The Federal Reserve Board

Remarks by Chairman Alan Greenspan

Energy supply

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Thank you, Jim, for that kind introduction. As I understand it, the goal of the Baker Institute here at Rice is to expand the bridge between the world of ideas and the world of action. There are few who have over the years joined those worlds as successfully as you have.

As economic policymakers understandably focus on the impact of the tragedy of September 11 and the further weakening of the economy that followed those events, it is essential that we do not lose sight of the policies needed to ensure long-term economic growth. One of the most important objectives of those policies should be an assured availability of energy. That imperative has, if anything, been elevated by the heightened tensions in the Middle East--an area that harbors two-thirds of the world's proven oil reserves. It is one you doubtless know well, since I am told the Baker Institute is engaged in a series of major research projects on energy supply and security issues.

This evening I would like first to review our recent experiences with prospective imbalances in energy supply and demand and the importance of market prices in resolving those imbalances. Then I plan to focus on the extraordinary role played by technology in augmenting potential energy supplies, particularly of oil and gas.

Technology alone is unlikely to restore the United States to the position of price leader, which characterized our role in world oil markets for most of the industry's first century. We, presumably, will never return as the overwhelmingly dominant world producer.

The position of the United States in price leadership and in the exercise of pricing power in oil markets dates back to John D. Rockefeller and Standard Oil. Reportedly appalled by the volatility of crude oil prices in the petroleum industry's early years, he endeavored with some success to control them. After the breakup of Standard Oil in 1911, pricing power remained with the American oil companies and later with the Texas Railroad Commission, which raised allowable output to suppress price spikes and cut output to prevent sharp declines. Indeed, U.S. crude oil production still accounted for more than half of the world total as late as 1952. However, that historic role came to an end in 1971, when excess capacity in the United States was finally absorbed by rising demand.

At that point, the marginal pricing of oil, which for so long had been resident on the Gulf Coast of Texas, moved to the Persian Gulf. To capitalize on their newly acquired pricing power, many producing nations in the Middle East nationalized their oil companies. But the full magnitude of their

pricing power became evident only in the aftermath of the oil embargo of 1973. During that period, posted crude oil prices at Ras Tanura in the Persian Gulf rose to more than $11 per barrel, significantly above the $1.80 per barrel that prevailed unchanged from 1961 to 1970.

The sharp price rise of the early 1970s engendered an abrupt end to the extraordinary period of growth in U.S. oil consumption and the increased intensity of its use that was so evident in the decades immediately following World War II. Between 1945 and 1973, consumption of oil products rose at a startling 4-1/2 percent average annual rate, well in excess of growth of real GDP. Subsequent to 1973, however, oil consumption grew, on average, only 1/2 percent per year, far short of the rise in real GDP, an issue to which I shall return.

But despite OPEC's persistent endeavors to control oil prices, the story since 1973 has been more one of the power of markets than one of market power. The signals provided by market prices have eventually resolved even the most seemingly insurmountable difficulties of inadequate domestic supply. The gap projected between supply and demand in the immediate post-1973 period was feared by many to be so large that rationing would be the only practical solution.

But it did not quite happen that way. To be sure, mandated fuel-efficiency standards for cars and light trucks accompanied slower growth of gasoline demand. However, some observers argue that, even without government-enforced standards, market forces would have driven increased fuel efficiency. Indeed, the number of small, fuel-efficient Japanese cars that were imported into the United States markets increased significantly in the late 1970s after the Iranian Revolution drove up crude oil prices eventually to $40 per barrel.

Moreover, at that time, prices were expected to go still higher. Projections of $50 per barrel or more were widely prevalent. The Department of Energy had baseline projections showing prices reaching $60 per barrel--the equivalent of more than twice that in today's prices.

The failure of oil prices to rise as projected in the late 1970s is a testament to the power of markets and the technologies they foster. Today, in real terms the price of crude oil is three-fifths less than in December 1979.

It is encouraging that, in market economies, well-publicized forecasts of crises more often than not fail to develop, or at least not with the frequency and intensity proclaimed by headline writers. This was certainly the case for the concerns about potential surges in the price of gasoline this past summer. The reason, of course, is that producers and consumers alike react to price signals in ways that help to fend off the predicted disasters.

This phenomenon was especially evident a year ago, when markets worked to help allocate limited supplies of fuel oil and to mitigate the problems that many had feared at the outset of the heating season in the United States, especially in the populous northeastern states, where fuel oil is widely used for heating. In response to low inventories of home heating oil, prices rose, demand slowed, and we drew in large amounts of heating oil from Europe. In the event, retail prices peaked early last winter and have declined appreciably since.

While the potential for a shortage of heating oil dominated concerns a year ago on the eastern seaboard, sharp increases in natural gas prices were threatening to markedly escalate the heating bills for the rest of the nation, which, in fact, they did for several months. A significant shortfall of

gas in storage, brought about by growing domestic demand and a limited ability to import, had been a particular concern at the time. But since the start of the year, spot prices for natural gas have fallen significantly, largely because the earlier run-up in prices induced a dramatic rise in drilling, a boost to production, and a curtailment of demand. Of course, demand has also been restrained by the overall weakness of the economy.

Responses to rising prices were also a major factor in stemming California's electric power crisis of earlier this year. When higher prices for wholesale electricity were finally allowed to be passed on to households and industry customers last spring, demand slowed dramatically. To be sure, had California experienced average summer weather, the partial passthrough of cost increases to the retail level arguably would have been inadequate to equilibrate demand and supply. But milder weather, coupled with a slowing economy, brought California through the summer with an ample buffer of excess capacity relative to peak loads. This was scarcely an exercise in free-market dynamics, but the experience did underscore that even the demand for electric power is price sensitive.

Although the short-term problems of the past year in the markets for gasoline, natural gas, and electric power were resolved without significant disruption, these events and others over the past few years have brought renewed attention to the longer-run prospects for American energy markets.

Largely in response to past oil price increases, the energy intensity of the United States economy has been reduced by almost half from the levels of the early 1970s. Much of the energy displacement was accomplished by 1985, within a few years of the peak in the real price of oil. Progress in reducing energy intensity has proceeded further since then but at a lessened pace. This more modest pace should not be surprising, given the generally lower level of real oil prices that has prevailed since 1985.

What has changed dramatically in recent years is the production side of the oil and gas markets, where technological changes are taking place that are likely to make existing energy reserves stretch further while keeping long-term energy costs lower than they otherwise would have been. The development of seismic techniques and satellite surveillance that are facilitating the discovery of promising new oil reservoirs worldwide have roughly doubled the drilling success rate for new-field wildcat wells in the United States during the past decade. New techniques allow far deeper drilling of promising pools, especially offshore. The newer recovery innovations reportedly have raised the proportion of oil reserves eventually brought to the surface from one-third to nearly one-half in recent decades.

One might expect that, as a consequence of what has been a dramatic shift away from the hit-or-miss wildcat oil and gas exploration and development of the past to more advanced technologies, the cost of developing new fields and, hence, the long-term marginal costs of new oil and gas would have declined.

And, indeed, these costs have declined, but by less than might otherwise have been the case, because much of the innovation in oil development outside of OPEC has been directed at overcoming an increasingly inhospitable and costly exploratory environment. That has been the consequence of more than a century of draining the more immediately accessible sources of crude

oil.

One measure of the decline in the marginal cost of additions to oil availability in recent years is the downdrift in the prices of the most distant contracts for future delivery of Light Sweet crude oil. Spot prices have soared and plunged over the past decade, but for the most distant futures contracts--which cover a time frame long enough to seek, discover, drill, and lift oil--prices generally have moved lower. The most distant futures prices in 2001 dollars fell from $25 per barrel just before the Gulf War to $17 to $18 a barrel a year and a half ago.

The current six-year futures contract has risen, on net, over the past year and has been a little more than $21 per barrel in recent days. Arguably, however, this rise is related less to technology and the structure of underlying marginal costs and more, in all likelihood, to the future implications of current heightened Middle East tensions.

The long-term marginal cost of extraction presumably anchors the long-term equilibrium price and, thus, is critical to an evaluation of the magnitude and persistence of any current price disturbance. Over time, spot prices are inexorably drawn back to the long-term equilibrium price, as the balance between underlying supply and demand is restored. A premium over long-term marginal costs doubtless exists for oil because so much of the world's crude oil reserves are in areas where disruptive turmoil is always a latent threat.

The longer-term outlook for natural gas prices is less tied down by history or current practice. Unlike oil, the natural gas consumed in the United States, as you know, is almost solely produced in the United States and in Canada, from which last year we imported 16 percent of our 23 trillion cubic feet of demand. The story of gas supply in the United States, in contrast to oil, is thus largely a domestic one.

Compared with oil, the industry is relatively new. Natural gas, as you know, is more difficult to transport in its gaseous form through pipelines and particularly challenging in its cryogenic form when transported as a liquid. It is the latter problem that has kept imports of liquefied natural gas at negligible levels.

Drilling technologies for natural gas have mirrored those for oil, and through much of the industry's history one could not tell whether a successful drilling hit would turn up valuable crude oil or natural gas, which was often flared for lack of transport facilities.

But with many of the transportation hurdles surmounted, demand has surged over the past two decades, reflecting the myriad new uses for natural gas in industry and as a clean-burning source of electric power.

At times in recent years, supply has not kept pace with the growth of demand. Indeed, the inventories of natural gas held in underground storage caverns were drawn down to record low days' supply levels last winter. As a consequence, spot prices of gas quadrupled, engendering a surge in domestic drilling.

But the very technologies that have improved our drilling success rates have also enabled us to drain newly discovered gas reservoirs at an increasingly faster pace. Data for Texas, for example, show that in recent years more than 50 percent of recoverable gas reserves were extracted from

wells in the first year of operation, compared with roughly 25 percent in the 1980s. As a consequence, to achieve a rise in net marketed gas, gross new discoveries, and the drilling activity associated with them, have had to accelerate.

The combination of demand for environmentally superior gas in our power plants and continued expansion of household and industrial use will be putting significant pressure on the reserve base as the economy recovers. Virtually all new electric power facilities now on the drawing board are gas-fired or dual-fired. To meet the higher anticipated needs, the always-present tradeoff between our energy requirements and our environmental concerns will doubtless be heightened in the years ahead.

Such inevitable tradeoffs have stimulated renewed interest in a greater expansion of coal, nuclear power, and nonconventional sources of energy. The nation, of course, has large reserves of coal, and, in terms of thermal equivalents, we produce more of it than either natural gas or petroleum. Moreover, rapid technological improvements in coal mining have resulted in productivity gains in this industry that have exceeded those for the economy as a whole by a wide margin and have led to sizable declines in the relative price of coal.

Still, the use of coal has been restrained by environmental concerns over emissions from coal-burning power plants. Technology has already alleviated some of these concerns and, given the realistic range of alternatives, coal is likely to remain a significant factor in our energy future.

An obvious major alternative to coal in electric power generation is nuclear power. Low prices for competing fuels and concerns about safety have been a drag on this industry. Nevertheless, its share of electricity production in the United States increased from less than 5 percent in 1973 to 20 percent about a decade ago and has since maintained that share. Given the steps that have been taken over the years to make nuclear energy safer and the obvious environmental advantages it has in terms of reducing emissions, the time may have come to consider whether we can overcome the impediments to tapping its potential more fully. Up front, of course, are the concerns of making plants safe from terrorist attacks. More difficult is the challenge of finding an acceptable way to store spent fuel and radioactive waste. If this problem can be resolved and if some of the long-deferred research and development efforts to make nuclear power more economical were to bear fruit, the potential for this source of energy could doubtless be much enlarged.

The remainder of our domestic energy production comes from a variety of renewable energy sources, the most prominent of which are hydroelectric power from dams and the energy generated through the recycling of waste and byproducts from industry and agriculture. Solar and wind power have proved economical in some small-scale and specialized uses, but together they account for only a tiny fraction of renewable energy.

More broadly, substantial experimentation and exploration is under way in the application of advanced technologies to alternative approaches to energy production and conservation. Improvements in fuel cell technology, for example, hold considerable promise in a wide variety of commercial applications, and fuel-efficient hybrid cars are approaching wider use. With rapid scientific advances, it is not inconceivable that technological breakthroughs will allow nonconventional energy sources to play a larger role in meeting our demand for energy than is currently the case.

In the more distant future remains the potentials of fusion power. A significant breakthrough in this area has been sought for years but seems discouragingly beyond reach. But success could provide a major contribution to our nation's future power needs. The input costs of fusion power would be minor, and it produces negligible nuclear waste or pollutants.

We cannot say with certainty how these technological possibilities will play out in the future, but we can say with some assurance that developments in energy markets will remain central in determining the longer-run health of our nation's economy. The experience of the past fifty years--and indeed much longer than that--suggests the important role that can be played by market forces in conserving scarce energy resources, directing those resources to their highest valued uses, and ultimately ensuring adequate productive capacity for the future.

It is obvious that to successfully exploit new sources of energy and the technologies that engender energy conservation will require considerable long-term investment in research, exploration, and development. An updated and improved means of energy transport, especially electric power transmission and distribution, will also be essential.

To be sure, energy issues present policymakers and citizens with difficult decisions and tradeoffs to make outside the market process; as always, national security and environmental concerns need to be addressed in setting policy. But those concerns should be addressed in a manner that, to the greatest extent possible, does not distort or stifle the meaningful functioning of our markets. We must remember that the same price signals that are so critical for balancing energy supply and demand in the short run also signal profit opportunities for long-term supply expansion. Moreover, they stimulate the research and development that will unlock new approaches to energy production and use that we can now only scarcely envision.

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