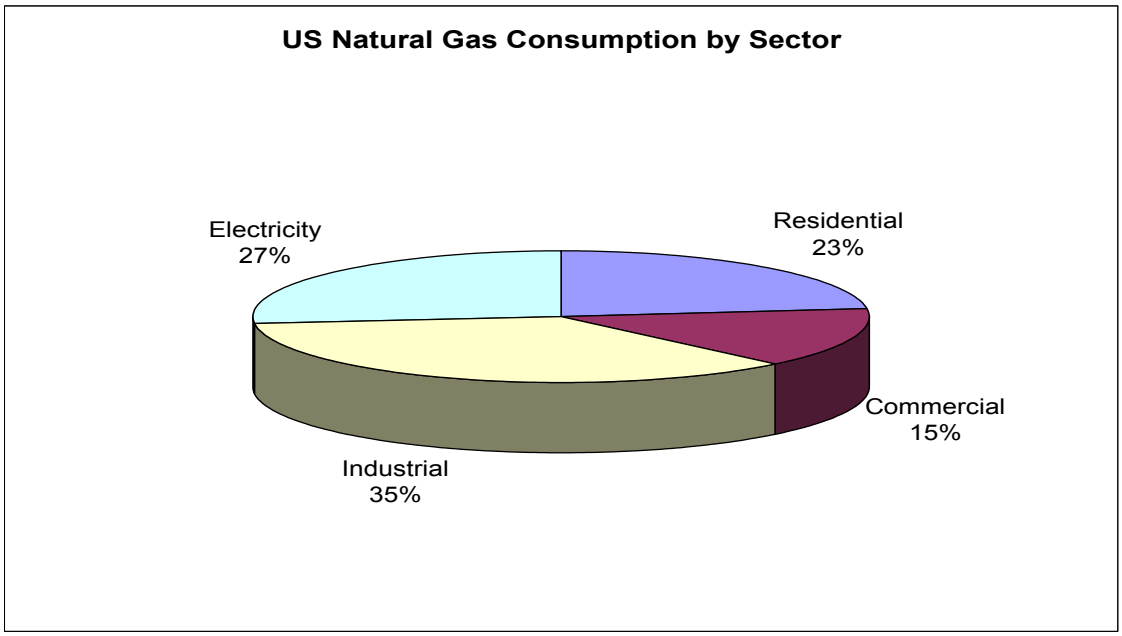
Policy Implications – A Declaration of Independence

Widespread fears of high prices and supply shortages have prompted calls for a variety of policy measures. Even though natural gas prices are at all-time highs, developers have been seeking subsidies from the Bush administration, as if a lack of profit-making potential were stifling exploration. In response, the Secretary of Interior recently reduced royalty fees from gas developers in the Gulf of Mexico by about $1 billion annually.[26] Regulations protecting public lands have been relaxed to promote drilling. States dependent on Canadian supplies are considering expanding pipelines to access other regions.[27] The effect of these decisions will be to increase the already severe depletion of U.S. natural gas resources.

Sadly, little or no action has been taken to increase the efficiency with which gas is consumed in the United States, despite voluminous evidence that significant improvements could be made cost-effectively.[28]

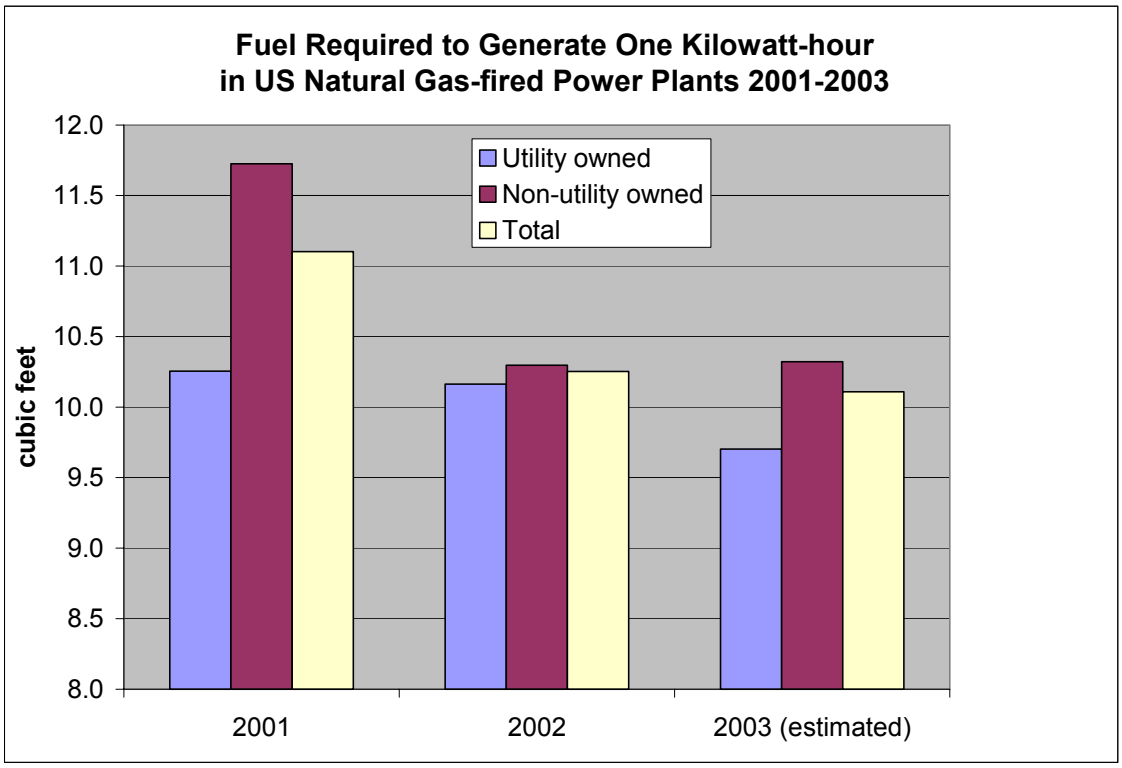
A recent report from the American Council for an Energy-Efficient Economy (ACEEE)[29] identifies a host of cost-effective measures to reduce demand for natural gas and electricity. According to the report, expanded investment in efficiency and renewable energy could reduce U.S. natural gas consumption by 1.9% (400 bcf/year) within a period of 12 months. Over a five-year period, investments in cost-effective efficiency and renewable-energy measures could produce reductions of 4.1% (850 bcf/year).

Figure 9



Major improvements are possible in the efficiency with which natural gas is used to generate electricity, a large component of U.S. demand, as can be seen in Figure 9. Figure 10 shows how rapidly progress has been made on this front in the last few years.

Figure 10



Note – 2003 figures based on USEIA Form 906 data through June, 2003.

But there is still much room for improvement. In 2002 and 2003, the average gas-fired power plant burned about 10 cubic feet of gas for every kilowatt-hour (10 cf/kwh) of electricity generated. If all the old power plants now operating were replaced or "repowered" with modern technology, an average of about 8 cf/kwh could be obtained. This 20% reduction in gas consumption for electricity generation would reduce U.S. total demand by about one trillion cubic feet per year (5%), an important first step in reducing the need for LNG imports.

As Figure 10 shows, rapid improvements in power plant efficiency are possible. Average fuel requirements dropped 9% from 2001 to 2003, largely in response to restructuring or "deregulation" in the industry. In California, for instance, investor-owned utilities divested their entire fleet of gas-fired plants, and under pressure of competition, the new owners were forced to retire or repower inefficient plants while building new ones.

However, hundreds of inefficient gas-fired power plants remain in service. State and federal regulators should focus on getting rid of them. Those operated by regulated utility companies could be rapidly phased out by enlightened regulatory policies. Plants

operated by non-utility companies are not subject to state regulation, but nearly all the electricity generated by these plants is sold to utilities for retail sales to their customers. State and local regulators could get them to modernize by insisting that all power purchased by regulated utilities be bought from efficient plants.

Moreover, even better technology is on the horizon. In December 2003, General Electric Power Systems unveiled a new high-efficiency gas turbine for utility-scale power generation.[30] At full power this LMS100 turbine requires only 7.2 cf/kwh. Even when operating at half power, it requires only 8.3 cf/kwh, a significant improvement over most existing power plants. (Compare these figures to the averages shown in Figure 10.) When the LMS100 is used in a "combined cycle," generating further electricity from its own waste heat, even higher efficiencies can obtained.

Beyond that are "combined heat and power" (CHP) facilities. Even the most efficient gas-fired power plants convert only about one-half of their fuel energy into electric energy. The other half is usually discarded as "waste heat." CHP facilities are now being built to make use of both the power generated and the leftover heat, effectively cutting fuel requirements in half.[31] According to one analysis, widespread deployment of CHP systems in regions of the country where electricity generation is heavily dependent on natural gas could reduce nationwide gas consumption by 6% to 9 %.[32]

Alternatives to natural gas are also available. The increase in natural gas prices in the last few years has made electricity from wind power fully competitive with electricity from natural gas. Adding wind power to the nation's energy supply could displace inefficient gas-fired generation, since these resources compete for the same niche in the electricity grid. Already in 2002, over 5.5 billion kilowatt-hours of electricity were generated from wind,[33] avoiding the consumption of 55 bcf of natural gas. Since wind turbines can be installed in less than a year and the United States is richly endowed with good wind resources, reliance on this source of energy could be expanded significantly and very quickly.

A concerted effort to improve the efficiency with which gas is used to generate electricity, together with a rapid expansion of electricity generated from wind and other renewable resources could avoid dependence on imported LNG for the foreseeable future without further increases in the price of gas. All that is lacking are national and state policies to make that modernization happen.

Furthermore, this independence would come at no cost to, or sacrifice by, consumers. Itwould require no change in heating and cooling levels and no change in energy-consuming behavior, as more energy-efficient homes and appliances reduced consumption. For example, solar water heating technologies installed on new homes during construction are cost-effective today and are increasingly being used to reduce the cost of residential water heating. The California Building Industry Association forecasts construction of nearly 200,000 new housing units in the state during 2004, almost all with gas-fired water heaters using an average of 25,000 cubic feet per year.

The installation of existing, cost-effective solar water pre-heaters with no moving parts could reduce this demand by 50%, for a total savings of 2.5 bcf per year on these houses alone.

As to dollar costs, ACEEE estimates that with the measures it identifies U.S. consumers would *save* more than three times the investment cost of modernization.[34] Savings would accrue not only from the reduced use of natural gas but also from the reduced price of gas caused by demand reductions.

Conclusion – At the Crossroads

We stand at an energy crossroads. In one direction lies growing dependence on imported LNG. This is a future of consumption checked only (and painfully) by higher prices. And it will bring with it economic vulnerability and quite possibly the continuing need for military interventions in troubled, gas-rich corners of the world.[35] Along this path also lie unabated emissions of greenhouse gases, which are causing the alarming increase in global warming. What's more, this path comes to a dead end when international gas resources eventually become depleted, as our once-abundant domestic supplies have.

The alternative choice is to use gas more sensibly, so that we can thrive with the diminishing resources that we have. This is the direction of efficiency and renewable energy resources, and it leads to independence from imported gas, increased national security, and reductions in global warming. This sustainable path can be traveled indefinitely and at a lower cost. The right choice should be obvious.

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[1] Data used in this report have been obtained from the U.S. Energy Information Administration (USEIA) unless otherwise noted. The USEIA "Natural Gas Navigator" is a very user-friendly tool for accessing gas data.
[2] The "Risky Diet" reports are available on the Center for Energy Efficiency and Renewable Technologies (CEERT) web site at www.ceert.org.
[3] See, for example, "Balancing Natural Gas Policy – Fueling the Demands of a Growing Economy," National Petroleum Council, www.npc.org.
[4] Projections based on LNG imports through October 2003, as reported by USEIA.
[5] U.S. gas storage levels at the end of March 2004 were down to 1014 bcf.
[6] The December price increase, coming as it did despite improving storage numbers, produced suspicions of market manipulation. See, for example, "CFTC Studies Natural-Gas Markets After Run-Up," *Wall Street Journal,* January 7, 2004.
[7] Data used here are monthly dry gas production figures available on the USEIA web site through their "Natural Gas Navigator." Recent monthly data should be treated as preliminary. Inexplicably, USEIA reports in its March 2004 *Short Term Energy Outlook* that U.S. production increased 2.2% in 2003. The reason for the discrepancy between this claim and the agency's published data is unknown.
[8] Canadian gas data are published by Natural Resources Canada in their monthly *Natural Gas Monthly Update.*
[9] [See reference in endnote 3].
[10] NYMEX closing prices as of April 7, 2004

[11] Projections by Lehman Bros. and Smith Barney reported in "Drilling Market Focus," *Oil & Gas Journal,* Jan. 26, 2004.
[12] The *Oil and Gas Journal* concurs in this opinion. See "US economy propels 2004 US energy demand," by Marilyn Radler, Economics Editor, *Oil & Gas Journal*, Jan. 26, 2004. Projected increases in demand will be met by increases in LNG imports, according to *O&GJ* projections.
[13] This ruling is now under appeal.
[14] USEIA, *International Energy Ourlook*. Mexican gas demand is projected to increase at an average annual rate of 6.1% over the next two decades.
[15] "U.S. LNG Markets and Uses", USEIA Office of Oil and Gas, January 2003. This report cites a total existing LNG annual sendout capacity of 826 bcf compared to the 2003 level of 507 bcf.
[16] For example, USEIA customarily includes a "balancing item," or fudge factor, in its monthly natural gas reports to make supply and demand figures balance.
[17] Note that Figure 5 is only illustrative. In the absence of LNG imports, actual prices would have been significantly higher, restricting demand and possibly increasing domestic supplies, thereby changing the storage levels from those shown in the figure.
[18] For a description of U.S. LNG markets, see "U.S. LNG Markets and Uses," USEIA, Office of Oil and Gas, January 2003.
[19] For example, on March 17, 2004, Calpine Corporation announced abandonment of plans to build an LNG receiving terminal in Humboldt Bay, California.
[20] For a description of the LNG process and cost estimates, see "Risky Diet 2003," Center for Energy Efficiency and Renewable Technologies.
[21] NYMEX gas futures contracts are for future delivery at Henry Hub, located in Louisiana. Spot prices shown in Figure 6 are the actual daily prices for gas bought and sold at this hub.
[22] Data on the extent of fuel switching are not available. Changes in demand for gas due to fuel switching therefore cannot be captured by the CEERT model,). Oil prices are usually quoted in dollars per barrel, but USEIA has translated these into $/BTU for purposes of comparison.
[23] USEIA, *Short Term Energy Outlook*, March 2004.
[24] USEIA, *Natural Gas Weekly*, March 11, 2004.
[25] For further details of this model, which we call the "TempGas" model, contact the author at rich@ceert.org.
[26] "Secretary Norton Highlights Interior Initiatives to Address Natural Gas Crisis," U.S. Department of Interior press release July 22, 2003. Not surprisingly, developers in other regions complained about the lack of subsidies for themselves.
[27] See "Order Instituting Rulemaking to Establish Policies and Rules to Ensure Reliable, Long-Term Supplies of Natural Gas to California," California Public Utilities Commission, R.04-01-025, January 2004.
[28] One significant exception was the U.S. Environmental Protection Agency's decision to adopt more aggressive efficiency standards for central home air conditioners announced March 17, 2004. These are to go into effect in 2006 and gradually reduce demand for electricity and natural gas in the future as existing equipment is retired.
[29] Elliott, et al, "Natural Gas Price Effects of Energy Efficiency and Renewable Energy Practices and Policies," ACEEE, December 2003. This report focuses on the downward pressure on gas prices which investments in efficiency and renewable energy would provide. It utilizes a standard computer model. Details are available at http://aceee.org/energy/efnatgas-study.htm.
[30] The General Electric press release on its LMS100 turbine can be found at http://www.ge.com/files/usa/company/investor/downloads/lms100_product_Intro_release.pdf.
[31] Details of a recently dedicated CHP facility at the Johnson & Johnson facility in La Jolla, California, are available from the San Diego Regional Energy Office at http://www.sdenergy.org/NewsDetail.asp?ID=25&ContentID=42.
[32] Presentation of Joel Bluestein, Energy and Environmental Analysis, Inc., to the 4th CHP Roadmap Workshop, Chicago, IL, September 24, 2003. Available at http://uschpa.admgt.com/Rdmap03Bluestein.pdf.
[33] See http://www.eia.doe.gov/cneaf/solar.renewables/page/rea_data/tablec1.html.
[34] (See reference in endnote 299).

[35] For example, U.S. and Philippine militaries recently engaged in a joint exercise to practice protecting the Malampaya gas field from potential "Muslim terrorists."