Consumer Federation of America

RESPONDING TO TURMOIL IN NATURAL GAS MARKETS:

THE CONSUMER CASE FOR AGGRESSIVE POLICIES TO BALANCE SUPPLY AND DEMAND

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EXECUTIVE SUMMARY

THE IMPACT OF RISING NATURAL GAS PRICES

For the past two years the average wellhead price of natural gas has been about twice as high as it was throughout the 1990s. As a result, the Department of Energy projects that the **average winter heating bill for a natural gas household will top $1,000 for the first time in U.S. history**. Low income households that heat with natural gas will be especially hard hit, as their total natural gas bill will take almost ten percent of their income this year.

The impact of natural gas prices on households and the economy can be felt in more than direct expenditures for heat and hot water**. Electricity prices are strongly affected by natural gas prices** because for about a decade natural gas has been the overwhelming fuel of choice for new electricity generation. Natural gas prices are passed through to consumers in the form of purchased gas adjustment clauses. Moreover, in many deregulated electricity markets the most expensive source of electricity sets the price for other sources of power. Natural gas price increases also flow through in the price of commercial services and industrial goods in varying degrees.

THE PRICE SHOCK

The price increases and extreme volatility have taken policymakers by surprise. In 1999 both the Energy Information Administration (EIA) and the National Petroleum Council (NPC) were quite optimistic about the prospects for domestic U.S. production of natural gas. At prices that are substantially below current levels, the NPC concluded that "sufficient resources exist to meet growing demand well into the 21st century." Five years later, and in spite of the fact that "for almost 4 years, natural gas prices have remained at levels substantially higher than those of the 1990s," the EIA projected "dependence on more costly supplies of natural gas."

THE COMPLEX CHALLENGE OF NATURAL GAS MARKETS

The pervasive and varied use of natural gas in the economy, the difficulty of delivering it to consumers and the suddenness of the price increase have combined to spark an intense debate over public policies to ensure adequate supplies. Estimating likely demand and sources of supply over the next several decades reveals a substantial potential shortfall that must be filled if severe economic impacts are to be avoided (see Exhibit ES-1). **The total cumulative "deficit" in North America over a couple of decades could be as large as 350 to 400 trillion cubic feet of natural gas beyond business-as-usual approaches**. This is the equivalent of all the natural gas produced in the U.S. in the past 15 years.

Seven broad categories of potential sources can be identified to fill the gap, which suggests that **the problem is not one of absolute scarcity, but choosing the right policies to meet the need.** Moreover, a review of the available alternatives indicates that no single

Exhibit ES-1:
Estimation Of Need And Potential Contribution Of Alternatives (Trillion Cubic Feet)

TOTAL NEED = 600 TCF CONSUMED + 350 TCF RESERVE	**~ 950 TCF**	
On Hand		
Discovered Remaining		
Proved	270	
Growth	270 – 330	
Shortfall ~	350 - 400	
FILLING THE GAP:		
SOURCE	**POTENTIAL CONTRIBUTION**	
DEMAND SIDE	**Cumulative 20-Year**	**2025 Annual Level**
Fuel Switching	20 – 40	3
Efficiency	70	8
SUPPLY SIDE		
Domestic, Non-traditional Alternatives		
Alaska		
Discovered	45	2-3
Undiscovered	258	
Gasification	10 – 40	2-3
Imports LNG	20 – 80	4
Domestic Traditional		
Sensitive Areas	115	
Conventional Undiscovered	650	
Unconventional Undiscovered	320	

Source: See Chapters I and II.

option can do the job. **Multiple approaches must be followed**. To evaluate the options, we establish a comprehensive framework that considers when and how policies affect the natural gas market.

POLICY FRAMEWORK

The objective of public policy should be to ensure a reliable supply of natural gas that is delivered in an efficient and equitable manner at affordable prices. Balance is critical to meet the needs of producers and consumers of natural gas both as a fuel and industrial input, as well as the needs of the environment.

There are over two dozen specific policies that have been put forward during recent debate on natural gas (see Exhibit ES-2). To choose between them we **distinguish between structural policies that change the options available in the market and conduct policies that influence the way market participants choose between the options** that are available to them. We also **distinguish between short-term, mid-term and long-term aspects of**

Exhibit ES-2:
NATURAL GAS POLICY MATRIX

	SUPPLY-SIDE		DEMAND-SIDE	
	STRUCTURE	CONDUCT	STRUCTURE	CONDUCT
SHORT TERM		Market monitoring; Transparency; Storage policy, State storage,	Off-the shelf conservation (e.g. insulation, appliances)	Consumer education; Gov't. facilities conservation; Labeling
MID TERM	LNG expansion; Coal gasification; Renewables & alternatives portfolio, tax incentive; Alaska NG pipeline	Reform access to conventional resources federal lands, Royalties rights of way; Tax incentives	Building codes; Appliance standards; Fuel switching; Fuel use restrictions	Demand response programs; Economic dispatch; Redesign PGAs; Performance targets
LONG TERM	R&D Production Transportation			R&D Efficiency

policies. While this establishes the framework for policy choice, it does not give us the criteria by which to evaluate specific options. We propose three broad categories of criteria by which to evaluate alternatives.

Economics includes both the basic benefit/cost of each option and the impact of the option on the market structure. We prefer policies that meet the need for energy at the **lowest cost**. We prefer policies that **increase the supply and demand elasticities in the market or bring new sources and actors to the market to promote competition**, since this not only lowers price but also dampens price volatility.

Environmental concerns are extremely important because energy production and consumption involve major externalities – costs that are not easily reflected in market transactions. **Production and transportation of natural gas has environmental impacts**, as does consumption. But natural gas is by far the **cleanest of the fossil fuels.**

Security of supply has traditionally focused on the **operation of facilities to prevent accidents**. Under current conditions, however**, vulnerability to intentional acts of sabotage** must be considered. Moreover, because international energy markets are dominated by cartels and producers with market power, any policy that relies on foreign resources of natural gas must also be assessed in terms of **the dependability of supply**.

FIRST STEPS

This paper takes the first steps in the policy process. It establishes a clear need and the criteria by which policies should be evaluated. It also ranks the broad categories of policies in the order in which they should be pursued (see Exhibit ES-3). It provides the outlines of where policymakers should focus, because we believe that **a broad consensus on the direction of policy is the critical first step to responding to the turmoil in the natural gas market**. Details of specific policies that should be implemented will be discussed in a subsequent paper.

First, markets must be free of manipulation. We believe that **strong measures to ensure confidence in markets are critical to establish the credibility of arguments for other policies**, even though they do not alter the long-term supply-demand balance in the long term. Ensuring market transparency and promoting greater storage could lower prices and reduce volatility, but, above all, **they would establish a prerequisite necessary for other policies – confidence that there is a "hard" problem in the imbalance of supply and demand**.

On the demand side, increasing **energy efficiency and fuel switching could fill just under a third of the deficit. These policies are superior to supply-side alternatives across all the criteria specified for policy evaluation**, **but they are insufficient to provide the entire solution**. By reducing demand, they ease the supply demand imbalance and also reduce the demand for infrastructure. Efficiency has clear environmental advantages, as it reduces both production and consumption external effects. Fuel switching may increase externalities associated with consumption, as it entails burning dirtier fuels.

Supply-side alternatives that rely on domestic resources, but not the traditional domestic natural gas resource base, are also attractive, since the domestic resource base is declining and has proven to be unreliable. **Coal gasification is commercially proven, but in its infancy**. It could expand for use in electricity generation in the mid-term and other uses in the longer term. Coal gasification has the advantage of relying on a domestic resource that is virtually inexhaustible. It might lower the need for widespread natural gas infrastructure, since it would be located at the sites where the output of gasified coal is consumed. It would require coal production and transportation facilities.

The **Alaska natural gas** pipeline appears to be under active development, with the state of Alaska becoming more active. This is **a substantial resource, not presently being used**.

Exhibit ES-3: Evaluation of Policy Alternatives

SOURCE	**ECONOMIC**			**ENVIRONMENT**		**SECURITY OF SUPPLY**		
	Cost/ Benefit	Market Structure	Volat- ility	Facility Footprint	Air	Reli- ability	Depend ability	Vulner- ability
<u>Reducing Turmoil</u>								
Transparency		+	+					
Storage		+	+			+	+	+
<u>Demand Reduction</u>								
Efficiency	+	+	+	+	+	+	+	+
Switching	+	+	+			+	+	+
<u>Alternative Domestic Suppy</u>								
Gasification		+	+	-	+			
Alaska	-		+	-				-
<u>Imports</u>								
LNG				-			-	-
<u>Traditional Domestic Supply</u>								
Sensitive Areas	+			-				
Undiscovered	-			-			-	

TOUGH SUPPLY-SIDE CHOICES

These policies would fill about half the projected shortfall in natural gas supplies. This would go a long way toward alleviating the pressure on the domestic base, but tough supply-side choices would remain.

Imports: Liquefied natural gas currently accounts for about two percent of consumption, but it is much more widely used on a global scale. **Unfortunately, LNG is likely to depend on foreign sources that are controlled by members of the OPEC cartel or suppliers with market power**. It also does not have environmental or security advantages. LNG will expand its role because of the cost of domestic resources, but because it offers little unique improvement, it does not deserve special policy attention.

Traditional Sources: With efficiency and these non-traditional domestic sources enhanced, **production from the traditional domestic resource base, conventional and unconventional on-shore and offshore, would have to remain at roughly the current levels to fill the remaining gap**. Undiscovered resources represent a very large potential, but, by the industry accounts, they are one source of the current problem, since they have proved less predictable and more costly than anticipated.

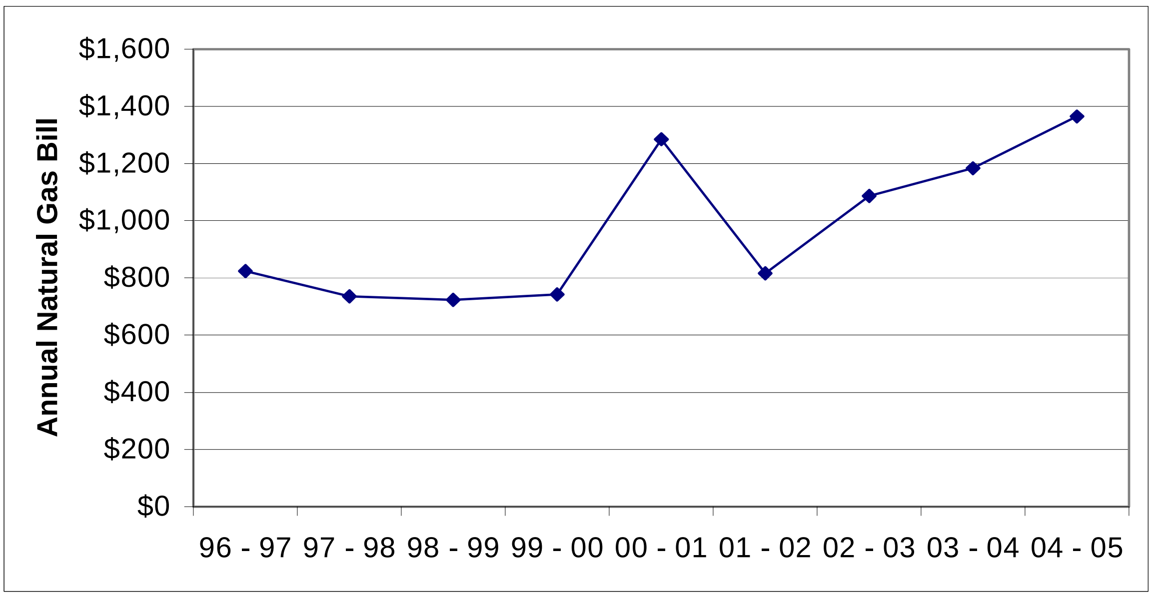
We rank drilling in **sensitive areas lowest in priority** because it represents, at best, be considered to address the mid-term term transition to other sources that **may have potentially large environmental costs**. Resources in environmentally sensitive areas are probably much more certain and lower in cost, but there are no guarantees they will restrain price increases because the same companies that control reserves today will do so in these areas.

I. NATURAL GAS DEMANDS IMMEDIATE POLICY ATTENTION

THE IMPORTANCE OF NATURAL GAS FOR RESIDENTIAL CONSUMERS

As debate over rising natural gas prices heats up,[1] members of Congress need look no further than the typical bills of their constituents to find the fuel for the fire. They will observe that well over half of their constituents (on average) heat with natural gas. Moreover, for the first time in U.S. history,[2] the Department of Energy projects that the average winter heating bill for households that use natural gas as their main source for heat will exceed $1000 for the upcoming 2004-2005 heating season (see Exhibit I-1). Including the cost of hot water and cooking, for these households, the annual bill for natural gas will exceed $1300, an increase of over $600 since the second half of the 1990s.[3]

Exhibit I-1:
Expenditures on Heating & Hot Water, Average Household that Heats with Natural Gas



Source: Energy Information Administration, *Winter Fuels Outlook*, various issues.

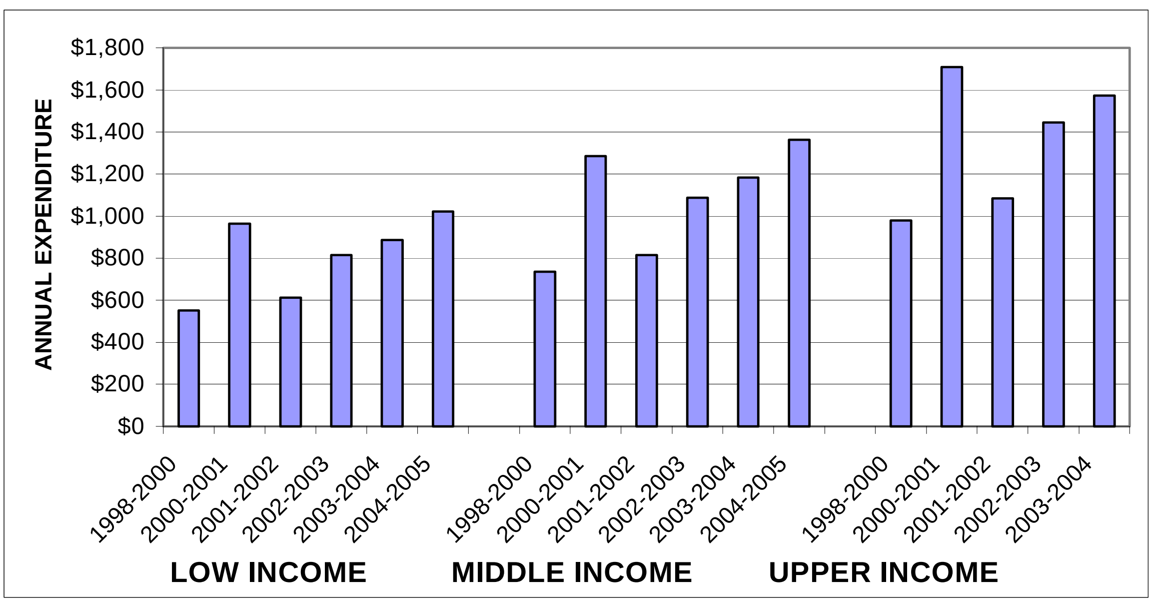
Traditionally,[4] one of the central concerns about rising energy prices is that their impact falls most heavily on low and middle-income households.[5] Because energy is a basic necessity of daily life, households have trouble cutting back when prices rise.[6] Even though wealthier households consume more than middle-income households, and middle-income households consume more than low-income households, consumption does not increase as fast as income. Therefore as income rises, energy expenditures take a much smaller part of the household income. More importantly, as prices rise, lower income households suffer larger relative burdens on their household budgets.[7]

Based on the Department of Energy's *2001 Housing Characteristics Tables* we estimate that the upper income group consumes 33 percent more energy than the average.[8] We estimate the lower income group consumes 25 percent less energy than the average.

Exhibit I-2 divides the population into three groups – low, middle and upper income. (Income is estimated based on the U.S. Census Bureau *Historical Income Tables – Households.*) We assume the bottom one-fifth of the population is low income. Their average income was about $10,000 in 2002. The Bureau of Labor Statistics *Consumer Expenditure Survey* for 2002[9] shows this group to be roughly those with incomes below $15,000. Middle income households are those in the middle fifth. Their mean income in 2002 was $42,800 in the Census Bureau data. The BLS data shows this group to be those with income between approximately $28,000 and $46,500. Upper income households are the top fifth. They had a mean income of $143,700 in 2002. In the BLS data the top fifth has incomes of about $75,000 or more. For all groups we adjust income for 2004 assuming growth in income equal to the change in 2004 as estimated by the Bureau of Economic Analysis, *Personal Income and Outlays,* annualized.

Lower income households that heat with natural gas have experienced an increase of about $500 in their gas bills. Upper income households have experienced a slightly larger increase, about $600.

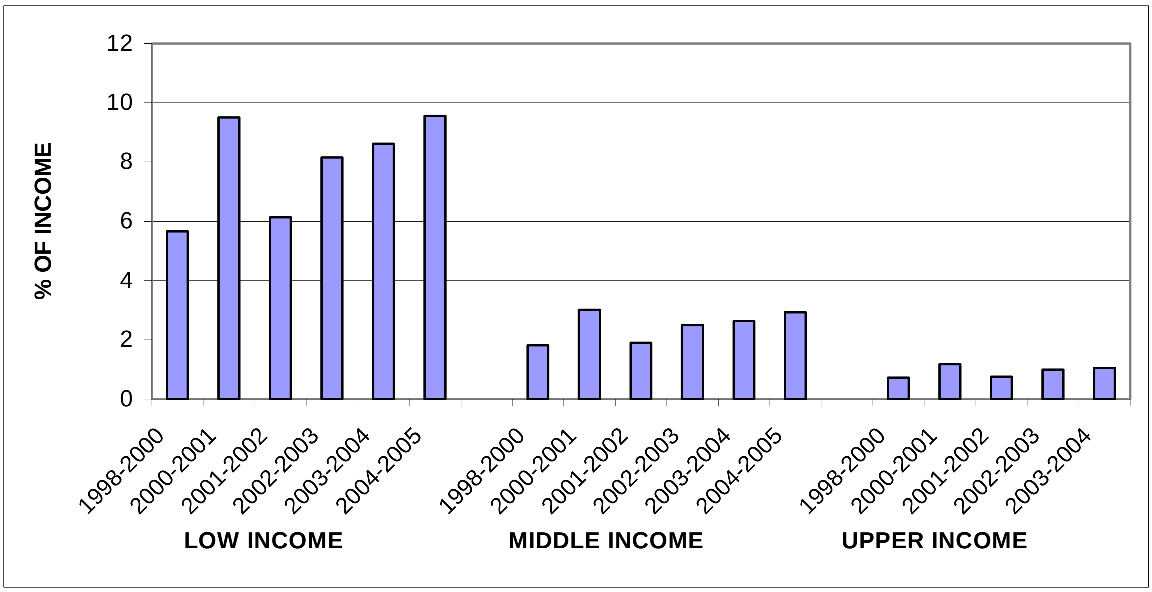
Exhibit I-2:
Annual Natural Gas Expenditures of Households that Heat With Natural Gas: Total Expenditures by Income Category



Source: Energy consumption: Bureau of Labor Statistics, *Consumer Expenditure Survey in 2002*, February 2004; Department of Energy, *2001 Housing Characteristics Tables* Income: U.S. Census Bureau *Historical Income Tables – Households;* Bureau of Economic Analysis, *Personal Income and Outlays.*

However, measured as a percentage of income, low income households have experienced a much greater increase in the burden of rising prices (see Exhibit I-3). For low-income households, natural gas expenditures have increased from just over 5 percent of income to just under 10 percent. For middle-income households, expenditures have increased from about 2 percent of income to about 3 percent. For upper income households, expenditures have increased from just under 1 percent of income to just over 1 percent.

Exhibit I-3:
Annual Natural Gas Expenditures of Households that Heat With Natural Gas: Percent of Income by Income Category



Source: Energy consumption: Bureau of Labor Statistics, *Consumer Expenditure Survey in 2002*, February 2004; Department of Energy, *2001 Housing Characteristics Tables* Income: U.S. Census Bureau *Historical Income Tables – Households;* Bureau of Economic Analysis, *Personal Income and Outlays.*

INDIRECT IMPACTS OF RISING NATURAL GAS PRICES

When price increases are large and sustained, the absolute size of the increase becomes a concern. In fact, over the past several years, as petroleum prices have skyrocketed they have caused "a marked slowing in spending."[10] Both *The Wall Street Journal* and *The New York Times* have recently linked rising energy prices and the flagging efforts to stimulate the economy.[11]

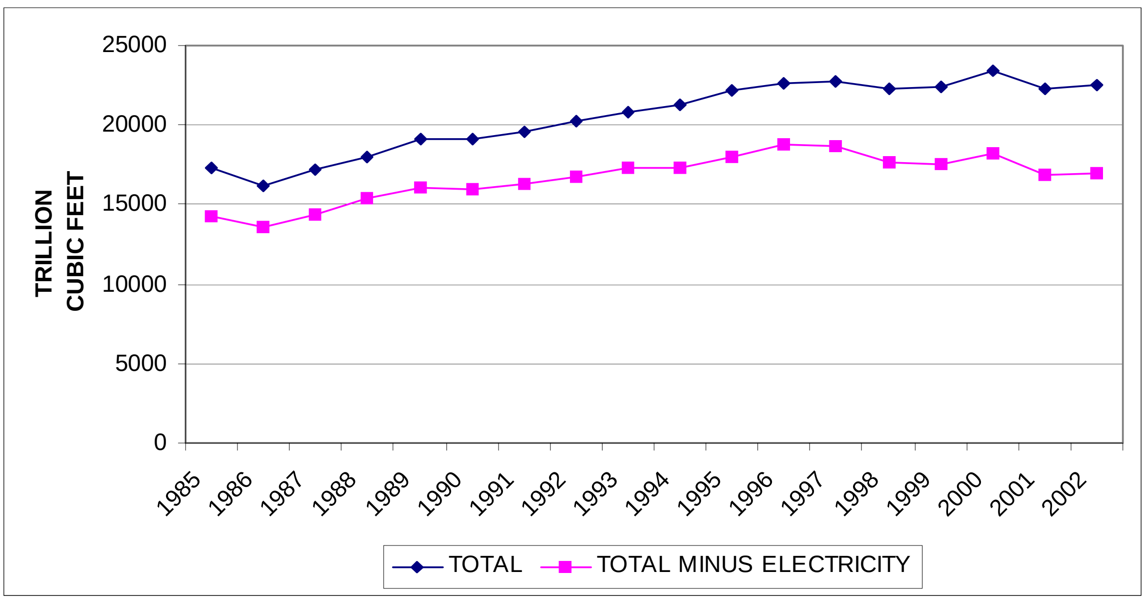
The drag on consumer budgets and the economy caused by rising natural gas prices reflects more than the direct effect on household budgets of natural gas consumption in the home. In fact, residential consumers account for slightly less than one-quarter of total natural gas consumption.

When the cost of natural gas rises, the cost of other goods and services that consumers purchase also rises. The extent to which the price increases are passed through to consumers depends on the specific industry and sector. In some cases costs are likely to be passed through, particularly where all suppliers have experienced similar increases. Thus, sectors that are not subject to international competition are likely to pass through the cost increases. Where there is international competition, particularly from places where natural gas prices have not increased, the ability to pass cost increases through may be more limited.[12]

One sector where consumers are likely to feel the pinch of natural gas price increases is the electricity sector. In this sector, gas costs are directly passed through in fuel adjustment clauses. In fact, in states where the electricity industry has been restructured and generation largely deregulated, rising natural gas prices may affect the cost of generation from other sources because natural gas sets the market price.

Over the course of the past decade the electricity sector was almost entirely dependent on natural gas for new generation facilities.[13] Exhibit I-4 shows the total U.S. consumption of natural gas and the total for uses other than electricity generation. Overall consumption grew because of the increased consumption in the electricity sector. This increased consumption by gas-fired generating plants also shifted the pattern of demand more heavily into the summer

Exhibit I-4:
Natural Gas Consumption



Source: U. S. Department of Energy, Energy Information Administration, *Monthly Energy Review*, various issues Table 4.4.

months since gas is especially used for peak load generation. As a result, it has become more difficult to put gas in storage in preparation for the winter heating season. The increase in natural gas consumption in the electricity sector is equal to about ten percent of total U.S. consumption.[14] Taken together, the residential and electricity sectors account for just under half of all natural gas consumed in the U.S.

Cost increases in the commercial sector are likely to be passed through to consumers since the services they provide are essentially local. The commercial sector accounts for 15 percent of total natural gas consumption. The residential, electricity and commercial sectors account for over 60 percent of all natural gas consumption in the U.S.

The U.S. has the highest price of natural gas in the world, at over $5 per thousand cubic feet (mcf).[15] While other advanced industrial nations are close, with prices about 10 percent lower, very low natural gas prices in Russia and throughout the Middle East and North Africa are putting severe pressure on U.S. manufacturing industries in which natural gas plays a significant role. Prices for domestic products rise, while output and jobs shift overseas. As a recent Congressional report put it:

> Because domestically produced natural gas is so vital to our nation's energy balance, rising prices make our nation less competitive. When prices rise, factories close. Good, high paying jobs are exported overseas. Today's high natural gas prices are doing just that. We are losing manufacturing jobs in the chemicals, plastics, steel, automotive, glass, fertilizer, fabrication, textile, pharmaceutical, agribusiness and high tech industries.[16]

THE PRICE SHOCK

This increase in natural gas bills has resulted from a sharp shift in the price of natural gas at the wellhead. For the decade and a half after decontrol in 1985, wellhead prices were stable in the range of $2 - $3 per mcf. There were a couple of spikes in the mid-1990s, but prices still finished the decade at levels just slightly above the early 1990s, averaging about $2.50 per mcf (see Exhibit I-5). Beginning in 2000 prices became much more volatile. In the past two years, they appear to have moved to a much higher plateau, averaging almost three times the price of the 1990s.

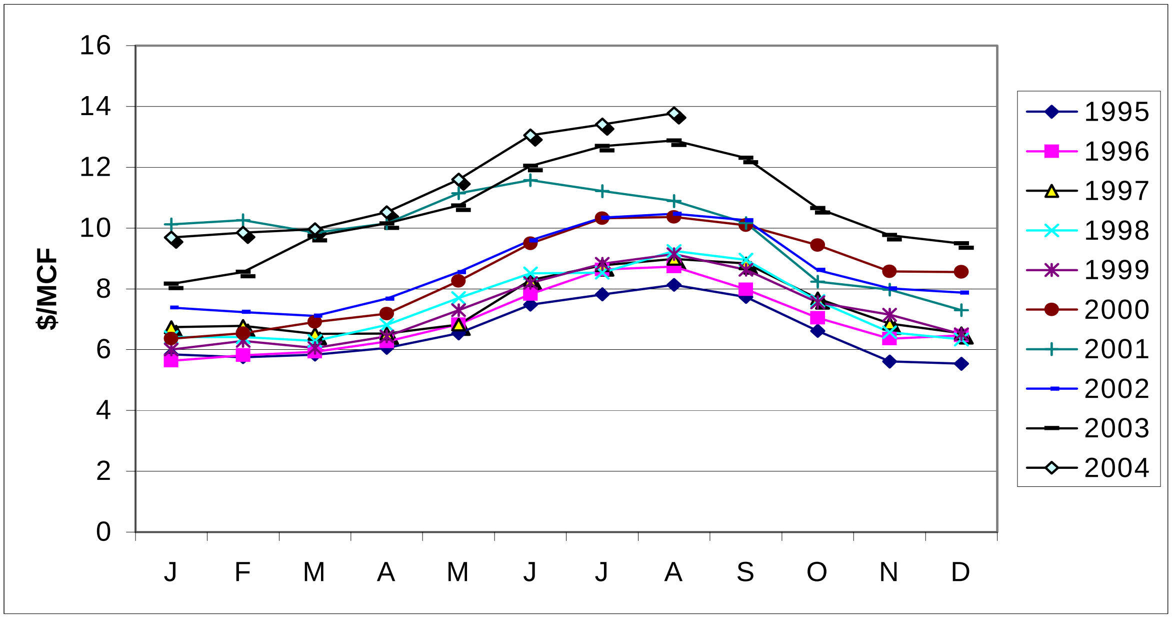
Although the delivered price of natural gas reflects more than the wellhead price, the pass-through of wellhead price changes account for the bulk of the change in natural gas prices over this period. Exhibit I-6 shows the delivered residential natural gas price on a seasonal basis. The jump in prices in 2001, 2003 and 2004 parallels the jumps in wellhead prices.

Ironically, although gasoline prices receive a great deal of attention, probably because they are posted on every street corner, natural gas prices have increased more than gasoline

Exhibit I-5:
U.S. Natural Gas Demand and Prices

Source: Ken Costello, Hilliard G. Huntington and James F. Wilson, *After the Natural Gas Bubble: A Critique of the Modeling and Policy Evaluation Contained in the National Petroleum Council's 2003 Natural Gas Study,* July 8, 2004, Figure 1.

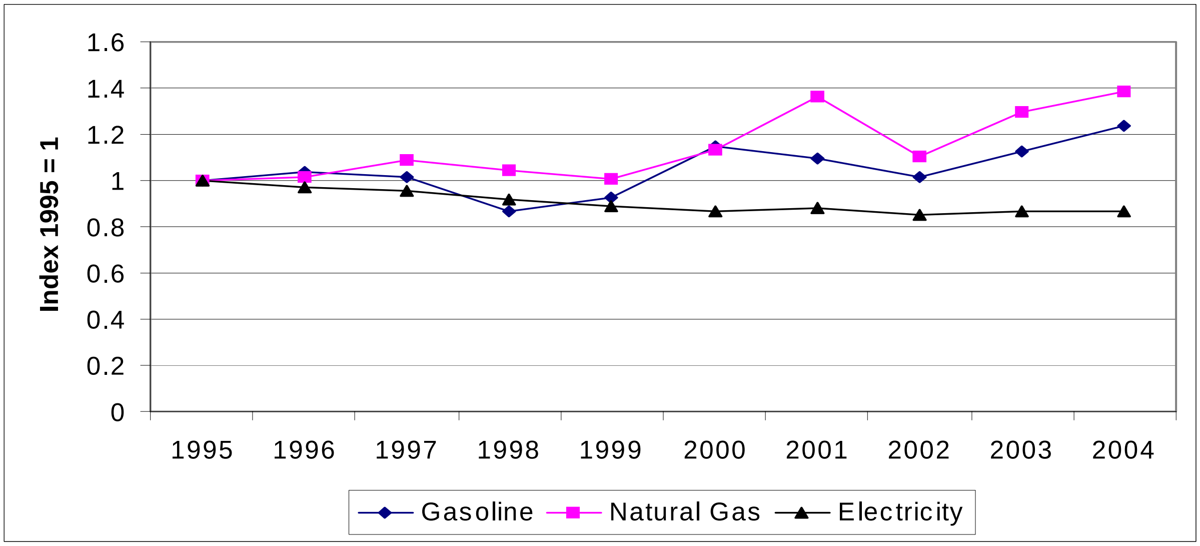
Exhibit I-6:
Seasonal Delivered Residential Natural Gas Prices



Source: Energy Information Administration, *Natural Gas Prices,* data base.

prices since the mid-1990s (see Exhibit I-7). The dollar increase in household expenditures for the typical household that heats with natural gas was just about as large as the increase in the gasoline bill for average households in the U.S. By this calculation, natural gas should receive as much attention as gasoline, but it rarely does.

Exhibit I-7:
Real Prices for Household Energy



Source: Energy Information Administration, *Monthly Energy Review*, Database.

PURPOSE AND OUTLINE OF THE PAPER

The suddenness of the price shift and the pervasiveness of natural gas throughout the economy have jolted a number of consuming sectors and created a stir among policymakers. As one analysis put it, "recent high natural gas prices, and uncertainty about future market directions, have understandably led to a wide range of opinions regarding the need for major government initiatives to encourage expanded gas supply and temper gas demand."[17]

The purpose of this paper is to sort through the competing empirical analyses of the current situation and suggest a comprehensive analytic framework to assess the policy options being discussed. With numerous recent large-scale attempts to project supply, demand and price, we describe the different views of the current situation and attempt to learn some policy lessons from the various descriptions.

In section II we use the debate over uncertainties about how a small change in the supply-demand balance could have resulted in such a large change in price to highlight the key assumptions, risks and uncertainties that consumers face. Some believe that pricing abuse played a role in the recent run-up. We believe there is some validity in this argument. Most analysts believe that meeting projected demand increases would put upward pressures on prices and see a challenging period ahead. We believe there is validity in this view as well.

In Section III we examine demand and likely sources of supply. We conclude that vigorous policy is needed, beyond efforts to eliminate any abusive pricing, to ensure that natural gas is affordable. A business-as-usual policy is unacceptable because the risks in the current situation and a "do-nothing" approach are severe. Dramatic, short-term shifts in domestic natural gas prices have created disequilibrium in the price of gas for households and industries that consume natural gas. The dash to gas in the electric utility industry has created disequilibrium in supply. Alternatives that would smooth the transition to a new regime in natural gas are not available. Simply waiting for the market to solve the problem will not work without imposing severe disruptions and burdens on consumers.

In section IV we define a framework for assessing the policy alternatives. We identify the time frame (short-term, mid-term, long-term) and the aspect of the market that policies address (supply, demand, structure, conduct). We establish economic, environmental and security criteria by which to evaluate policies and then apply these criteria to seven broad categories of policies. Because the domestic market has become unstable and shocked consumers with rising prices and disappointing performance, we approach the analysis as one in which we seek to alleviate the pressures on the domestic natural gas resource base.

In Section V, we propose the first steps in the policy process. Having established a clear need and the criteria by which policies should be evaluated, we rank the broad categories of policies in the order in which they should be pursued. We provide the outlines of where policymakers should focus, but we do not discuss the details of the policies. We believe that a broad consensus on the direction of policy is the critical first step to responding to the turmoil in the natural gas market.

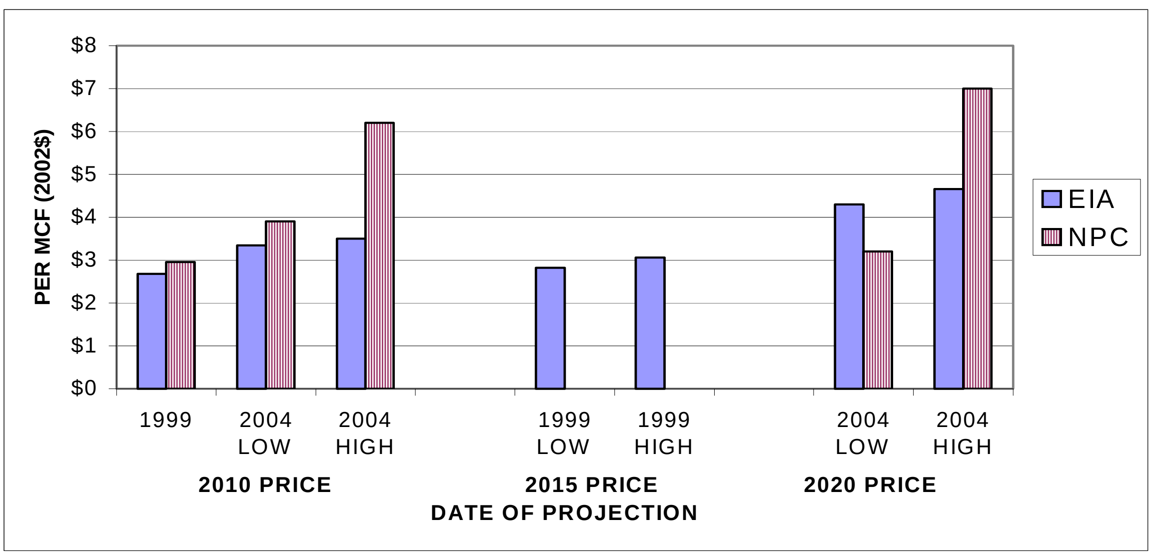
II. UNCERTAINTIES ABOUT NATURAL GAS MARKETS

CHANGING VIEWS OF NATURAL GAS MARKET FUNDAMENTALS

The sudden shift in natural gas pricing has resulting in a dramatic reconsideration of natural gas market fundamentals which must be the starting point for public policy analysis. Given the vital role of natural gas in the economy, projecting supply, demand and price paths is critical to assessing what types of policies are needed.

Exhibit II-1 presents estimates of future wellhead prices by two prominent energy organizations – the Energy Information Administration and the National Petroleum Council – that made projections at roughly the same time. The 1999 projections came at a key moment. The dramatic increase in gas-fired electricity generation was becoming apparent and concerns were expressed about whether production could keep pace. The reports were also written just before prices began to rise sharply and become volatile.

Exhibit II-1
The Dramatic Shift in Projected Wellhead Prices



Source: National Petroleum Council, *Natural Gas: Meeting the Challenges of the Nation's Growing Natural Gas Demand* (December 1999), p. 20, *Balancing Natural Gas Policy* (September 2003), p. 14; Energy Information Administration, *Annual Energy Outlook 2000* (December 1999), Table C-14, *Annual Energy Outlook* (January 2004), Table C-14.

Both the EIA and the NPC were quite optimistic in 1999. Projecting prices in the range of $2.80 to $3.80, the NPC concluded that "sufficient resources exist to meet growing demand well into the twenty-first century."[18] With the EIA projecting prices less than $3 in the *Annual Energy Outlook* the section headings tell a similar story – "Rising Gas Prices and

Lower Drilling Costs Increase Well Completions, High Levels of Gas Reserve Additions Are Projected Through 2020, Significant New Finds Are Likely To Continue Increases in Gas Production."[19]

The tone in the 2004 reports was considerably changed. The EIA added a dollar to its projected prices and the NPC added over two dollars. The NPC declared that "North America is moving to a period in its history in which it will no longer be self-reliant in meeting its growing natural gas needs."[20] The EIA report opens with a cautious note,

> For almost 4 years, natural gas prices have remained at levels substantially higher than those of the 1990s. This has led to a reevaluation of expectations about future trends in natural gas markets, the economics of exploration and production, and the size of the natural gas resources. The *Annual Energy Outlook 2004* forecast reflects such revised expectations, projecting greater dependence on more costly alternative supplies of natural gas.[21]

There is also less certainty about the supply-demand balance. The NPC claims that "Current higher gas prices are the result of a fundamental shift in the supply and demand balance…. [that] will result in undesirable impacts to consumers and the economy, if not addressed."[22] Others correct the record, pointing out, as Exhibit I-5 above shows, that,

> to be clear, however, the fundamental shift in the NPC outlooks has been in supply, not in demand…. In the 2003 NPC Report, the resource base assessment for the Lower-48 and Canada has been reduced by 20%… The NPC forecast of U.S. gas consumption… has been reduced by over 15% compared to the 1999 report, while prices are expected to be 40% to 70% higher than anticipated in the 1999 report."[23]

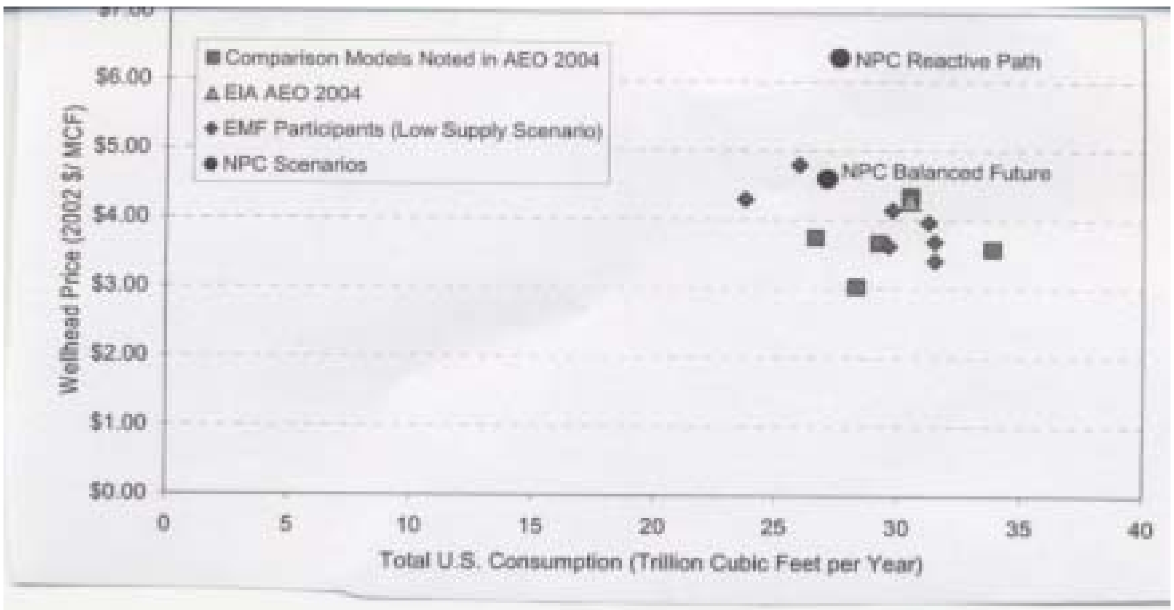
The fact that the NPC's price projections are fifty percent higher in their base case than most others should not obscure a more important observation (see Exhibit II-2). There is a consensus that prices over the next twenty years will be in the range of $4.50 (in 2002 dollars) per mcf. With average wellhead prices at over $5 per mcf today, $4.50 may not sound like a big number, but it still represents more than a doubling of the price compared to the previous twenty years. Moreover, in order to keep price at that level, a large projected increase in the appetite for natural gas in North America must be slaked. Comparing Exhibit I-5 to II-2 shows a growth in U. S. consumption from about 22 trillion cubic feet (tcf) to a range estimated generally at 27 to 31 tcf.

CONSUMPTION AND THE ELASTICITY OF DEMAND

The size and uncertainty of the supply-demand imbalance creates a complex policy problem. By analyzing the fundamental demand-side and supply-side forces in the natural gas market we gain insight into how to approach the problem.

The NPC and Cambridge Energy Research Associates (CERA)[24] have strongly emphasized supply-side solutions. The NPC supports conservation, but does not study its impact in detail. CERA did offer a demand side hypothetical exercise that is instructive as a place to start the analysis. CERA asked, 'what would happen to prices if natural gas consumption declined 8 percent at the peak?' The conclusion was that prices would decline by $1.50 per mcf, a very substantial amount. The details were not given about the underlying assumptions, but at the stated prices, this represents a decline of between 20 and 30 percent.

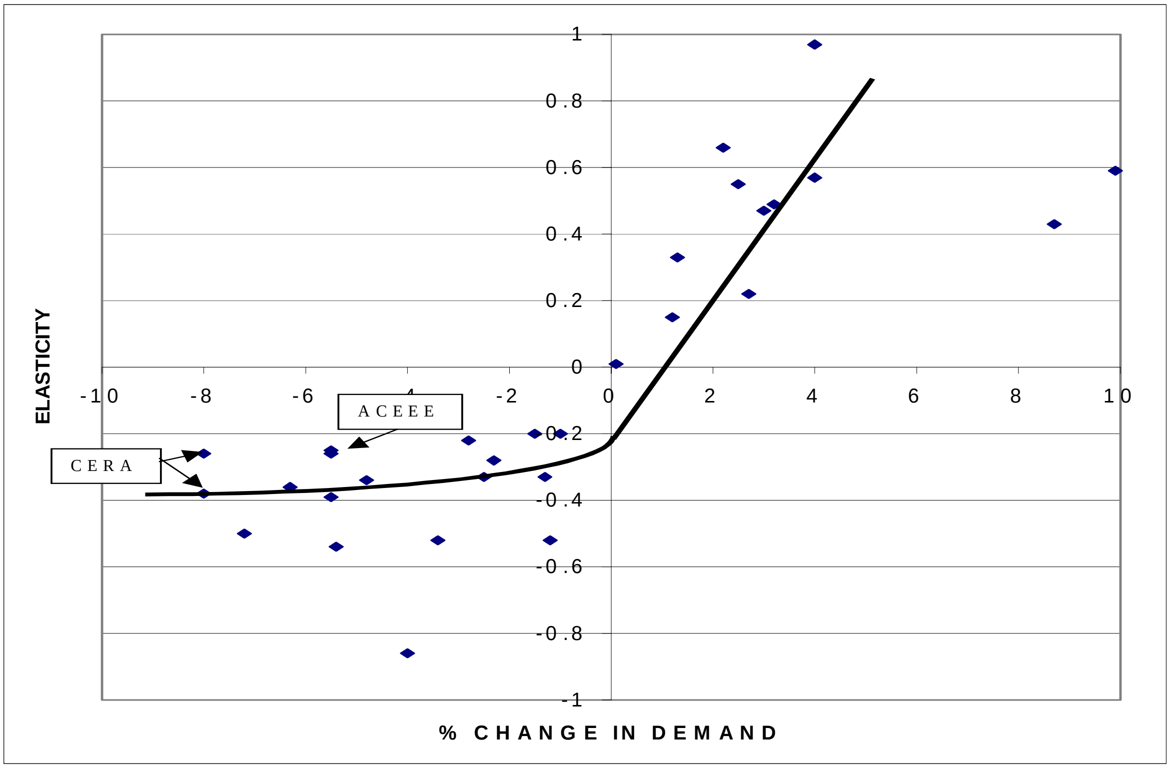
Exhibit II-2:
Comparison of Natural Gas Outlooks, 2020



Source: Ken Costello, Hilliard G. Huntington and James F. Wilson, ***After the Natural Gas Bubble: A critique of the Modeling and Policy Evaluation Contained in the National Petroleum council's 2003 Natural Gas Study,*** **July 8, 2004, Figure 3.**

The exercise is hypothetical primarily because CERA makes no claims about whether such a reduction could be achieved, not because the price responsiveness is wrong. The American Council for an Energy Efficient Economy (ACEEE)[25] conducted a similar exercise. It is intriguing to compare the supply elasticity implicit in the ACEEE study of the potential for conservation and efficiency to lower the price of gas. ACEEE contends that a 5.5 percent reduction in natural gas consumption could be achieved in five years.[26] For them the hypothetical is a real possibility. Interestingly, the impact on price in the ACEEE analysis is quite similar to the CERA analysis. The 5.5% reduction in demand is projected to result in a 22 percent reduction in price.[27] In the longer term, ACEEE projects efficiency-driven demand reductions of over 20 percent.[28]

Exhibit II-3:
Elasticities Implicit in Nine Models of the Natural Gas Market



Source: Energy Modeling Forum, *Natural Gas, Fuel Diversity and North American Energy Markets*, September 2003, Table 5 and 6. Cambridge Energy Research Associates, *Charting a Path: Options for a Challenged North American Natural Gas Market*, 2004, p. 30; American Council for an Energy Efficient Economy, *Natural Gas Price Effects of Energy Efficiency and Renewable Energy Practices and Policies*, December 2003, Tables 13 and 14.

Price effects in this range can be found in a wide variety of studies (see Exhibit II-3). The Stanford Energy Modeling Forum[29] put seven major natural gas market models[30] through a series of standardized scenarios and calculated the implicit elasticities. The price changes associated with reductions (increases) in demand were actually implicit in the response to the question, 'what would happen to demand if supply were lower than the base case?'

CERA and ACEEE are on the low side of the implicit price effects. The other models generally predict larger price reductions for a given demand reduction. **More importantly, the bigger risk is on the high side. Increases in demand have much bigger impacts on price than decreases.** This is a characteristic of the supply curve in a tight market. Economists say that supply is inelastic – supply does not easily expand to meet demand – so price increases sharply when demand increases. Put another way, large price increases do not elicit large increases in production.

The implications are quite important for policy choices. If demand reduction can be implemented quickly, conservation and efficiency can make a substantial contribution to lowering prices. This exercise serves an important purpose. It suggests that even if we are pessimistic about the supply side, we do not have to capitulate to extremely high prices.

However, we must acknowledge that demand is quite inelastic, as well. As noted in Section 1, because energy is a necessity, when prices rise people have difficulty cutting back. Energy consumption is determined by the physical and economic structure of daily life.[31] People consume natural gas for heating primarily and, increasingly, indirectly for electricity. The amount they consume is dictated in large part by the kinds of buildings in which they live and work and the energy efficiency of the appliances they use. Natural gas has become the fuel of choice in many residential uses. It has been the favorite of the electricity industry for about a decade. Short-term elasticities are in the range of .3, long-term elasticities are in the range of .6. An occasional estimate of long-term elasticity is in the neighborhood of 1.0, quite inelastic compared to other commodities.[32]

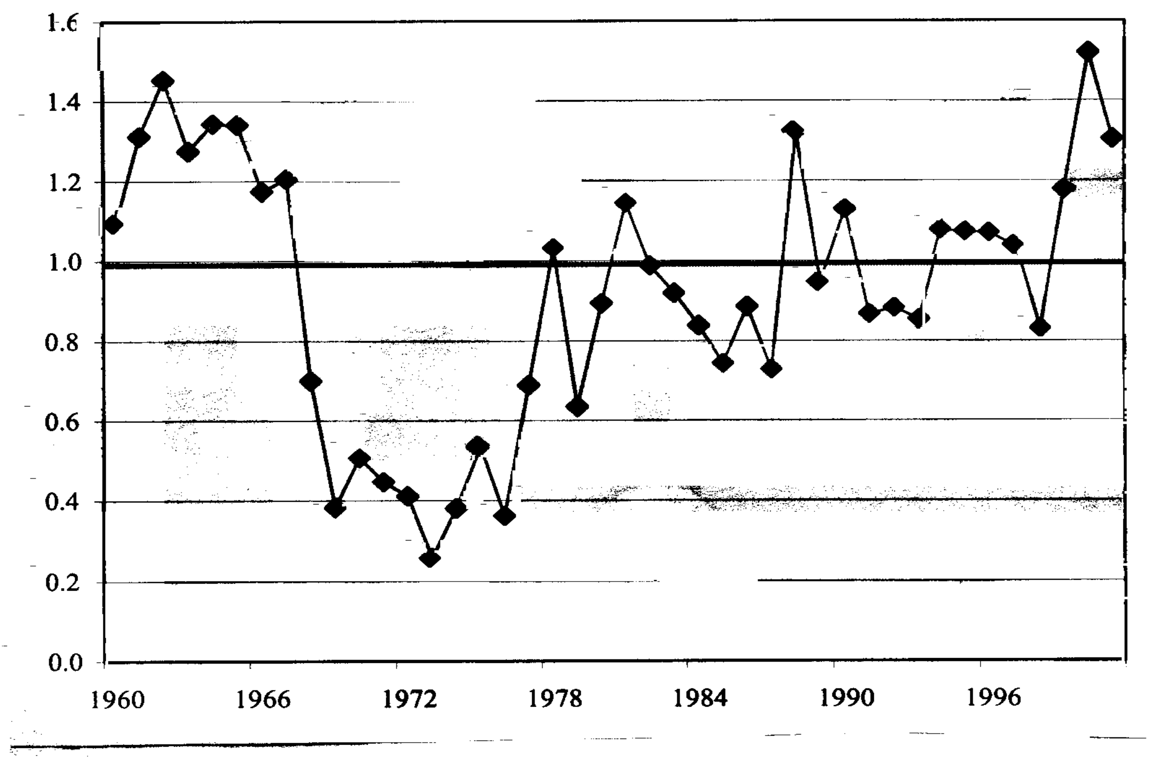
UNCERTAINTY ABOUT SCARCITY

One of the reasons we observe differences in assumptions about the supply price response is that analysts believe we are at different places on the supply curve. The change in demand or supply has a different effect on price if the resource base is exhausted and difficult to expand than if it is not as mature and easier to develop.

This difference of opinion (between the EIA and the NPC, for example) will play a prominent role in the debate over natural gas policy. An interesting aspect of the conflict over the NPC report and the current situation is the assertion that we are suffering from a sudden realization that the resource base is not what we thought it was. Thinking we had plentiful supplies, we stimulated natural gas consumption particularly in the electricity sector. But supplies were actually tighter than we thought. The sudden discovery of scarcity in the face of increasing demand has led to a substantial price shock. This view provides a “scarcity” explanation of the recent price increases that has created substantial economic rents. As demand crept up and the resource base was depleted, the industry got a shock. Its expectations that it could continue to replace natural gas supplies at modestly rising prices were wrong. Given limitations on where the industry can drill and the amount of gas to be found, it will take much higher prices to keep supplies up. Because existing supplies have been discovered and developed at much lower costs, they earn a very high rate of profit.

Not everyone agrees on the pessimistic view of the resource base. The fact that it is a surprise does not help its credibility. First, the Stanford Energy Modeling Forum points out that the long-term trend of reserve replacement is not consistent with the extremely pessimistic view (see Exhibit II-4).

Exhibit II-4:
Natural Gas Replacement Rate (=Additions/Production)



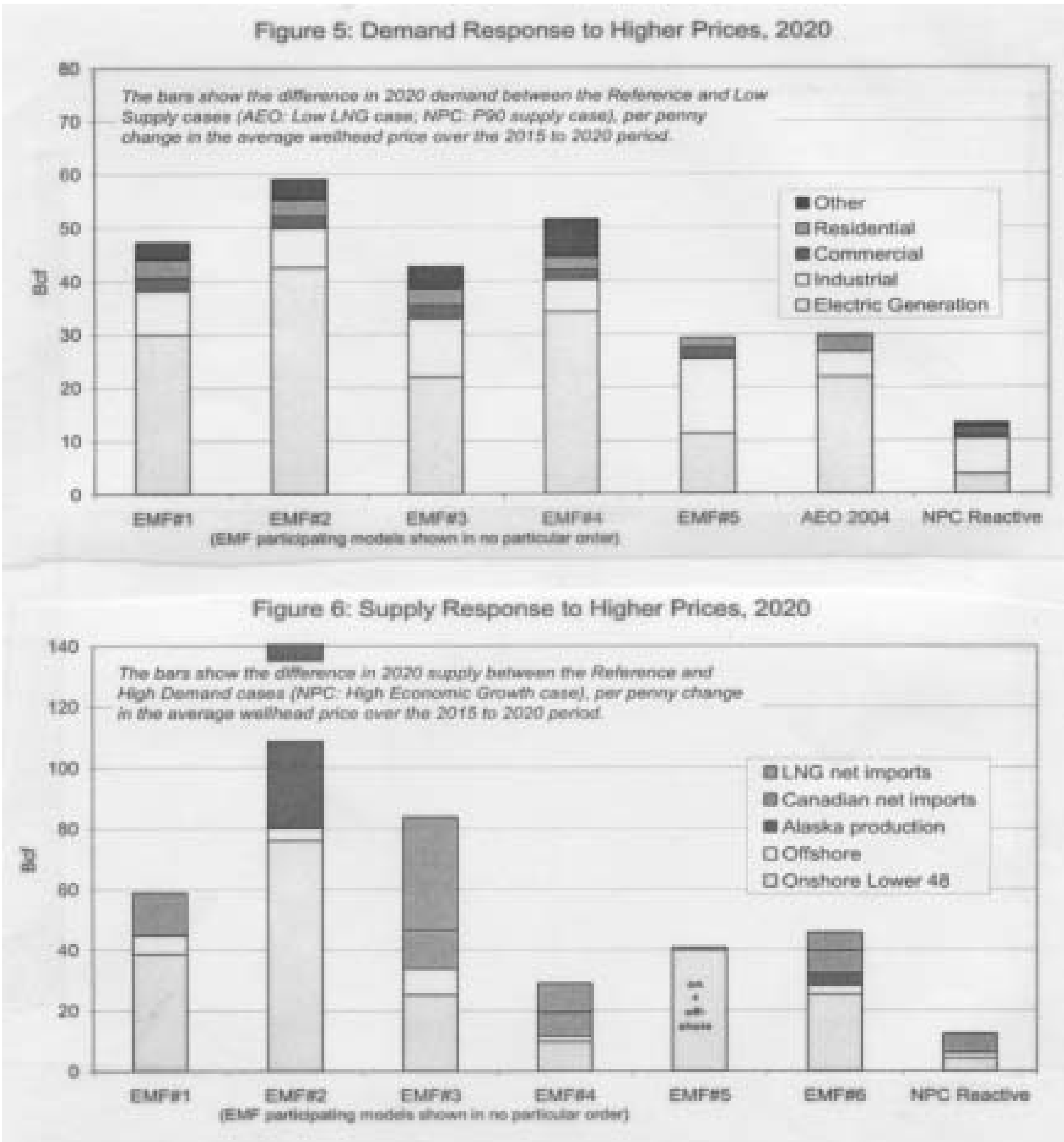
Source: Energy Modeling Forum, *Natural Gas, Fuel Diversity and North American Energy Markets*, September 2003, Figure 2.

The reaction of prices assumed in the pessimistic NPC view appears extreme (see Exhibit II-5). Second, it is not clear how the supply and demand sides will react over time. The elasticities of supply and demand are extremely low in the NPC study, the equivalent of very short-term elasticities. Over the longer term, supply and demand should be more elastic.

If the problem is not scarcity, but prices are well above what historical patterns suggest, what is the explanation? The NPC does not entertain the possibility that strategic behaviors by producers — withholding supply, failing to look for new sources, or manipulation of markets — have contributed to the problem. An alternative view attributes at least part of the problem to strategic and manipulative behavior.[33]

The move of the majors into gas changed the nature of the sector.[34] The consolidation in the industry came hand-in-hand with a shift in resources as the majors acquired resources through merger (rather than exploration) and a shift of drilling away from exploration. [35] Decisions about which well to produce and which well to cap, how much to inject into storage, how to use pipeline capacity and, ultimately, how to report prices are affected by business decisions. Decisions about which types of wells to drill may change replacement

Exhibit II-5:
The National Petroleum Council Natural Gas Study Dramatically Underestimates Market Responses to Price Increases



Source: Ken Costello, Hilliard G. Huntington and James F. Wilson, *After the Natural Gas Bubble: A Critique of the Modeling and Policy Evaluation Contained in the National Petroleum Council's 2003 Natural Gas Study,* July 8, 2004, Figures 5 and 6.

rates.[36] Standard and Poor's has recently noted that this trend has continued and raised questions about it:

> It is unclear that producers are investing enough to grow production materially – and this follows a year [2003] in which the domestic gas production (including acquisitions) of integrated producers appears to have declined…
>
> [M]ajor integrated companies, which appear to be reinvesting only 30 to 40 percent of their domestic cash flow in the United States, have made strategic decisions to allow their shallow-water and onshore natural gas production to deplete to redeploy capital to international (mainly oil) projects.[37]

It is also important to recognize in the case of natural gas that the trading markets that drive the wellhead price are quite new. Most were set up in the 1990s, as part of the restructuring of the natural gas industry.[38] Enron played a large role in these markets and when it collapsed, so too did much private trading.[39] Today, the markets are "very thin" and that raises concerns about trading,[40] but the evidence is mounting that manipulation and abusive practices have long been part of these markets.[41] As recently as the end of November 2004, indictments were still being handed down for the misreporting of natural gas trades in 2000 and 2001 and reporting of gas stocks and prices were in disarray.[42]

CFA's view is that scarcity and strategic behavior have interacted. We cite the maturity of the domestic resource base as the reason public policy should not overemphasize domestic drilling as a solution. We recognize that this has implications for scarcity, and we accept the need to expand supply in an environmentally sound way. However, we believe that strategic behavior played a role as well. Inadequate competition has augmented volatility and accelerated the upward price spiral. **The implication of this discussion is that we should put some eggs in the scarcity basket and some eggs in the strategic basket. Perhaps more strongly, we can suggest that vigorous efforts should be made to first ensure that strategic behavior is not the underlying problem.**

PRICE VOLATILITY AND STOCKPILES

Whatever one believes about the role of concentration and manipulation in the ongoing market tightness, the importance of stockpiles is widely recognized. Prices run up quickly as a result of even slight disruptions in the supply-demand balance because short-term supply and demand in the energy industry are extremely inelastic. Contrasting energy commodities to financial instruments like stocks and bonds, a recent book entitled *Energy Risk* identified the uniqueness of energy markets. The key elements are the supply-side difficulties of production, transportation and storage, and the demand-side challenges of providing for a continuous flow of energy to meet inflexible demand, which is subject to seasonal consumption patterns.

> [T]he deliverables in money markets consist of a "piece of paper" or its electronic equivalent, which are easily stored and transferred and are insensitive to weather conditions. Energy markets paint a more complicated picture. Energies respond to the dynamic interplay between producing and using; transferring and storing; buying and selling – and ultimately "burning"

> actual physical products. Issues of storage, transport, weather and technological advances play a major role here.
>
> In energy markets, the supply side concerns not only the storage and transfer of the actual commodity, but also how to get the actual commodity out of the ground. The end user truly consumes the asset. Residential users need energy for heating in the winter and cooling in the summer, and industrial users' own products continually depend on energy to keep the plants running and to avoid the high cost of stopping and restarting them. Each of these energy participants – be they producers or end users – deals with a different set of fundamental drivers, which in turn affect the behavior of energy markets…
>
> What makes energies so different is the excessive number of fundamental price drivers, which cause extremely complex price behavior.[43]

Having product in storage for quick release is crucial in determining the price and market behavior where supply and demand are inelastic:

> Economic frictions (including transportation, storage, and search costs) which impede the transfer of the underlying commodity among different parties separated in space or time can create the conditions that the large trader can exploit in order to cause a supracompetitive price…
>
> Although the formal analysis examines transportation costs as the source of friction, the consumption distortion results suggest that any friction that makes it costly to return a commodity to its original owners (such as storage costs or search costs) may facilitate manipulation.
>
> The extent of market power depends on supply and demand conditions, seasonal factors, and transport costs. These transport cost related frictions are likely to be important in many markets, including grains, non-precious metals, and petroleum products.
>
> Transportation costs are an example of an economic friction that isolates geographically dispersed consumers. The results therefore suggest that any form of transaction costs that impedes the transfer of a commodity among consumers can make manipulation possible…
>
> All else equal, the lower the storage costs for a commodity, the more elastic its demand.[44]

Every investigation of every petroleum product price spike in the past several years points to "unusually low stock" as a primary driver for all petroleum products.[45] Natural gas stocks are very much influenced by the need to build stockpiles to meet the inevitable surge in demand during the winter heating season.[46] One recent study found the volatility of natural gas prices to be greater than oil prices because of the nature of the infrastructure required to deliver natural gas to consumers:

> The dependence of natural gas on more inflexible sources of supply and the greater role of transportation opens the window to profiteering. It appears that volatility in natural gas returns is more persistent than volatility in oil returns. By itself, this result suggests that there may be a 'larger window of profit opportunity' for investors in natural gas than in oil….
>
> [N]atural gas return volatility responds more to unanticipated events (e.g. supply interruptions, changes in reserves and stocks, etc.), regardless of which market they originate in… For example, a major event-causing shock will lead to an immediate increase in volatility in natural gas returns and culminate in a (relatively) prolonged period of volatility. If prices and thus returns rise in response to volatility, there may be immediate profit opportunities in natural gas following shocks in either market.[47]

The long-term trend to much lower stocks relative to demand is clear in natural gas. Compared to the decade of 1985-1994, stocks were about 25 percent lower in the 1995-1999 period.[48] During the price spikes of the new millennium, the second half of 2000 and the first half of 2001 and 2003, stocks were 40 to 50 percent lower than in the 1985-1994 period and 25 percent lower than in the 1995-1999 period. These declines came during a period of a small increase in consumption. The tightness in the market magnifies the impact of stockpiles.

> In a goof that may prompt more calls for greater natural gas market transparency, the Energy Information Administration Thursday acknowledged a major mistake in data issued last week on U.S. gas stockpiles… EIA said only 17 billion cubic feet of gas had been withdrawn from U.S. storage facilities between November 12 and 19 – not 49 bcf, as the agency reported last week… The revelation could prove particularly sensitive because the surprisingly high number reported last week prompted a major and rapid run-up in gas futures prices – based on faulty data.[49]

This recent storage reporting incident highlights both the importance of and concern over natural gas storage[50] and the continuing concerns of price transparency and manipulation.[51]

III. THE URGENT NEED FOR AGGRESSIVE POLICY

This debate over elasticities and the causes of recent price increases should not be allowed to obscure the underlying challenge in the natural gas market. Critical insight into the pressing need for aggressive policy can be gained by projecting demand for natural gas and then inquiring how that demand can be met.

DEMAND

As noted, natural gas is the dominant fuel source for home heating and the overwhelming energy choice for new electricity generation units built in the past decade, in addition to being a preferred feedstock for chemical products. The important role that natural gas plays on the demand side means that as the economy grows and population increases, demand will increase as well. Exhibit II-2, above, shows that the energy/economy models generally project U.S. demand to be in the range of 25 to 30 trillion cubic feet (tcf) per year in 2025. This represents a modest rate of growth from the current level of consumption of about 22 tcf.

The points plotted in Exhibit II-2 reflect only U.S. consumption, but most studies recognize that future supply and demand analyses should include Canada and Mexico as well. The North American market is integrated by pipelines, and pipeline imports for North America play an important role in all scenarios, accounting for between five and twenty percent of total U.S. consumption. All else equal, annual North American demand is likely to grow from just over 25 tcf today to over 35 tcf in twenty years. Over the next twenty years, North America is likely to consume approximately 600 trillion cubic feet of natural gas (in the base case scenarios).

Exhibit III-1 presents an accounting of the need and potential sources of natural gas over the next two decades drawn from the recent round of reports.

SUPPLY

The primary source of supply will be already discovered gas reserves in the U.S., Canada and Mexico that are currently proved, about 270 tcf. Additional supplies will come from reserves that are likely to be proved, which fall in the range of 300 tcf. This totals about 600 tcf. However, because the resource base recently "surprised" the market and revisions to reserve estimates have recently been downward, by as much as 20 percent, we should be cautious about projected reserves and use a range of estimates of the unproven part of the resource base, perhaps 270 to 330 tcf.

In order to keep the gas industry operating on a continuous basis, companies strive to replace the gas they produce. For example, note that today North America has about 270 tcf of discovered proved reserves, with consumption of about 27 tcf. Thus, the reserve-to-production ratio is about 10 to 1. Since base case consumption will be about 35 tcf in twenty

Exhibit III-1:
Estimation Of Need And Potential Contribution Of Alternatives (Trillion Cubic Feet)

TOTAL NEED = 600 TCF CONSUMED + 350 TCF RESERVE		**~ 950 TCF**	
On Hand			
Discovered Remaining			
Proved		270	
Growth		270 – 330	
Shortfall	~	350 - 400	
FILLING THE GAP:			
SOURCE		**POTENTIAL CONTRIBUTION**	
DEMAND SIDE		**Cumulative 20-Year**	**2025 Annual Level**
Fuel Switching		20 – 40	3
Efficiency		70	8
SUPPLY SIDE			
Domestic, Non-traditional Alternatives			
Alaska			
Discovered		45	2-3
Undiscovered		258	
Gasification		10 – 40	2-3
Imports LNG		20 – 80	4
Domestic Traditional			
Sensitive Areas		115	
Conventional Undiscovered		650	
Unconventional Undiscovered		320	

Source: National Petroleum Council, *Balancing Natural Gas Policy: Fueling The Demand Of A Growing Economy* (September 2003); American Council for an Energy Efficient Economy, *Natural Gas Price Effects of Energy Efficiency and Renewable Energy Practices and Policies*, December 2003, *Smart Energy Policies*, September 2001; Cambridge Energy Research Associates, *Charting a Path: Options for a Challenged North American Natural Gas Market*, 2004.

years, the industry will strive to have discovered, proved reserves of about 350 tcf at the end of the period. Thus, beyond the current discovered reserves, there is a "shortfall" in the range of 330 to 400. That is almost as much natural gas as was produced and consumed in North America in the past decade and a half. This is the challenge.

FILLING THE GAP

Exhibit III-1 identifies broad categories of potential sources that could contribute to that total. The demand side estimates are taken from the American Council for an Energy

Efficient Economy.[52] The projected reduction in demand with aggressive efficiency policies are just under 25 percent, which is well within the range of what is technologically and economically feasible, especially when the full range of options for holding down the use of gas in the electricity sector are taken into account.[53]

Fuel switching is based on estimates from CERA.[54] Fuel switching potential is not technologically constrained, having been higher in the past. Rather, environmental constraints and sunk investment in capital equipment set the limits. If public policy were to promote fuel switching (i.e. relax environmental constraints), over time dual fuel capacity would expand as capital equipment were replaced. The choices of which fuel to burn would then be set by relative prices. In this respect, a reserve of fuel switching capacity could act as a break on future price increases. These observations apply to fuel for heat, not as feedstock.

In this analysis, the supply side domestic resources are based on the recent NPC study primarily because it allows us to identify and differentiate specific sources that are policy relevant. The Department of Energy's Annual Energy Outlook projects resources about 15 percent higher than the NPC. This reflects a difference of opinion about the resource base.

The NPC identified sources of supply in the lower 48 states that it considers to be constrained by environmental restrictions. We term these sensitive areas. Given their location and the detailed knowledge of neighboring areas, we assume they would otherwise fall in the category of conventional undiscovered resources. Because they are the subject of intense policy debate, we treat them separately and therefore have subtracted them from the estimate of conventional undiscovered.

We can also separate out Alaska, which is another critical policy alternative.[55] Both the NPC and the DOE assume Alaskan gas becomes available in about a decade. In other words, they assume that an Alaska Natural Gas pipeline will be built.

Two other sources are less conventional but could play an important role. The worldwide trade in liquefied natural gas is growing rapidly, although it plays a small role in the U.S. at present.[56] Gasification of coal is another possibility.[57] The initial facilities will be built to generate electricity, which has been driving increases in natural gas consumption for the past decade. However, over time, and depending on the price of gas, coal gasification could provide gas for other uses. As with Alaskan gas, both LNG and coal gasification are not likely to make substantial contributions in the near term.

CONCLUSION

This discussion makes it clear that the policy problem is not one of an absolute shortage, but the choice of sources. Stimulating most of the potential sources would require significant changes in policy to reach their full potential. Moreover, the recent run up in price, and the claims of industry about rising costs and increasing difficulty of finding natural gas, suggest that just relying on discovery of conventional and unconventional sources may be very expensive. In other words, it would appear that policies should be implemented to ensure not only that our natural gas needs are met, but at affordable prices.

On the other hand, the existence of a range of alternatives and uncertainty about each supports the recommendation that detailed consideration of the costs and benefits of the alternatives be considered carefully before policy choices are made. The impact of each alternative varies substantially across a number of dimensions. For this, we need a policy framework.

IV. POLICY FRAMEWORK

Comprehensive Solutions Must Reflect the Complexity of the Problem

This brief discussion of the impacts of rising natural gas prices and the review of the uncertainty about the causes of past and the prospects for future price increases makes it clear that energy in general, and natural gas in particular, must be seen as extremely complex. It must be viewed not only as a fuel directly consumed for heat and hot water but also as an input used for the production of other goods and services. Because it is an input, substitution or competition between uses takes on special importance. Natural gas (i.e., the methane molecule) is special among energy raw materials because of the ways in which it is consumed (the demand side) and the way in which it is delivered to consumers (the supply side).

On the demand side, it is extremely versatile. As a fuel, it is used to produce warmth in buildings, to heat water, to cook food, and, increasingly, to generate electricity. To a lesser extent, it is used to power vehicles. As a feedstock, it is used to produce a broad range of products from fertilizers to plastics.

On the supply side, natural gas is very difficult to deliver. Natural gas resources are generally located far from where consumption and use take place. Volatile and explosive, methane molecules can only be transported and stored in sealed systems under pressure. Almost all natural gas delivered in the U.S. is produced in North America and delivered by pipeline. Almost all imports of natural gas come from Mexico and Canada and are moved by pipeline. Most analysts believe that liquefied natural gas (LNG) will play a larger role in meeting U.S. demand in the next several decades. The natural gas resources for LNG will be from outside North America and require tankers, terminal facilities and pipelines to reach American consumers.

Environmentally, natural gas is the cleanest burning of the fossil fuels. However, drilling poses problems, as with other fossil fuels. In some senses, the transport and delivery of natural gas pose more severe problems than other fossil fuels because of the volatility of the methane molecules. Yet the impact of natural gas accidents, while more dangerous to human life, are less dangerous to the environment. Importation of liquefied natural gas also has significant environment impacts because of the need for terminal facilities and pipeline capacity.

The complexity of the natural gas situation is compounded by the suddenness of the recent price increases and the uncertainty of the causes, or at least the dispute over the causes.

The objective of policy should be to ensure a reliable supply of natural gas that is delivered in an efficient and equitable manner at affordable prices. Balance is critical to meet the needs of producers and consumers of natural gas both as a fuel and industrial input; these decisions must be made with a watchful eye on environmental impacts.

On the supply side, natural gas markets do not appear to be functioning well. There are concerns about the price setting mechanism and the ability of price signals to elicit efficient drilling activity. And, there are large environmental and other externalities that affect the supply side.

On the demand side, there are traditional collective action and externalities problems with natural gas. Individual decisions by consumers do not reflect the full societal value of natural gas. In many cases there is a disconnect between the critical decisions that affect consumption (building efficiency, new appliance choice) and the actual consumption of gas because someone other than the consumer often makes them.

Reliability/security issues are not well reflected in market transactions. The essential criteria by which the performance of the natural gas sector has traditionally been measured are its economic and environmental qualities, but in the current context, the issue of reliability has taken on particular importance. To the extent that reliability was a concern in the past, it focused on the operation of the system and accidents. Today reliability includes the security of facilities and the threat of disruption of supplies.

The recent concern over natural gas has elicited a wide range of suggested policies. Over two dozen specific policies have been suggested by a variety of groups (see Exhibit IV-1). All would improve the supply-demand balance, but there are important distinctions between them.

- The policies affect different aspects of the natural gas market in different time frames.
- Some policies affect the structure of the market. Others affect the behavior of producers and consumers in the market.
- They possess different economic costs and distribute costs and benefits differently.
- They affect the environment and reliability/security differently.

By structural policies, we mean policies that affect or change the options faced by consumers or producers. For example, an appliance standard that precludes an extremely inefficient model from being produced or requires a highly efficient model changes the options available to consumers. Construction of an LNG facility or the Alaska Natural Gas Pipeline would make a new source of gas available in the market.

By conduct policies, we mean policies that influence the decisions of consumers or producers to select among options. For example, consumer education might seek to convince consumers to purchase a more efficient appliance than has been required by a standard. A royalty reduction or a tax break might seek to convince a producer to drill on land he might otherwise have passed over.

Exhibit IV-1:
NATURAL GAS POLICY MATRIX

	SUPPLY-SIDE		DEMAND-SIDE	
	STRUCTURE	CONDUCT	STRUCTURE	CONDUCT
SHORT TERM		Market monitoring; Transparency; Storage policy, State storage,	Off-the shelf conservation (e.g. insulation, appliances)	Consumer education; Gov't. facilities conservation; Labeling
MID TERM	LNG expansion; Coal gasification; Renewables & alternatives portfolio, tax incentive; Alaska NG pipeline	Reform access to conventional resources federal lands, Royalties rights of way; Tax incentives	Building codes; Appliance standards; Fuel switching; Fuel use restrictions	Demand response programs; Economic dispatch; Redesign PGAs; Performance targets
LONG TERM	R&D Production Transportation			R&D Efficiency

Given the importance and flexibility of natural gas, a full range of public policy tools must be used on both the supply and demand sides of the market. Policies should address the structure of natural gas markets and the conduct of producers and consumers in the short-, mid-, and long-terms.

POLICY EVALUATION CRITERIA

Identifying the policy alternatives and their effect on the market and in what time frame is only part of the process. We also need to develop criteria by which we will choose among these alternatives. As noted above, there are three broad areas of policy concern – economics, environment and security. Each of these areas has specific issues that should be addressed. For the consumer, the primary considerations are economic, but environmental and security consideration must be taken into account. While minimizing costs is a goal, it is paramount that policy choices produce outcomes that are economically acceptable. In choosing between economically acceptable outcomes, policies that lower environmental costs and/or security concerns should be preferred.

Economics

Cost/Benefit: An estimate of the cost to achieve each potential increase in supply or decrease in demand can be calculated. We prefer policies that meet the need for energy at the lowest cost.

Market Structure: Policies affect the market structure differently. We prefer policies that increase the supply and demand elasticity and bring new players into the market to promote competition. For commodities like natural gas, where the elasticity of supply and demand are low compared to most other goods and services, one aspect of market structure that receives a great deal of attention is price volatility. Price volatility is disruptive, magnifying the perceived burden on consumers and making it difficult for industrial consumers to plan their production processes and price their products in markets where competitors have access to natural gas at lower or more stable prices.

Environment

Production (Facility) Footprint: Energy production, transportation and distribution have environmental impacts. These are frequently conceptualized as external social costs. Relaxation of environmental standards to allow drilling or construction of facilities can impose those costs on society. We should also keep in mind that supply of natural gas requires infrastructure to deliver. That is, if consumption grows by thirty percent, as the base case models project, then a substantial increase in pipeline capacity will be needed to deliver the gas to consumers. An alternative that saves on this infrastructure should be preferred.

Consumption: As noted, natural gas is one of the cleaner burning fuels. Nevertheless, the consumption of energy has environmental impacts.

Security

Reliability of operations: Operating pipelines, terminals, and drilling rigs are complex and difficult activities. They are subject to accidents and disruptions from weather and other problems.

Vulnerability of the system: Under current circumstances, intentional acts of sabotage or terror to disrupt the flow of natural gas must be considered.

Dependability of Supply: Some of the policy alternatives are dependent on foreign sources of supply. They may be subject to withdrawal or manipulation. Some sources of supply may be uncertain for other reasons such as weather or human behavior.

V. FIRST STEPS IN A CONSUMER FRIENDLY APPROACH TO NATURAL GAS

The pay-off of the analytic exercise is a comprehensive basis for ranking the alternative policy choices according to the evaluation criteria. Rankings are subjective, but informed by the framework (see Exhibit V-1). We have placed the policies into two groups – first steps and tough choices. The policies are discusses in the order in which they should be pursued.

Exhibit V-1: Evaluation of Policy Alternatives

SOURCE	ECONOMIC		ENVIRONMENT			SECURITY OF SUPPLY		
	Cost/ Benefit	Market Structure	Volat-ility	Facility Footprint	Air	Relia ability	Depend ability	Vulner-ability
<u>**Reducing Turmoil**</u>								
Transparency		+	+					
Storage		+	+			+	+	+
<u>**Demand Reduction**</u>								
Efficiency	+	+	+	+	+	+	+	+
Switching	+	+	+			+	+	+
<u>**Alternative Domestic Suppy**</u>								
Gasification		+	+	-	+			
Alaska	-		+	-				-
<u>**Imports**</u>								
LNG				-			-	-
<u>**Traditional Domestic Supply**</u>								
Undiscovered							-	
Sensitive Areas				-			-	

REDUCING TURMOIL

The above discussion highlights the importance of ensuring that markets are free of manipulation. In a sense, this is the short-term response to the short-term problem. With a reserve to production ratio of ten years, there is no absolute shortage in the near-term. The problem is that prices have run up much more quickly than supply can respond. The short-term problem is about price and its causes are controversial. We believe that strong measures to ensure confidence in markets are critical to establish the credibility of arguments for other policies.

Two policies that affect market structure and volatility but do not alter the supply demand balance in the long term are transparency and storage. These policies will not increase supply or reduce demand, but they could lower prices. They would also establish a prerequisite necessary for other policies – confidence that there is a "hard" problem in the imbalance of supply and demand.

Transparency

From the consumer point of view, market structure and price volatility demand public policy attention in the short term. Since the supply side of the market is uncertain and concerns about strategic behavior are substantial, policies to ensure transparency of market supply and to prevent manipulation of prices should be implemented. The Federal Energy Regulatory Commission has yet to implement procedures to accomplish this. Reporting of transactions is still spotty.

Storage

Lack of stockpiles has played a key role in both oil and gas price increases. The Federal Energy Regulatory Commission has even considered ordering the construction of public storage facilities. Public utility commissions have investigated and could order utilities to have stockpile on hand as the peak season approaches.

DEMAND REDUCTION

Efficiency

The most obvious conclusion of the previous discussion is that vigorous efforts to improve efficiency should be the first, but not the only, policies pursued. Efficiency has a positive impact on almost every one of the evaluation criteria. Its potential to lower prices has been noted. Efficiency has obvious environmental benefits by reducing the need for facilities and the consumption of fossil fuels. To the extent that it reduces the need for resources, it improves security. It could have market structural benefits, if demand is reduced sufficiently to shift the market equilibrium to a more elastic region of the supply curve, but that is not likely.

Reducing demand for natural gas by about one quarter of the base level projection could be achieved with the implementations of three broad categories of policies – building codes,[58] appliance standards,[59] and industrial use[60] – that essentially accelerate the adoption of currently available best practices or readily achievable savings with off-the-shelf technologies. The potential savings over a longer period are higher. The key challenge is to move higher efficiency products and practices into widespread use. Standards, incentives and education programs are the vehicles to do so.[61] These discussions do not include the impact of a renewable portfolio standard, which could have a large effect on the electric utility sector.[62] Although several states have recently adopted significant renewable standards, 10 to 20 percent, the federal government has not.

Fuel Switching

The ability to burn alternative fuels was once much more prevalent than it is today. It has a cost and reliability profile similar to conservation, with the added benefit that it may help to dampen price volatility. However, to the extent that the alternative fuel is a fossil fuel, it is likely to have a negative environmental impact in terms of air pollution.

These two demand side alternatives could fill about a third of the gap. Since these two sets of policies reduce the level of demand, they also lower the need for reserves to maintain the reserve to production ratio. Instead of proved reserves of 350 tcf, the industry would need only 250, roughly the current level.

Nevertheless, several supply-side policies would have to be pursued to fill the gap.

Alternative Sources of Supply

Three alternative sources of supply of natural gas – LNG, coal gasification, and Alaskan gas – have received considerable attention. There are two obvious reasons. First, the fact that supplies are tight raises concerns about whether there will be gas available. Second, the dramatic increase in natural gas prices makes these alternatives attractive. Engineering/ economic analyses indicate that these alternatives all are economically competitive in the range of $4 to $5 per thousand cubic feet, although each has unique risks or uncertainties. LNG is on the low side,[63] and both coal gasification[64] and Alaskan gas on the high side.[65] Thus, the dramatic rise in prices in the past two years has catapulted the alternatives into the center of the debate over sources of supply.

Given the nature of these alternatives, all must be considered mid-term prospects at best. Permitting and construction lead times mean substantial contributions are likely to take at least half a decade for LNG and probably a decade for gasification and Alaskan gas.

Coal Gasification

Based on a virtually inexhaustible domestic resource that would bring new suppliers into the market, coal gasification could be a stabilizing force. The U.S. has been called the Saudi Arabia of coal, with 25 percent of the world's coal reserves, compared to two or three percent of its oil reserves. The reserve to production ratio at current levels of consumption is over 250 years, compared to 10 for natural gas. Coal also has the advantage of not having many competitive uses – it is largely used for electricity generation, and not a feedstock for industrial products. As a large facility, gasification plants have negative footprint characteristics. However, it has a modestly favorable environmental air quality profile.

Although coal gasification presently is 10 to 20 percent more costly than traditional coal, there are two factors that might improve its cost profile.[66] Although there are over 100 plants around the world,[67] it is seen as an unproven technology in America and bears a risk premium. If public policy requires reduction of carbon dioxide emissions, or other major pollutants, it would have a cost advantage.

Alaskan Gas

Bringing gas to North American markets has a price disadvantage associated with the high cost of the pipeline. It also has a large environmental impact because of the facility. The cost drawback of Alaskan gas lies in the very large capital outlay and long lead time in building the pipeline. Yet it could bring substantial sources of supply to market.

Pursuing the four alternative sources of supply discussed above that are domestic, but non-traditional, would fill just under half the "shortfall." They would take a tremendous amount of pressure off of the traditional resource base. The conservation and fuel switching effects would alleviate upward pressures on prices, as would the steps to create transparency and storage capacity.

Imports of Liquefied Natural Gas

Another source of natural gas that does not rely on the traditional resource base is LNG imports. Liquefied natural gas currently accounts for about two percent of consumption, but it is much more widely used on a global scale. Unfortunately, LNG is likely to depend on foreign sources that are controlled by members of the OPEC cartel or suppliers with market power. It also does not have environmental or security advantages. The role of LNG will expand because of the cost of domestic resources, but because it offers little unique advantages, it does not deserve special policy attention.

Traditional Sources of Gas

Under a policy scenario that pursues the above first steps aggressively, production from the traditional domestic resource base, conventional and unconventional on-shore and offshore, would have to remain at roughly the current levels to fill the remaining gap. Nevertheless, they still present tough choices. This still leaves a substantial challenge for the supply side. Looking at domestic production, we find a mix of plusses and minuses.

Undiscovered Resources

Undiscovered resources represent a very large potential, but, by industry accounts, they are one source of the problem, since they have proved less predictable and more costly than anticipated. Given the recent downward revisions in reserve estimates, we consider undiscovered resources (conventional and unconventional) to pose a dependability problem. Given the projections of the NPC, the unconventional sources appear to be more costly than the alternatives. Current prices should elicit sufficient effort to exploit these resources.

Sensitive Areas

Drilling in sensitive areas may have a high environmental cost, although we would expect it to be low cost to produce. Whether it would have an effect on price is uncertain because of the market structure issues. The same players who dominate the market today would be the most likely to develop these resources. We rank drilling in sensitive areas lowest in priority because it represents, at best, be considered to address the mid-term transition to other sources.[68]

ENDNOTES

[1]Concerns about natural gas prices have been expressed for over a year. For residential customers see "Heating Costs Going Through Roof," *CBS Evening News*, Jan. 20, 2004, www.cbsnews.com; Mayer, Caroline E., "The Cost of Keeping Warm: Weather Threatens to Push Heating Bills to New Heights," *The Washington Post*, January 17, 2004, p. E-1. "Low Temperatures, High Prices," *York Daily Record*, January 19, 2004; Hopper, Michael, "Heating Costs Pinch Pockets," *Topeka Capital-Journal*, January 18, 2004; Power, Meg, *Energy Bills of Low-Income Consumers in FY 2005* (Washington: Economic Opportunity Studies, November 23, 2004). For industrial customers,the Industrial Energy Consumers of America raised the issue in December 2003 (see *41 Month Natural Gas Crisis Has Cost U.S. Consumers $111 Billion*, Washington, December 3, 2003) and December 2004 (*Consumers Ask FERC to Expedite Daily Natural Gas Storage Reporting – November 24 EIA Report Cost Consumers as much as $1.0 Billion*, December 2004). Ironically, the data that led to the price spike was incorrectly reported (see Beattie, Jeff, "EIA Gas Data Goof Triggers Market Misfire," *Energy Daily*, December 3, 2004).

[2] Energy Information Administration, *Winter Fuels Outlook: 2004-2005* (Washington: Department of Energy, October 2004)

[3] Energy Information Administration, *Natural Gas, Data Base*; *Winter Energy Outlook*, various issues.

[4] Cooper, Mark, Susan Punnett, and Theodore Sullivan, *Equity and Energy: Rising Energy Prices and the Living Standards of Low Income Americans* (Boulder: Westview Press, 1982).

[5] Even *The Wall Street Journal* recently discovered the regressive nature of energy price increases in a column with the headline "To Have and Have Not," (Lahart, Justin, September 23, 2004, C-1).

> Beltway types can argue all they like over what the divide between rich and poor is doing. But there is little doubt that the gulf between the retailers that sell to America's hoity-toity and those that sell to the hoi polloi is growing…
>
> So why is Joe Six-Pack in so much less of a spending mood than Joe Millionaire?
>
> A big reason is that high fuel costs affect middle-income and low-income families more than they hurt the upper echelons. For 2001, the Transportation Department found that households earning $30,000 to $39,999 went through 1054 gallons of gasoline. At $1.33 a gallon, say, that would be about $1,402. Households earning more than $100,000 went through 1558 gallons. That is more gasoline, but it represented a far small portion of their income – less than 2% compared with about 4%.

[6] A discussion on the difficulty of cutting back on energy consumption in the short term is provided by Hunt, Lester and Neil Manning, "Energy Price and Income Elasticities of Demand: Some Estimates for the UK Using the Cointegration Procedure," *Scottish Journal of Political Economy*, May 1989, pp. 189-190.

> Our results suggest the long-run income-elasticity of energy demand is around .4 and .5, whereas the short-run (impact) income elasticity is around .6 to .8. The affect of a change in income on energy demand is, therefore, greater in the short-run than in the long run. This may follow from the inflexibility of firms' and households' energy-using capital and appliance stocks in the short-run; an increase in income will, therefore bring about an immediate decrease in the derived demand for energy in the short-term, but this derived demand is reduced in the longer term as more energy efficient machines are installed.
>
> The long-run price elasticity of energy demand estimate is approximately -.3 and the short-run (impact) elasticity approximately -.1. Therefore, the effect of a change in the real price of energy is less in the short-run than in the long-run which is in contrast to the above case for income changes. This may also reflect the fixed nature of the machine and appliance stocks in that a rise in the real price of energy produces a modest fall in energy consumption in the short-term. Energy consumption falls further in the longer-term, however, as the price increase induces the installation of more energy efficient domestic appliances and capital goods.

[7] Taylor, Lester, Telecommunications *Demand: A Survey and Critique* (Cambridge, MA: MIT Press, 1980), p. 82), describes another necessity, telephone service, as follows:

> When substitution effects are large relative to income effects, consumers can substitute away from goods whose prices have risen with little loss in utility. However, when income effects are large relative to substitution effects, an increase in price means a relatively large decrease in utility...since the income effect is indicated to be large relative to the substitution effect in the price elasticity of demand.. the welfare of these households may be significantly decreased by increase in the price.

[8] Bureau of Labor Statistics, *Consumer Expenditure Survey in 2002*, shows expenditures for all utilities as 50 percent higher for the top quintile, but this is driven by consumption of electricity, primarily for air conditioning.

[9] Bureau of Labor Statistics, *Consumer Expenditure Survey in 2002*, February 2004.

[10] Ben White, "Jobs Data Send Mrkets Tumbling," *Washington Post*, Augsut 6, 2004; Eduardo Porter, "Economy slowed in 2dn Quarter, U.S. Report Says," *New York Times*, July 31, 2004

[11] In the spring, before record gasoline prices had hit consumers, the *Times* made a direct connection between energy prices and tax cuts. Banerjee, Neela, "Drivers Tend to Shrug Off High Gas Prices, for Now," *The New York Times*, May 4, 2004, C-1 cited figures indicating "the tax cut gave consumers about $70 billion in additional spending power this year, while the rise in crude oil prices… has so far cost Americans only about $35 billion." Greg Ip and Jackie Calmes, "Thanks to Oil, Economy Faces Headwinds in Political Season," *Wall street Journal*, August 9, 2004, put it as follows:

> High oil prices aren't the only thing weighing on the market and the broader economy. Another factor is the fading effect of the stimulus policies that were designed to counteract the 2001 recession and sluggish recovery. Some economists believe consumers needed the steroids of repeated tax cuts and successive rounds of mortgage refinancing to sustain their remarkable spending binge from late 2001 through the spring. With that stimulus now wearing off and Treasury in no position to administer more, consumers may finally be retrenching, partly in response to the high debt levels they have taken on in recent years.

[12] As Greenspan, Alan, Chairman of the Federal Reserve, put it ("Testimony of Chairman Alan Greenspan, *Committee on Energy and Natural Resources*, *United States Senate*, July 30, 2003), "The updrift and volatility of the spot price for gas have put significant segments of the North American gas-using industry in a weakened competitive position. Unless this competitive weakness is addressed, new investment in these technologies will flag."

[13] National Petroleum Council, *Balancing Natural Gas Policy: Fueling The Demands of a Growing Economy* (Washington: September 2003), Volume II, p. 90.

[14] EIA, *Monthly Energy Review*, Table 4.4.

[15] International Energy Agency, *Energy Policies of IEA Countries* (Paris: Organization for Economic Development and Cooperation, 2004), Figure 2 shows North American prices passing other regions in 2003.

[16] House Energy and Commerce Committee, The Task Force For Affordable Natural Gas, *Natural Gas: Our Current Situation*, September 30, 2004.

[17] Costello, Ken, Hillard G. Huntington, and James F. Wilson, *After the Natural Gas Bubble: A Critique of the Modeling and Policy Evaluation Contained in the National Petroleum Council's 2003 Natural Gas Study* (Stanford, CA: Energy Modeling Forum, November 2004), p. 2.

[18] National Petroleum Council, *Natural Gas: Meeting the Challenges of the Nationa's Growing Natural Gas Demand*, 1999, p. 36.

[19] Energy Information Administration, *Annual Energy Outlook* 1999 (Washington, D.C.: U.S. Deaprtment of Energy, 1999), pp. 74-75.

[20] NPC, 2003, p. 5.

[21] Energy Information Administration, *Annual Energy Outlook* (Washington, D.C.:2003), p. 2.

[22] NPC 2003, p. 7.

[23] Costello, et al., p. 22.

[24] Cambridge Energy Research Associates, *Charting a Path: Options for a Challenged North American Natural Gas Market*, 2004.

[25] American Council for an Energy Efficient Economy, *Natural Gas Price Effects of Energy Efficiency and Renewable Energy Practices and Policies*, December 2003.

[26] ACEE, p. 28.

[27] ACEE, p. 31.

[28] Nadel, Steven and Howard Geller, *Smart Energy Policies: Saving Money and Reducing Pollutant Emissions Through Greater Energy Efficiency* (Washington: American Council for an Energy Efficient Economy, September 2001), Table 1.

[29] Energy Modeling Forum, *Natural Gas, Fuel Diversity and North American Energy Markets*, Stanford, September 2003.

[30] U.S. Department of Energy, Brookhaven National Laboratory, *U.S. MARKASL* (MARKASL); Canadian Energy Research Institute, *Energy 2020* (E2020); U.S. Energy Information Administration, *National Energy Modeling System* (NEMS); U.S. Department of Energy, Onlocation, Inc., *Policy Office Electricity Modeling System* (POEMS); U.S. Environmental Protection Agency, ICF Consulting, *NANGAS/IPM* (NANGAS); California Energy Commission, *North American Regional Gas* (NARG); Charles River Association, *Model for US and International Natural Gas Simulation* (CRA).

[31] Kaufman, Robert K., "The Mechanisms for Autonomous Energy Efficiency Increases: A Cointegration Analysis of the US Energy/GDP Ratio," *The Energy Journal,* 25, 2004; de Nooij, Michiel, et al., "International Comparisons of Domestic Energy Consumption," *Energy Economics*, 25, 2003; Norman, Donald A., "Lifestyles of the Energy Rich: Household Energy Consumption in the United States and Conservation Policy," *Advances in the Economics of Energy and Resources,* 10, 1997.

[32] See Bohi, Douglas R., *Analyzing Demand Behavior: A Study of Energy Elasticities* (Baltimore: Johns Hopkins University Press, 1981); Waverman, Leonard, "Econometric Modeling of Energy Demand: When Are Substitutes Good Substitutes?," in David Hawdon, *Energy Demand: Evidence and Expectations* (London: Surrey University Press, 1992), p. 16. Urga, Giovanni and Chris Walters, "Dynamic Translog and Linear Logit Models: A Factor Demand Analysis of Interfuel Substitution in US. Industrial Energy Demand," *Energy Economics*, 25, 2003, p. 18, concludes that "estimates of long run cross elasticities are well below the threshold of unity."

[33] Cooper, Mark, "Real Energy Crisis is $200 Billion Natural Gas Price Increase," *Natural Gas & Electricity,* 21, 2004, Industrial Energy Consumers Association, 2004.

[34] Energy Information Administration, *The Majors' Shift to Natural Gas* (Washington, September 2001).

[35] EIA, Performance Profiles: 2002, pp. 81-83.

[36] EIA, Performance Profiles: 2002, pp. 71-72.

[37] Beattie, Jeff, "U.S. Oil and Gas Producers Investing in Mergers, Not More Drilling – S&P," *Energy Daily,* April 26, 2004.

[38] Energy Information Administration, *The Natural Gas Industry and Markets in 2002* (Washington, February 2004), p. 3.

[39] EIA, *The Natural Gas Industry*, p. 2.

[40] Four years after the initial signs of trouble and in spite of reforms instituted by the Federal Energy Regulatory Commission, things were still bad, reflected "In numbers the FERC Chairman Pat Wood compared to a 'cold shower,' staff of the Federal Energy Regulatory Commission said Wednesday that only 20 percent of companies are reporting all of their natural gas trades and about 10 percent are reporting power trades to public indices." (Davis, Tina, "Gas Prices Reporting Better, But Still Lagging – FERC," *Energy Daily*, May 6, 2004).

[41] Moody, Diane, *Natural Gas Price Indices: Price Manipulation Issues* (Washington: American Public Power Association, January 2003), *Natural Gas Price Issues: Update* (Washington: American Public Power Association, November 2004).

[42] Beattie, "EIA Gas Data Goof; Moody, Diane, *Natural Gas Price Issues: An Update* (Washington, D.C.: American Public Power Association, November 2004), *Natural Gas Issues* (Washington: American Public Power Association, October, 2003).

[43] Pillipovic, Dragana, *Energy Risk: Valuing and Managing Energy Derivates* (New York: McGraw-Hill, 1998), p. 3.

[44] Pirrong, Stephen Craig, *The Economics, Law and Public Policy of Market Power Manipulation* (Boston: Kluwer, 1996), pp. 10… 24… 59. See also, Williams, Jeffrey and Brian Wright, *Storage and*

Commodity Markets (Cambridge: Cambridge University Press, 1991); Deaton, Angus and Guy Laroque, "On the Behavior of Commodity Prices," *Review of Economics and Statistics*, 1992.

[45] Consodine, Timothy J. and Eunnyeong Heo, "Price and Inventory Dynamics in Petroleum Product Markets," *Energy Economics*, 22, 2000, p. 527, conclude, "supply curves for the industry are inelastic and upward sloping." See also "Separatiblity, Functional Form and Regulatory Policy in Models of Interfuel Substitution," *Energy Economics*, 1989; Linn, Scott C. and Zhen Zhu, "Natural Gas Prices and The Gas Storage Report: Public News and Volatility in Energy Markets," *Journal of Futures Markets,* 24, 2004; Esnault, Benoit, "The Need for Regulation of Gas Storage: The Case of France," *Energy Policy,* 31, 2003, shows that as a large importer, storage plays a key role, which is precisely the situation that applies to all but a handful of states in the U.S.

[46] Caruso, Guy, *Outlook for Natural Gas & Petroleum*, Energy Information Administration, May 19, 2003; Trapman, William, *Natural Gas Storage,* Energy Information Administration, October 29, 2002, show the low levels of storage in early 2001 and 2003. Policy Development and Energy Sections, *Natural Gas Price Volatility,* June 3, 2003, pp. 3-4, notes storage in 2003 at the start of the injection season was "50% lower than the previous year" and that "high prices of gas during the storage season make firms think twice about making purchases of gas for injection."

[47] Soderholm, P., "Fuel Flexibility in Western European Power Sector," *Resource Policy,* 26, 2000, p. 162, cited in Ewing, Bradley T., Farooq Malik and Ozan Ozfidan, "Volatility Transmission in the Oil and Natural Gas Markets," *Energy Economics,* 24, 2002, p. 536.

[48] Energy Information Administration, *Natural Gas,* database.

[49] Beattie, Goof, p. 1.

[50] Beattie, Jeff, "FERC Plan for Spare Gas Storage Ripped," *Energy Daily,* October 20, 2004.

[51] Moody, Update; Beattie, Jeff, "Record Gas Storage Does Little to Dampen Prices," *Energy Daily,* November 8, 2004; "EIA Looking at More Fixes to Storage Reporting," *Energy Daily,* December 9, 2004.

[52] Elliot, R. Neal, et al., *Natural Gas Price Effects of Energy Efficiency and Renewable Energy Practices and Policies* (Washington: American Council for an Energy Efficient Economy, December 2003).

[53] Nadel, Steven, Anna Shipley and R. Neal Elliot, *The Technical, Economic and Achievable Potential for Energy Efficiency in the U.S. – A Meta-Analysis of Recent Studies* (Washington: American Council for an Energy Efficient Economy, 2004).

[54] CERA, Table 2. See also Pyrdol, John and Bob Baron, *Fuel Switching Potential of Electric Generators: A Case Study* (Stanford, CA: Energy Modeling Forum), EMF Working paper, July 2003.

[55] In addition to NPC, 2003, see National Commission on Energy Policy, *Increasing U.S. Natural Gas Supplies* (Washington: October 2003).

[56] Energy Information Administration, *The Global Liquefied Natural Gas Market: Status and Outlook* (Washington: U.S. Department of Energy, December 2003); Chanatry, David, "The LNG Battlefield," *Public Power,* 62, 2004.

[57] Rosenberg, William G., Dwight C. Alpern and Michael R. Walker, *Deploying IGCC in this Decade with 3Party Covenant Financing* (Cambridge, MA: John F. Kennedy School of Government, Harvard University, July 2004); Booz Allen, Hamilton, "Coal-Based Integrated Gasification Combined Cycle: Market Penetration Strategies and Recommendations," *Gasification Technologies*, October 2004. Childress, James and Robert Childress, "2004 World Gasification Survey: A Preliminary Evaluation," *Gasification Technologies*, October 2004.

[58] Nadel, et al., 2001, pp. 20-22; Prindle, William, et al., *Energy Efficiency's Next Generation: Innovation at the State Level* (Washington: American Council for an Energy Efficient Economy, November 2003), pp. 5-12; Nadel, Shipley and Elliot.

[59] Nadel, pp. 8-9; Prindle, pp. 1-4; Geller, Howard, Toru Kubo and Steven Nadel, *Overall Savings from Federal Appliance and Equipment Efficiency Standards* (Washington: American Council for an Energy Efficient Economy, 2001).

[60] Nadel, pp. 14-18; Prindle, pp. 13-19; Worell, Martin and Price; Martin, N.E., et al., *Emerging Energy Efficient Industrial Technologies,* 2000; Martin et al.; Price, L. and E. Worrell, *International Industrial Sector Energy Efficiency Technologies* (Berkeley, CA: Lawrence Berkeley National Laboratory, 2000).

[61] Elliot, et al., pp. 60-64.

[62] Elliot, et al., pp. 49-60, Nogge, Alan, et al., *Powerful Solutions: 7 Ways to Switch America to Renewable Electricity* (Cambridge, MA: Union of Concerned Scientists, 1999).

[63] CERA, Charting, p. 20, suggests a minimum price of $3.50 to make LNG competitive, but EIA, Global, pp. 42-48, suggests a somewhat higher price.

[64] Rosenberg, et al. p. 3.

[65] National Commission on Energy Policy, pp. 6-7.

[66] Rosenberg; p. 3.

[67] Childress and Childress.

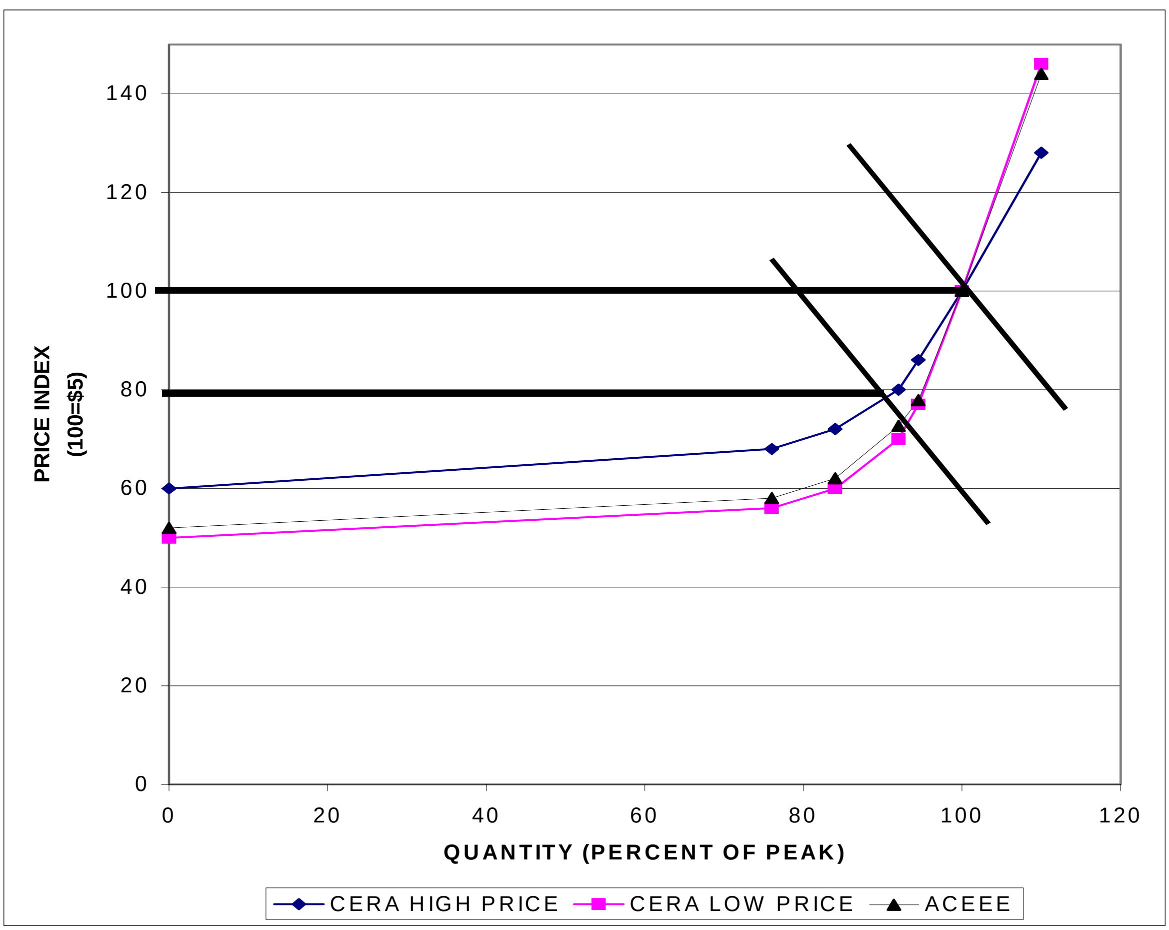
[68] Environmental Working Group, *Big Access, Little Energy – The Oil and Gas Industry's Hold on Western Lands*, August 2004, questions whether lifting environmental restrictions will have a substantial impact on reserves and production.

APPENDIX: GRAPHICAL PRESENTATION OF NATURAL GAS MARKET EQUILIBRIUM

This Appendix presents a graphical discussion of supply and demand factors that have entered into the discussion in Chapter II.

Exhibit A-1 constructs a supply curve to fit the implicit supply elasticities discussed in the text. It assumes that the elasticity doubles with each increment in demand. For example, Cambridge Energy Research Associates (CERA) assumes a $1.50 reduction in price in the face of an 8 percent reduction in demand. Exhibit A-1 shows that in the simulation models, an 8 percent increase in demand results in a $3.00 increase in price (twice as large). Based on this observation, we assume that a second 8 percent reductions in demand would result in only a $.75 reduction in price. We plot three supply curves reflecting two CERA scenarios and the American Council for and Energy Efficient Economy (ACEEE) scenario. This analysis can

Exhibit A-1: Conservation/Efficiently Can Have a Substantial Effect on Price

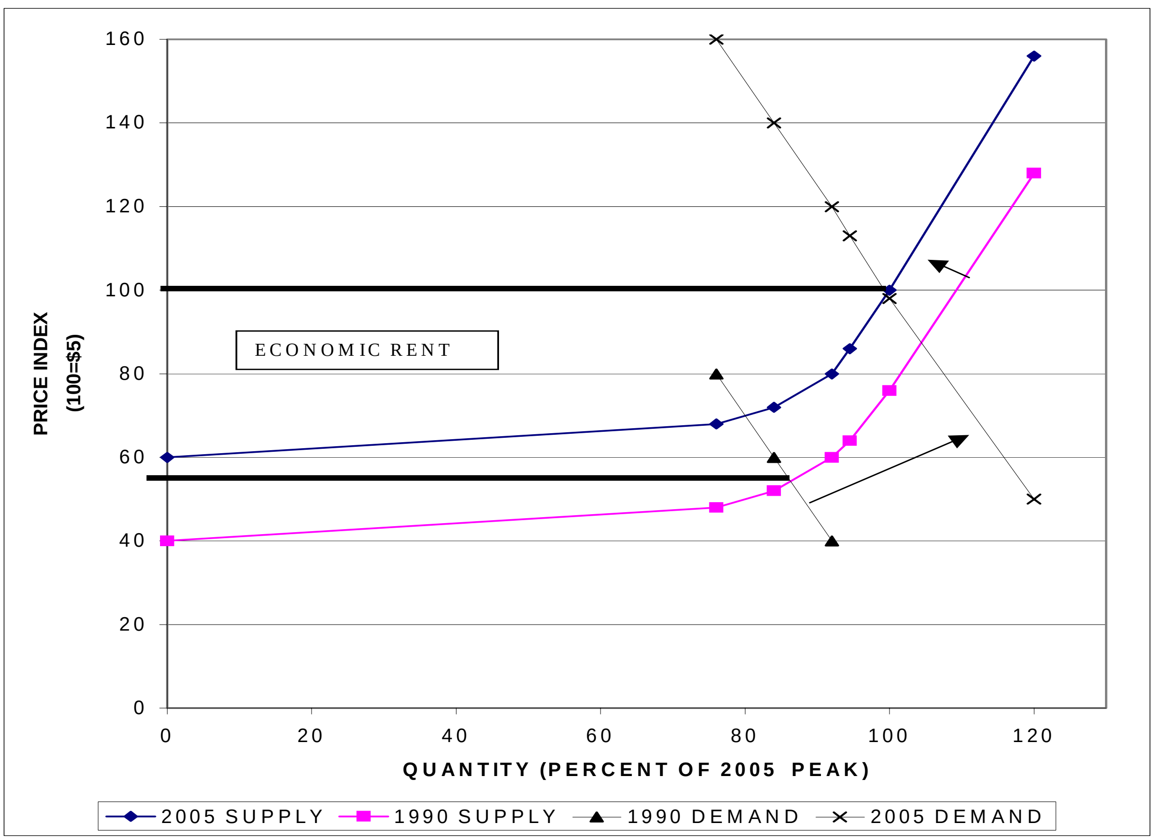


be used to illustrate the uncertainties and points of contention in the debate over the analysis of the natural gas market.

Because of the inelasticity of supply, large changes in demand do not elicit large changes in supply. Therefore, price changes are large, as noted in the text.

As noted in the text, one of the reasons we observe differences in assumptions about supply elasticity is that the analysts believe we are at a different place on the supply curve (see Exhibit A-2). The change in demand or supply has a different effect on price if the resources base is exhausted and difficult to expand, than if it is not as mature and easier to develop. Alternatively, we can depict these differences as a question of where the modeler believes the supply curve is located.

Exhibit A-2: The Market Forces View: Shifts in the Supply Curve and Demand Curve Interact to Create a Price Shock

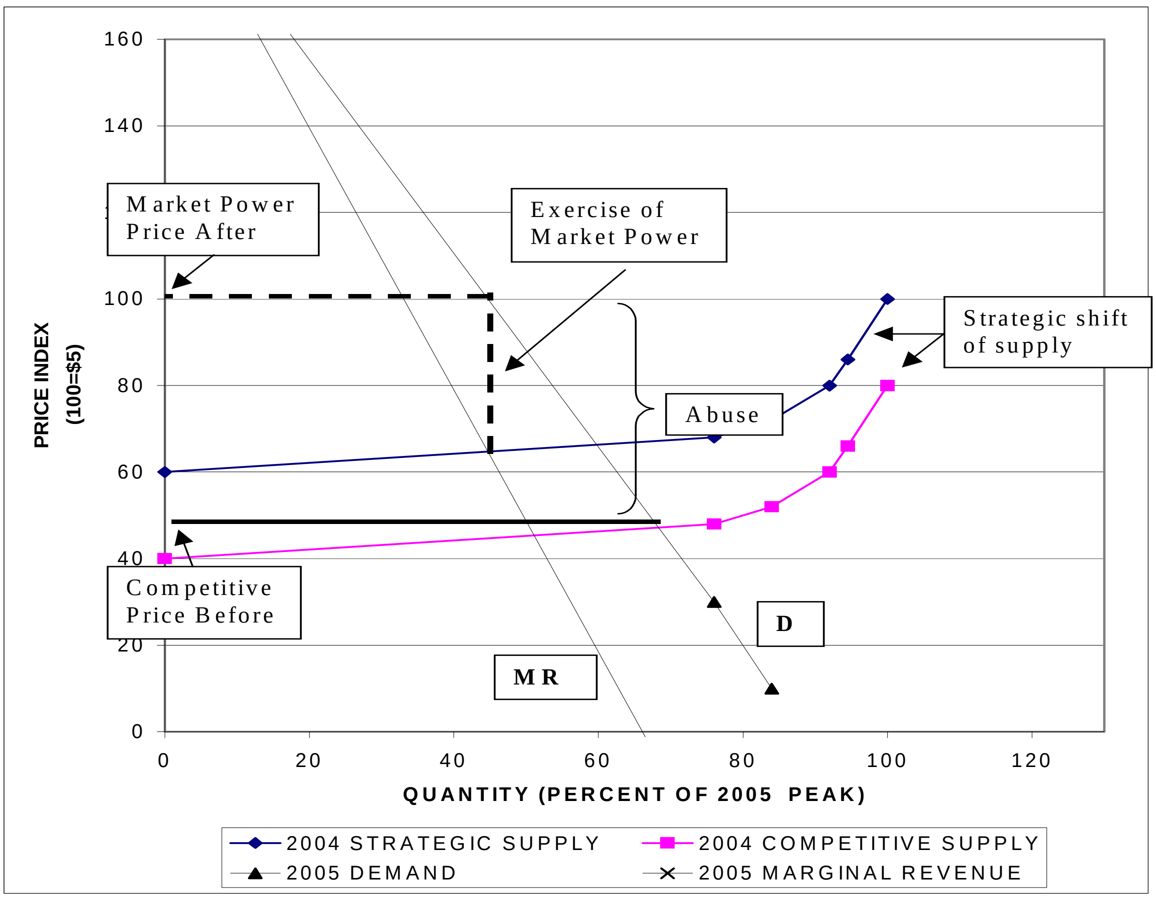


Thinking we were on the lower supply curve, we stimulated natural gas consumption. But because we were on the upper supply curve, prices increases much more rapidly than expected. Note that in Exhibit A-2 the price has approximately doubled, which is what we have experienced in the past three years.

It should be noted that this argument involves a substantial amount of scarcity or economic rents. Existing supplies were found at much lower prices, but they fetch the very high prices needed to clear the market today. They are paid a high price, but that does not elicit quick increases in supply.

The possibility of manipulation, never entertained by the National Petroleum Council (NPC), can also be described in these terms. The strategic view sees a price run-up largely as a function of strategic and manipulative behavior (see Exhibit A-3). Mergers increased market power. Producers shifted their focus out of exploration and have been able to withhold

Exhibit A-3: A Strategic (Market Power) View of Recent Price Increases



supplies. Producers set price where the marginal revenue equals marginal cost, driving prices up.

Scarcity and strategic behavior can interact (see Exhibit A-4). The domestic resource base is mature and the increase in demand in the electricity sector was driven by a strong desire to reduce capital costs in that sector and the ability to shift energy price risk to consumers, where the negative effects on consumers of electricity and natural gas were not taken into account.

Exhibit A-4: Interaction of Scarcity and Strategic Behavior in the Recent Price Increases