DOE/S--0040

DE86 009604

THE NATIONAL ENERGY POLICY PLAN

A Report to the Congress
Required by Title VIII of the
Department of Energy Organization Act
(Public Law 95-91)

UNITED STATES DEPARTMENT OF ENERGY
Washington, D.C. 20585

MASTER

1985

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

EB

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

TO THE CONGRESS OF THE UNITED STATES:

I am pleased to report to you that the state of our energy health is good, and the prospects for its future promising.

Our energy climate has undergone a remarkable transformation in just five years. Crude oil prices have declined, with savings passed on to consumers. The United States is using energy more productively, and our energy supply is more diversified than ever. Total U.S. energy production is at an unprecedented level, and we are far less vulnerable to disruption of our energy supplies.

Our renewed energy health is a testament to the ingenuity of the American people and the strength of American businesses, large and small. We have rightly placed our trust in our people and the belief that we were not running out of energy, only imagination. We have reduced regulation, wherever and whenever possible. We have placed our confidence in the marketplace, rather than government, to make key economic decisions about energy.

The result is a foundation of energy stability and energy security. We stand at the beginning of a new era of energy strength in which the United States has the resources and capabilities to sustain vigorous economic growth, as well as our important role in the free world.

With this new opportunity, of course, come new challenges. Unless these challenges are met, we may not achieve the energy exploration, technological advance, and conservation improvements this Nation needs. We have more work to do in cutting regulatory barriers, especially natural gas controls, diversifying our resources, and increasing alternate energy sources, which should further reduce our dependence on insecure energy imports. I am submitting the Fifth National Energy Policy Plan, which addresses the job ahead.

We are fortunate we can look forward to the coming era with confidence that we have learned from the lessons of the past and that with new tools and justified belief in the American people, our technology, and free markets, we will meet the energy challenges and opportunities ahead.

Ronald Reagan

THE WHITE HOUSE,

TABLE OF CONTENTS

I. The Course Ahead—An Introduction and Executive Summary	1
Energy Stability in Price and Supply	2
Energy Security in an Uncertain World	3
Emergency Preparedness	3
International Energy Security	3
Research	4
Domestic Production	4
Efficiency in Energy Use	4
Energy Strength: A Balanced and Diversified Mix	4
Oil and Gas	4
Conservation	5
Coal	5
Nuclear	6
Electricity	6
Renewables and Alternative Fuels	6
Conclusion: Steering by the Signals	7
II. Currently Predominant Fuels—Oil and Gas	9
Oil—Domestic, Imported, and Stored	9
The Proven Benefits of Decontrol	9
Adequacy of Refinery Capacity	10
Strategic Petroleum Reserve	10
Outer Continental Shelf Leasing	11
Natural Gas	11
The Success of Partial Decontrol	12
The Need for Full Decontrol	12
Transportation of Gas	12
III. America's Energy Triad	13
Conservation—Our Largest Single Resource	13
Conservation's Success	13
A Broad and Continuing Energy Ethic	14
The Role of the Federal Government	14
Related Benefits	15
Coal	15
Basic Federal Policy	16
Converting Resource Into Supply	16
Expediting the Movement of Coal	17
Cleaner Coal for Wider Use	17
Nuclear Energy	18
Legislative Modifications	19
Radioactive Waste Management	19
Research and Development	19
Improving Public Understanding	20
Making Goods and Services Available Abroad	20

Uranium Enrichment	20
Supplies of Uranium	20
IV. Sources of Diversity and Long-Term Supply	21
Electricity	21
Responses to Rising Demand	21
Financial Condition of the Industry	23
The Public Utility Compact	24
The Problem of Rate Shock	24
Electricity Regulation at the Crossroad	25
Renewable Energy	25
The Pace of Growth	26
Role of the Federal Government	26
Some Reasons for Optimism	27
The Significance of Exports	27
Alternative Fuels	27
V. Sources of Uncertainty	29
The International Context	29
Cooperation Through the International Energy Agency	30
Other Multilateral Coordination	30
Bilateral Consultations	30
Canada/Mexico Outlook	30
Emergency Preparedness	31
Environmental Effects of Energy Production and Use	31
Balancing Diverse Goals	32
Improved Environment Through Multiple Fuel Options	33
The Acid Rain Issue	33
Summary	34
Research and Development	34
VI. Summary of Current Projections	37
Energy Price Projections	40
U.S. Energy Trends (Reference Case)	40
Primary Energy Consumption	40
Energy Production	41
Primary Inputs to Generate Electricity	41
VII. Public Comments on the Nation's Policy Toward Energy	43
Conservation	43
Fossil Fuel and Environmental Issues	43
Renewable Energy	43
Emergency Preparedness	43
Nuclear Energy	43

I. THE COURSE AHEAD

An Introduction and Executive Summary

A dozen years ago, a much-publicized oil embargo triggered a series of jolts to the U.S. economy and life patterns. Crude oil supply shortages, long lines at gasoline stations, inflationary pressures, and a disquieting aura of subjection to a foreign cartel were epitomized in the term "Energy Crisis," but the hurt and the threat extended far beyond the fairly narrow sector of our society traditionally designated as "energy." Everyone and everything seemed doomed to be unsettled indefinitely by these new developments.

Our Nation's problems were exacerbated at first by successive policies that tried to dictate in detail the type of energy Americans would produce and how they would be permitted to consume it. The failure of these policies encouraged runaway price rises for energy and for every product or service that embodied energy. Continuing high levels of oil imports were based on an unwarranted perception of national helplessness rather than on thoughtful economic judgment.

Rationing and rigid controls of various types were soon discredited widely, yet no alternative crystallized. The objectives most people sensed to be important—improved domestic production, sound conservation of the scarcest energy resources, diversification of our national energy base, and reasonable prices throughout—were bound to elude this country if the only incentive to them was government exhortation. They did.

The Administration that took office in 1981 turned U.S. national energy policy around; and it has held to the same basic heading since then. Resistance to this course has slowed progress in a few respects, and some adjustments (such as those described in this document) can be helpful.

Just a few days after being sworn in, the President decontrolled U.S. oil markets. Since then, the Nation has committed itself increasingly to rely on the resourcefulness and ingenuity of the American people in response to market forces. Heavyhanded government planning has been abandoned. The results that have flowed from these changes have been impressive. The American people are being served well.

The United States must be able to explore for, locate, develop, and use new energy sources and conservation technologies. The record shows that this is done best in a climate of reduced government regulation, fewer controls, lower tax rates within a fair tax system, and a commitment to the principles of free international trade in energy. Unwarranted

government intervention creates rigidities that prevent or discourage market forces from adjusting to change. Appropriate economic responses are blocked. Technological breakthroughs become far less likely.

The log of recent years in energy *policy* planning (as distinguished from the earlier efforts at micromanaged *energy planning*) is replete with success stories. Crisis management has been superseded by stability. National energy security has improved. Americans have moved a long way toward an energy system in which efficiency freely develops strength.

Considering a broad range of factors (including environmental quality, domestic availability, and cost—as well as the time it takes for new technology to suffuse and transform enormous residential, commercial, industrial, and transport markets), it makes the most sense at this time for the energy sector of the U.S. economy to emphasize coal, nuclear energy, and conservation wherever they are economical. Electricity, though not a source of primary energy itself, has been an important delivery mechanism through which to apply this "triad." It will continue to be so.

Nevertheless, an economically efficient, flexible energy system continues to steer the Nation away from an overdependence on even this important handful of energy resources. Petroleum, natural gas, and renewable sources (ranging from "old" hydro to "new" solar) are all part of the balanced energy mix that is appropriate to support economic growth and to permit producers and consumers to choose freely among all practical and competitive energy options. But it will be the marketplace, rather than the Government, that actually makes the decisions about development pace for each one.

Consider how well this approach has been working over the past 5 years:

- Crude oil prices have declined; and the savings have been passed on to consumers in the form of retail prices for heating oil, gasoline, and other petroleum products that are markedly lower than they were at the beginning of 1981.
- The United States is using energy more productively during the 1980's than ever before in its entire history.
- Total U.S. energy production has reached an unprecedented high level.
- The worldwide oil cartel is under increasing pressure.

- This country is far less vulnerable today to damage from any potential disruption of fuel supplies than it was just 5 years ago—thanks to generally lower levels of oil imports, greater diversity of our supply sources, and the conversion of the Strategic Petroleum Reserve (SPR) from a mere “good intention” to the status of an effective insurance policy for the Nation.
- With all that, our air is cleaner and the quality of our waters has improved.

At the same time, we should recognize that our energy situation is not perfect. Some nonessential regulations still discourage economical energy production and use. The Nation still spends more than \$40 billion a year on net energy imports. It remains part of a world energy system in which our own prices and supplies are affected inevitably by problems and successes around the globe. And the principal domestic fossil energy sources this country is tapping must eventually diminish. Until potential suppliers can reduce the capital-intensive costs of some widely available renewable sources (for example, solar energy) and the high gathering or processing costs of other sources (for example, biomass, shale oil, and synthetics), Americans must focus their consumption on what is at hand. This means that for many years to come the United States will need more oil, gas, and coal from its domestic resource sites, including Federal lands and the federally managed Outer Continental Shelf (OCS). Our people should be able to count on nuclear power. All sectors of the economy must develop even more efficient ways of producing and using energy resources of all kinds.

In this context, let us consider our national energy policy goal and the strategies that are intended to lead America along a pathway to growing stability, security, and strength in regard to energy.

The Reagan Administration's goal in energy policy continues to be that Americans should have an adequate supply of energy, available at a reasonable cost. The basic strategies for holding to this goal are to maximize the practical reliance on the free decisions of the entire populace, while maintaining public health and safety and environmental quality, and to promote a balanced and mixed energy resource system. Specific sections of this document outline how these strategies are being applied at this time to respective energy sources.

As the Nation looks forward to even fuller realization of its firm energy goal, it has become clear that this goal presupposes three broad conceptual objectives: energy stability, energy security, and energy strength. During the past 5 years, the United States of America has achieved energy stability. The Nation has made substantial progress in its continuing effort to achieve energy security. Thanks to the essential energy triad of energy conservation, abundant coal, and reliable nuclear power, our country is steadily developing energy strength.

Energy stability means a situation in which problems of energy availability and price do not destabilize the U.S. economy and our way of life. It means an energy climate that gives Americans confidence and promotes steady economic growth. It includes a consistent regulatory policy, upon

which all energy producers and consumers can rely. Though it may seem a paradox, it is the very flexibility of our free-market system and its long-run ability to cope with *changing* circumstances that bring stability.

Energy security means that adequate supplies of energy at reasonable cost are physically available to U.S. consumers, from both domestic and foreign sources. It means that the Nation is less vulnerable to disruptions in energy supply . . . and that it is better prepared to handle them if they should occur. By maintaining and having the resolve to use the Strategic Petroleum Reserve, ensuring an adequate defense capability (to discourage cutoffs in energy supplies), closely coordinating energy emergency policies with our allies, and facilitating the production of U.S. energy resources, great progress has been made in ensuring the availability of adequate supplies at a reasonable cost.

Over the longer haul, energy security leads to *energy strength*. Energy security produces confidence that the current favorable situation can continue for the foreseeable future. The vast energy resource base of the United States has the potential of providing the power for our own continued economic development, as well as for the advancement and defense of the free world. But the promise of this potential will not be achieved without effort.

Secure domestic sources of energy helped mold the foundation of this Nation, and they have not declined in importance. The future of this Nation depends as much on what is done in the coal fields of Kentucky or in the gas fields of Oklahoma as it does upon what is accomplished at the negotiating table in Geneva.

A strong America is inseparable from a secure America. National strength, and the strength of future generations, is rooted as deeply in the full use of all our economic resources—including especially competitive domestic energy resources—as it is in the full protective strength of armed forces.

Energy Stability in Price and Supply

Energy problems currently are not a destabilizing force in the national life and economy. To give just a few examples:

- Since early 1981, market forces have reduced real oil prices on the world market by more than 40 percent.
- Between 1981 and 1985, the cost of a gallon of gasoline or heating oil for Americans declined by about one-third relative to disposable income per capita.
- Total domestic crude oil production has risen annually since 1981, reaching in 1985 the highest level for any year since 1973.
- Nuclear energy has surpassed oil and natural gas (as well as hydroelectric power) to become the second largest source of electricity in the United States. Nuclear powerplants currently provide more than 15 percent of total electric generation, second only to coal.
- Net imports of crude oil and petroleum products for 1985 (less SPR imports) were about 27 percent of

domestic oil consumption, compared with 37 percent of consumption for all of 1980.

- At the end of 1980, the Strategic Petroleum Reserve held just over 100 million barrels of crude oil, equivalent to only about 17 days' supply of the net imports for that year. But now the SPR holds nearly 500 million barrels of oil, the equivalent of about 120 days of current net imports.

Yet, this good news must not lead to complacency. There are many problems we will face if we do not prepare for them:

- Domestic reserves of oil and gas have been generally falling—more slowly than before, but nonetheless falling.
- Areas of significant potential oil and gas reserves onshore and offshore are being delayed or foreclosed from exploration and development.
- Some indexes of exploration activity and drilling are now lower than at any time in the past 6 to 8 years in the United States.
- No new nuclear powerplants have been ordered in the United States for domestic construction since 1978, and 75 nuclear plants once scheduled for construction have been canceled since then.
- Less than 3 gigawatts of new coal-fired electric capacity have been ordered since 1981.
- The Energy Information Administration projects declines in domestic oil production after 1990 and corollary increases in oil imports.

None of these issues or problems constitutes an unavoidable threat provided we anticipate it and act wisely to counteract it.

The Reagan Administration supports policies that will protect the energy stability that has been achieved. Unless we continue to build on what has been achieved in recent years, the present favorable results of our immediate past efforts in energy exploration, production, and conservation could deteriorate. For example, while oil and gas reserves have been maintained at high levels, reserves could drop significantly unless opportunities and economic incentives for exploration and development are continued. Market-oriented policies that build upon America's vast production and conservation resources and its technological genius, free of arbitrary regulation, provide the best hope of maintaining the momentum of energy progress of the past 5 years. But the regulatory burden is not yet adequately restructured to permit appropriate economic and energy judgments to be made. To the extent it is able to work, the flexibility provided by a balanced and mixed energy system has proven superior to rigid plans and regulations in securing a stable energy system.

Energy Security in an Uncertain World

Over the past decade or so, energy has ridden a roller coaster of public sentiment—from complacency to crisis

and, perhaps, back toward complacency again. This country enjoys stability now, and there are good prospects of future stability. But a commitment to energy security means that the Nation cannot afford to drift. The United States must never again allow itself to become as vulnerable to foreign supply disruptions as it was in the 1970's.

This Administration will continue to work on five major aspects of protection for America's energy security: emergency preparedness, international energy security, research and development, domestic production, and efficiency in energy use.

Emergency Preparedness. An important lesson of the 1970's was that energy security requires preparations for unforeseen energy emergencies. The Reagan Administration has acted upon that lesson by building the Strategic Petroleum Reserve, supporting the diversification of energy technologies and applications, improving relations with allied countries, and dismantling the U.S. price controls that aggravated past disruptions in world oil markets.

Rapid filling of the SPR over the past 5 years has been one of the most effective actions taken by the United States to enhance energy security. Current market conditions (lower U.S. import levels and large amounts of excess oil production capacity in the world) reduce the potential dangers from oil supply disruptions in the near term. The Administration will continue to review SPR fill rates to be certain that the insurance provided by the reserve is maintained in a cost-effective manner.

Since the end of 1980, the supply of oil in the SPR has more than quadrupled. Thanks to these farsighted efforts, the United States is now much better prepared to cope with potential disturbances in the world oil market. The dismantling of price and allocation controls, and our determination to resist them in the future, coupled with national readiness to use the SPR promptly to supplement oil supplies during any supply-disruption emergency, ensures that the gasoline lines of 1973-74 and 1979 will not return.

International Energy Security. Cooperation with other countries in promoting energy security has been a hallmark of U.S. policy since the 1970's. America's international policy toward energy security reflects its domestic goal of reducing government intervention to allow markets to function more freely.

The United States seeks a stable and secure world energy environment, recognizing the interdependence as well as the independence of other nations. We have played a strong leadership role in the International Energy Agency (IEA), which was established by the Agreement on an International Energy Program of 1975. In recent years, we have reached agreement on a range of measures that enhance our mutual energy security, including undertaking:

- To preserve or create open energy markets (particularly with respect to oil-product imports), to encourage greater energy production of all types, and to foster greater energy trade.

- To guard against increased vulnerability by concentrating on secure sources and by avoiding undue dependence on any one source of energy supply.
- To maintain adequate oil stocks, and to coordinate early drawdowns of stocks and complementary measures among IEA partners in the event of a supply disruption.
- To enhance international collaboration in research and development through early consultations and joint program planning—thus improving economic efficiency and the rate of technology development.

Research. Appropriate investment in research and development is fundamental to energy security. The Federal Government should not and cannot do the entire job, but it can help. Its energy R&D focuses now on all sources of energy—renewables, conservation, fossil, nuclear, fusion, and alternative fuels—as well as on the effects of energy activity on human health and the environment. It concentrates on a generic role—one that inspires and complements initiatives of the private sector rather than competing against it or skewing national economic incentives through random subsidies.

Research and development in energy technologies advance through several phases: basic research, applied research, proof-of-concept, process development, and finally commercialization. The Administration's policy focuses Federal efforts on the earlier phases of the process. It is willing to undertake precommercial stages of higher risk projects that show potential for large long-term benefits, but which would not be cost-effective for private organizations because of their inability to reap the benefits or because of the projects' high cost, uncertainty, or likely slow payoff. Even here, private-sector participation is encouraged to the maximum practical extent—thus adding leverage to Federal resources. In addition, private financial commitments are a solid test of the true value placed upon a category of research by nongovernment interests and may help determine the level of spending and priority that any particular area justifies.

The decision as to the economic feasibility of the later, more expensive phases of R&D is always left most appropriately with the marketplace. This approach invites investors in the private sector to select the technologies to push to commercialization—the ones they think will ultimately gain market acceptance. Experience shows that the Federal Government is not as well equipped to make such decisions.

Domestic Production. Energy security, stability, and strength all depend in large measure on the United States' ability to explore for and develop domestic energy resources. This Administration supports the economic development of these resources to the fullest extent practicable, consistent with maintaining high standards of public safety, health, and environmental quality. To that end, the Administration supports policies that will:

- Open up additional offshore oil and gas fields to expeditious exploration and production, in accordance with strict environmental safeguards.
- Eliminate the remaining Federal price controls on domestic natural gas production.

- Provide access to the vast supplies of coal on Federal lands.
- Restore U.S. primacy in uranium enrichment.
- Provide a stable and predictable regulatory environment for the efficient, economical production of energy.

Efficiency in Energy Use. Energy productivity (as measured by the Nation's real economic output per unit of energy consumed) improved about 16 percent between 1980 and 1985—the greatest improvement in efficiency since World War II. This progress is continuing, despite falling real energy prices and a de-emphasis of government demonstration programs and “mandated conservation.” Market forces and private initiative, not government programs, are the best promoters of further improvements in energy efficiency.

Energy Strength: A Balanced and Diversified Mix

What kind of energy future do Americans want? How can we achieve it?

Fundamentally, the Nation deserves a future in which its resources are used effectively to strengthen the economy and security of both the United States and the free world. The resources exist to make this a reality: fossil fuels, nuclear energy, solar and other renewables, an efficient electricity supply system, and conservation. But energy strength also derives from the human potential of national laboratories and the tens of thousands of private research facilities across a Nation that is committed to knowledge and skill and general excellence. It comes from the incentives of a free-choice environment, from industrial inventiveness, and from innovative technologies. Decisions are better made on a regional or local basis; what makes sense in the Sun Belt may not always make sense in the Northeast—and vice versa.

Today's energy stability gives us the opportunity to build an expanded base of technical knowledge for resources that we will have to count on in the future. Nonetheless, it would be foolish to suggest that the future of the United States is not still inextricably tied to oil and gas development. These two fuels of convenience are the ones that will remain the marginal sources of supply for the rest of this century and beyond. This is precisely why—by relying on market forces—this Administration has cultivated a diversification of energy resources. This progress will be continued for all elements of a balanced energy mix.

Oil and Gas. For the rest of this century, oil and gas are likely to remain the principal energy sources of the American people. They now provide about two-thirds of the commercial energy used in the United States, and they are projected still to be furnishing more than half in the year 2000.

In addition to promoting a free-market economy and full deregulation of natural gas, the most vital component of Federal action is the timely development of oil and gas resources on federally managed areas of the Outer

Continental Shelf. Federal OCS lands currently account for about 12 percent of all proved U.S. oil reserves and 19 percent of our total proved reserves of natural gas. Development of these resources does not mean a sacrifice of environmental quality goals, because the environmental record of exploration and production companies operating on the OCS is excellent.

While U.S. production of oil has recovered from the lows of a few years ago, the Nation's oil and gas reserves have not risen. In response to the price rises of the 1970's and very early 1980's, they have only stopped falling sharply—oil reserves have fallen by less than 5 percent and gas reserves by less than 1 percent from 1980 to 1984. If this country fails to find and develop new oil and gas fields—and to squeeze every economical drop from existing reservoirs—it stands a chance of letting the progress of the past few years slip away. At the same time, the Interior Department's estimated (not proved) reserves on the OCS have been greatly diminished because the experience in the frontier areas of Alaska and the Atlantic coast has been disappointing. In spite of all the past optimism, there is not a single producing well in Federal waters off Alaska at present, and it is not clear to what extent there will be.

Because of the foregoing, the Administration opposes any moratorium on OCS leasing. By preventing development of domestic resources that are known to be available, delaying work on the OCS only strengthens OPEC's efforts to control production and raise prices. The Nation's dependence on imported oil increases, its energy security is lessened, and the pace of economic growth is inevitably slowed.

Along with OCS development, it is important that national energy policy buy more time for an eventual transition to renewable energy and alternative fuels by fully developing *onshore* oil and gas resources too. Market demands and private sector initiatives can coax 14 billion barrels of additional crude oil from existing U.S. oil fields through enhanced oil recovery—even if only today's technological know-how is applied across the board. This alone would increase recoverable reserves by roughly 50 percent, but the National Petroleum Council—a longtime advisory body to the Federal Government—says that advances in technology could double that increase. The size of the possible reward is worth giving it adequate free-market incentives; therefore, the Department of the Interior will continue to try to make available for exploration and development oil and gas resources on Federal lands (which include the OCS), and the Department of Energy (DOE) also will continue its limited role in basic research that supports the development of new, advanced ways to increase oil recovery.

It is also essential that the remaining Federal price controls on natural gas be eliminated and that the Nation continue to move toward a more competitive system of transport for this fuel. Natural gas is the only primary fuel whose prices remain under controls, with the price of about half of all gas production still regulated by the Federal Government. As a result, "old gas" (including that from many fields that started production well after the oil embargo of 1973-74) is not

coming to the marketplace as it could. A considerable amount is irretrievably lost in this way.

The complete elimination of oil price controls in 1981 and the partial decontrol of natural gas on January 1, 1985, demonstrated clearly that decontrol encourages more production—and thereby causes consumer prices to decline. Natural gas prices will be lower and total gas production will be higher by about 1 trillion cubic feet per year if all natural gas supplies are decontrolled.

Conservation. Energy conservation is an integral part of the "energy triad." It has proven to be the most expeditious way to reduce the need for new or imported energy resources; and in fact it now contributes more to balancing our national energy ledger than does any single fuel source.

Despite a 21-percent increase in the number of U.S. households since 1973, for example, current total energy consumption in the U.S. household sector is almost the same as it was 12 years ago. Savings in the industrial, commercial, and transportation sectors are similarly impressive. Even if current energy prices remained stable or declined moderately, it would appear to be economically feasible to continue efficiency gains at a substantial pace for the next 25 years.

Since the beginning of this Administration, the Department of Energy has been redirecting its research efforts in conservation technologies, usually in partnership with private industry. The central policy thrust has been to promote economically efficient use of energy resources by minimizing Federal control and involvement in energy markets, and—through R&D—to increase the range of technological options available to the private sector.

The Administration also has sought to remove regulatory barriers that discouraged market response to conservation opportunities. Success in reducing inflation and interest rates has encouraged the up-front investments in conservation that can save money for energy consumers in the long run. The impetus for conservation is best left to the marketplace. Inequities and anomalies are created by government efforts to stimulate and subsidize specific technologies. Recent energy history has shown that U.S. consumers and producers are quick to take economical actions that improve the efficiency of energy use.

Coal. There is enough coal in this country to satisfy the Nation's current use rate well into the 23rd century. Coal accounts for about 80 percent of the recoverable fossil fuel resources in the United States. Conventional oil resources, on the other hand, make up only a small fraction of our known fossil resources. Yet many Americans still tend to think of coal as a symbol of the old "smokestack industries"—a resource with much to offer in terms of energy and economic security, but only at the expense of our environment. That stereotype is wrong.

Opportunities are just as ripe to advance the frontiers of coal technology as they are for any other energy option; and this is exactly what is being done. A modern coal-fired powerplant is cleaner than most older oil-fired plants. If regulations are made flexible enough to accept them, there are new technologies (such as fluidized-bed combustion and

coal-gasification combined-cycle plants) that already offer the potential for excellent environmental performance—at less cost, and with higher efficiencies.

Coal is another vital member of the energy triad. Since 1973, coal's share of the U.S. energy market has expanded by about one-third. It is increasingly the fuel of choice for utilities, which now generate approximately 55 percent of all electricity using coal.

The Federal Government owns more than 30 percent of the Nation's coal reserves, and this Administration will continue to try to make these resources available through leases to private producers. But opposition to Federal coal leasing poses a threat to availability of these resources. At the same time, the Department of Energy will support basic research that underlies the continuing development of methods to use coal with greater efficiency and with less adverse environmental effects.

Nuclear. Nuclear energy, the third member of the triad, is an energy source as vital to the United States as it is misunderstood. It has the best safety record of any large-scale commercial energy technology in human history. Nuclear power today is the second largest source of electricity in the United States, providing more than 15 percent of the Nation's electricity needs. It is expected to provide more than 18 percent of the Nation's electricity during the 1990's. As electricity provides an increasing share of U.S. energy needs, nuclear power will assume an increasingly important role—particularly if, as expected, its technology continues to improve.

Despite this, nuclear power has lost valuable ground as a future energy option. No nuclear powerplants have been ordered since 1978. Some have been canceled during late stages of construction. The U.S. commercial reactor industry is ailing. Yet the United States cannot afford to become a second-class nuclear power-producing country.

The Administration is pursuing a fivefold strategy to help make sure that nuclear powerplants remain an available option within the country's balanced and diversified energy supply mix. It has proffered specific legislation for licensing and regulatory reform. It is staying on track with the tightly scheduled, yet scrupulously careful development of high-level waste storage and ultimate disposal. It has focused fundamental R&D on programs that should contribute to greater safety margins, standardized plant designs, and more usable systems. It is endeavoring to make the American public better informed about the "how" and "why" of peaceful nuclear power. And, finally, it is working constantly to remove unnecessary barriers to those technology and equipment exports that do not encourage the spread of nuclear weaponry. America's role as a reliable and effective global supplier of peaceful nuclear technology is, in fact, important to its continued influence in averting weapons proliferation.

Electricity. For most of the 20th century, the United States has led the world in the development and maintenance of a reliable, low-cost electricity supply system. Today the United States has a surplus of generating capacity; but this condition is likely to be temporary, given current expecta-

tions about future economic growth and concurrent growth in the demand for electricity. Investment in additional generating capacity will be needed; the challenge is to ensure that the most economically efficient generating technologies can be selected, and that capacity is augmented as the need for this develops.

A sufficient and efficient electricity supply system has enormous economic and strategic implications. Electricity is a critical ingredient for almost every economic enterprise in the United States. The electricity supply network is the medium through which some of the most important future energy resources—coal, nuclear, and renewables—will be delivered to their markets. Reliable, competitively priced electricity supplies are particularly important to "high technology" economic growth and development.

The electricity supply system is one of the most heavily regulated sectors in the U.S. economy. Many Americans have come to regard electricity as an "entitlement"; they expect that it will continue to be reliable and available with the flick of a switch whether or not its fair costs are covered by rates they pay. Unfortunately, things cannot work that way.

The central issue today is how best to balance the risks associated with investment in new generating capacity with the rewards to be gained from those investments once new facilities become operational. The traditional "utility compact" (no unusual risks, no unusual profits) is disintegrating because it is no longer balanced. Over the past decade, regulatory practices have made the risks associated with such investments very large while possible benefits to the investors remain limited. As a result, many utility managers today are reluctant to undertake new investments, even if it appears that society will need them in the long term.

The Administration believes that the best way to ensure timely and appropriate investments in the electric utility sector is to develop and promote an improved regulatory environment that increases reliance on economic competition—among utilities, among generation technologies, and among end-use technologies. The outmoded Fuel Use Act and Holding Company Act should be repealed, some applications of the Public Utility Regulatory Policies Act deserve re-evaluation, and the Federal Energy Regulatory Commission should extend its experiments in the direction of free competition; but reform will still be gradual. Electricity regulation is an obligation shared by the Federal Government and all 50 States.

Renewables and Alternative Fuels. Renewable energy resources—now primarily wood and water—contribute about 9 percent of this country's domestic production. With the caveats outlined in the chapter entitled "Summary of Current Projections," this fifth National Energy Policy Plan (NEPP-5) projects that they could provide nearly 13 percent of the total domestic production of primary energy by the end of this century. This could rise to 15 percent by 2010, as more economical renewable energy technologies develop.

The Federal program in solar and other renewable energy research and development has addressed key, high-risk technical issues that will provide a scientific and engineering

knowledge base for industry to develop renewable energy systems with greater efficiencies, longer system life, and lower system costs based on advances in the use of new materials.

Conclusion: Steering by the Signals

This Nation learned lessons about energy in the 1970's that it must never forget. During the first half of the 1980's, those lessons have been implemented in policy.

The resources the world needs are available. The earth has at least a 200-year supply of coal at current consumption rates. There are between 1 and 2 trillion barrels of recoverable crude oil resources in the world, an amount equal to many decades of global consumption at the current level of about 20 billion barrels per year. There are also an estimated 10,000 trillion cubic feet of ultimately recoverable natural gas, compared with current world consumption of about 50 trillion cubic feet per year. Over the past 30 years, the "life index" of the world's crude oil reserves has stayed at about 35 years (plus or minus 5), while the natural gas reserve life index has remained at about 50 years (again, plus or minus 5). The world's supply of uranium can sustain converter reactors well into the 21st century, and breeder technology could turn this fuel into a virtually unlimited supply.

But these worldwide physical resources are only part of the story. The United States' own rich endowment is but another part. This Nation's free-market economy also encourages timely innovation and technological change. It does so by rewarding those individuals who find economical solutions to current problems. Based on history, there is good reason to

be confident that innovations in both production and conservation technologies will probably extend the benefits to be derived from the energy resources that are recognized now.

There is no secret to sustained progress toward energy stability, security, and strength. In 1981, the President challenged the Nation to look toward its future with confidence and optimism, to build on traditional values, and to move forward again. Today, that forward-looking optimism is stronger than ever in regard to energy. It is made so by the continued resurgence of the economy, the resultant drop in unemployment, and continued progress of American technology and scientific innovation.

These successes contradict the views some people held strongly only a few years ago—that the United States was running out of energy, and that shortages were inevitable. That pessimism translated into a government policy of allocation and price controls on energy—an approach that could be characterized as "allocating misery during shortage." Contrast it—both in spirit and in substance—with part of the message of the President's second inaugural address on January 21, 1985: "There are no limits to growth and human progress when men and women are free to follow their dreams."

Today Americans have the luxury of planning—individually and collectively—for future energy needs in an atmosphere of calm, reasoned resolve. The Reagan Administration is confident, but it will not be complacent.

Given the right market signals, the right mix of Federal cooperation, and the right regulatory climate, the American economy has the competitive vigor and the inherent strengths to take new technologies off the drawing boards and put them into commercial practice. Using these tools, the Nation can look to a future of energy stability, security, and strength.

II. CURRENTLY PREDOMINANT FUELS—OIL AND GAS

Oil and natural gas still provide nearly 65 percent of the energy supplies consumed each year in the United States. National policy toward these two resources affects our whole economic fabric.

Conventional oil makes up less than 4 percent of this country's currently known reserves of fossil fuel. The past volatility of its price and supply on the world market has been troubling. Natural gas is a bit more abundant domestically, especially in offshore fields that the industry has made a good start at developing; yet the price and supply of gas also have created concerns among American consumers within the past dozen years.

The United States literally moves on oil; this fuel supplies more than 97 percent of all the energy consumed in the transportation sector. Natural gas is the energy source that heats the homes and workplaces of most people. It is far and away the leading source for the combined residential-commercial sector, and it is readily interchangeable with oil in other applications—including combustion turbines for generating electricity.

Oil—Domestic, Imported, and Stored

Over the past 5 years, thanks in large measure to the dismantling of U.S. price controls, the Nation has made broad and substantial progress in reducing its vulnerability to oil supply disruptions. Both the efficiency of oil use and U.S. oil production have increased. As a result, U.S. oil imports have dropped dramatically. In addition, the Strategic Petroleum Reserve (SPR) has swelled to almost 5 times the size it was in early 1981—reaching proportions where it can justifiably be called the Nation's insurance policy against disruptions in oil supply.

The principal policy challenge in regard to oil at this time is to maintain this improved position as unpredictable future circumstances arise. Reference-case projections for NEPP-5 (summarized in Chapter VI) show U.S. use of lower cost foreign oil rising while lower real prices permit domestic production to drift downward slightly during the 1990's as petroleum becomes more expensive to find and produce. But projections are not predictions, as this Administration has cautioned repeatedly in the past. The most efficient course, regardless of possible future surprises, will be to let innovators and free markets continue to reach the multiple adjustments that elude rigid government planning. The benefits of

oil price deregulation will continue. We will continue to oppose blanket moratoria against drilling on the Outer Continental Shelf (OCS).

The Proven Benefits of Decontrol. Almost immediately upon taking office, President Reagan eliminated all Federal price and allocation controls on oil. Confounding many of the so-called "experts," oil decontrol was followed by an increase in U.S. oil production *and* a decline in oil prices. Decontrol bolstered U.S. efforts toward economical energy efficiency, and the worldwide increase in potential supply caused by the growth of non-OPEC production has been striking. In January 1981, the average refiner acquisition cost of imported crude oil was \$38.85 per barrel. In September 1985, it was \$26.59 per barrel (which is equivalent to \$22.38 per barrel in 1981 dollars). In real terms, crude oil prices have declined by more than 42 percent.

The effect on petroleum product prices—what consumers pay—has been equally significant. In 1981, heating oil cost \$1.19 per gallon. For the first half of 1985, its price per gallon was down to \$1.04—only 88 cents in 1981 terms. Leaded regular gasoline cost \$1.31 per gallon in 1981; but in 1985 drivers were paying an average of \$1.12 per gallon for it—less than one 1981 dollar. Thus, in 1985, you could buy about 35 percent more heating oil and gasoline with a fixed portion of your income than you could have bought in 1981.

Market pricing of oil resulted in a massive move to fuel switching and conservation sparked by individual decisions. From 1980 through 1985, domestic oil consumption *declined* by more than 8 percent—despite an increasing population, higher industrial output, and more vehicles on the road. Individual domestic producers responded by holding prices down in order to avoid losses in sales and to maintain production. During this period, the increase in domestic oil production from 10.2 million to 10.6 million barrels per day (including natural gas liquids) was in sharp contrast to the experience of members of the Organization of Petroleum Exporting Countries. They attempted unsuccessfully to maintain artificially high prices by constraining their production. It declined from 23.6 million barrels per day in 1981 (including natural gas liquids) to about 16.7 million barrels per day during 1985. Non-OPEC production in the free world rose from 21.4 million barrels per day to about 25.3 million barrels per day over the same period.

Before oil decontrol, its opponents argued that it would only increase oil company profits, with little or no effect on U.S. oil production. The Nation's experience since 1981 has

demonstrated how wrong they were. In 1985, domestic production was anywhere from 1 million to 3 million barrels per day above the level that had been predicted for this period in 1979 and 1980. Decontrol caused a dramatic reversal in the trends of U.S. oil production. During the 1970's, with price ceilings, total U.S. oil production declined 1.5 percent per year. Since 1981, it has increased each year; and in 1985 U.S. oil production was higher than at any time since 1973.

The production benefits of decontrol are not temporary phenomena. In 1984, the last full year for which data are available now, the total of "proved and recoverable" crude oil reserves in the United States increased for the first time since 1970. This increase is primarily the result of new field discoveries offshore and improved oil recovery efficiencies onshore. The fact that both production and, more recently, reserves have increased (even slightly) at the very time oil prices are falling should force analysts to reexamine the gloomy outlook of the 1970's on this Nation's ability to keep producing adequate supplies of oil at reasonable costs. However, many analysts believe reserves will diminish even with strong drilling efforts.

The prompt reduction in U.S. dependence on expensive and insecure oil imports following decontrol was perhaps the clearest example of how reliance on free markets contributes to the Nation's energy security. In 1973, net U.S. oil imports were 6.0 million barrels per day, or 35 percent of domestic oil consumption. By 1977, exhortations to produce and to conserve oil had obviously failed. Net petroleum imports (including an insignificant amount acquired for the SPR that year) were sharply higher—8.6 million barrels per day, or 46 percent of U.S. consumption. By comparison, net petroleum imports in 1985 were only about 4.1 million barrels per day, about 27 percent of consumption.

Adequacy of Refinery Capacity. Declining U.S. and world oil consumption created a surplus of refining capacity, and the less competitive refineries have shut down in the world's major refining centers. The competitive pressure has been especially strong in the United States, because the oil price and allocation controls of the 1970's gave domestic refiners a significant advantage over foreign refiners in crude oil cost (averaging about \$2.00 per barrel) while those controls were in effect. As a result, domestic refineries were able to operate at close to full capacity, while nearby Latin American refineries were operating at only 65 to 70 percent of capacity.

Between 1981 and 1985, 111 U.S. refineries were closed. Of these, 90 had capacities of less than 30,000 barrels per day each, and almost all were technically unsophisticated. The overwhelming majority of the closings occurred because decontrol eliminated the artificial cost advantage of controlled-price crude; and U.S. refining capacity remains more than adequate to satisfy the requirements of any foreseeable energy emergency in the next several years. Operating at a 95-percent utilization rate (which was typical of the industry in the late 1960's and early 1970's), processing facilities in this country could supply more than 17 million barrels per day of products—or roughly a million barrels per day beyond

current total national demand. By historical contrast, the United States never had enough operable domestic refining capacity to satisfy its own use of petroleum products during the entire period from 1962 through 1979.

Some observers have expressed concern over the fact that imports of petroleum products may rise in relation to imports of crude oil—reflecting the desires of some Third World suppliers to process raw material themselves as a means of strengthening their industrial base. As noted above, this poses no current threat to U.S. ability to refine most (if not all) of the Nation's product needs in case of an emergency. As a matter of fact, net imports of petroleum products were averaging about 1.24 million barrels per day during 1985, as compared with the 1984 average of 1.47 million barrels per day and the historical high of 2.8 million barrels per day in 1973. Although net imports of gasoline and gasoline blending components have increased in recent years, rising from 179,000 barrels per day in 1981 to about 440,000 barrels per day in 1985, these 1985 imports still represent less than 7 percent of total U.S. gasoline demand through September 1985. Furthermore, gasoline imports are coming from more than 20 different exporting countries, most of them outside the Persian Gulf. The Administration will continue to review the adequacy of refining capacity to meet emergency requirements.

Strategic Petroleum Reserve. The rapid filling of the Strategic Petroleum Reserve has been one of the most effective actions taken by the United States to enhance energy security. The SPR has been built up from just over 100 million barrels at the end of 1980 to nearly half a billion barrels by the end of 1985. At current levels, the SPR provides an effective national insurance policy against likely oil supply disruptions.

When plans for the SPR were being formulated in 1977, U.S. net oil imports were running at 8.6 million barrels per day, and the Energy Information Administration's 1977 Annual Report to Congress projected net imports to reach 11 million barrels per day by 1985 and nearly 14 million by 1990. Changes in the world oil market have caused those forecasts to be revised downward substantially. Net oil imports (excluding imports for the SPR) are now only a little more than about 4 million barrels per day, and the NEPP reference-case projection is for less than 6 million in 1990. This means that the amount of oil already in the Strategic Petroleum Reserve provides more protection now (and over the next 5 years) than a 750-million-barrel system was expected to provide at the time the initial plans for the SPR were formulated.

A 750-million-barrel system would have been expected in 1977 to equal only 68 days of net imports in 1985 and 54 days in 1990. Today, approximately 500 million barrels of oil in the SPR provide substantially more coverage than that—about 120 days of net imports in 1985 and about 82 days in 1990. Furthermore, the decontrol of oil prices has made the actual *protection* afforded by the reserve even greater than that indicated in simple "days of import equivalence." And

the very existence of the SPR reduces any impulse on the part of overseas suppliers to attempt another embargo.

The section of Chapter V dealing with international affairs describes how the Strategic Petroleum Reserve fits into U.S. cooperation with its allies in emergency preparedness.

Outer Continental Shelf Leasing. Production of oil and gas resources from federally managed areas of the Outer Continental Shelf has been an important source of our energy supplies in recent years. In 1984, more than half of all new U.S. oil field discoveries (by estimated volume) were found there. These areas have the potential to contribute greatly to the filling of future energy needs. The timely development of the OCS is one of the most vital unfinished components of the national energy agenda.

In 1984, State and Federal offshore production provided more than 14 percent of all domestic crude oil and condensate production, averaging about 1.3 million barrels of oil per day. In the same year, offshore production also provided more than 29 percent of all domestic natural gas production, averaging about 14.3 billion cubic feet per day. Federal OCS lands currently account for about 12 percent of the total proved U.S. oil reserves. They contain 19 percent of the total proved U.S. natural gas reserves.

Long lead times are often required to find and produce oil and gas once a tract has been leased. On average, it takes 2 to 5 years to obtain the appropriate permits to begin drilling once a lease has been awarded. Several more years may pass before actual delivery of oil or gas can occur. In frontier areas, such as Alaska, the delay can be even longer—up to 15 years from the lease sale until initial production begins.

This Administration is strongly opposed to any moratorium on OCS leasing. By postponing or preventing the development of low-cost domestic energy resources that are already known to be available, even temporary moratoria on OCS development can cause great damage. Moratoria increase dependence on imported energy, reduce national security, and slow economic growth. The importance of OCS oil and gas development also can be judged by the benefit to the U.S. economy that is expected to result. Leasing since the start of the Administration's 5-year OCS leasing program in 1982 is expected to bring more than \$70 billion in economic benefits by lowering the total cost of the resources used to acquire the energy supplies used by the economy in future years. Similarly, the proposed 5-year OCS leasing program for 1987 through 1991 is expected to yield about \$30 billion in economic benefits. Most of these benefits are in the form of lease and tax revenues paid to the Federal Treasury. For example, in fiscal year 1986, revenues from bonuses and royalties in OCS oil and gas leases are expected to be about \$5 billion.

Timely development of OCS resources does not mean that environmental quality must be sacrificed. The environmental record of exploration and production companies operating in the OCS is excellent. In the 30-year history of Federal OCS development, the Santa Barbara incident in 1969 is the only oil spill that resulted in significant amounts of oil reaching shore. Since then, environmental regulations have been

strengthened, and there have been great advances in the drilling technology used to control blowouts. As a result, more than 4 billion barrels of oil have been produced from OCS operations since 1971, but only about 800 barrels have been lost from blowouts. From the record, it is clear that the oil industry can develop the OCS in an environmentally safe manner.

Natural Gas

Natural gas, which accounts for more than one-fourth of all domestically produced energy, is the only primary fuel whose prices remain to a considerable extent under Federal controls. Paradoxically, the regulations that persist on "old gas" are wasting this resource and keeping average prices artificially *high* despite a gas surplus that is now in its fourth year.

If the remaining price controls were eliminated, as the Reagan Administration has long urged, market forces would encourage producers to turn more attention to the easier-to-tap fields that were opened prior to the late 1970's. Instead of being capped prematurely (thus reducing the total volume of natural gas they will ever be able to produce), the wells in "old" fields would be developed to their most efficient capacity. More "infill" wells would be drilled, and other steps would probably be taken to enhance production. A market-determined mix of new and old gas would help assure consumers of receiving adequate supplies of gas (and other energy sources whose supply and demand are affected by gas) at reasonable prices.

Fundamentally, the Administration supports realistic energy pricing based on true costs, available supply, and free-market demand. It believes that energy consumers should always be able to choose the lowest cost form of energy to meet specific requirements; and this is why it also has consistently called for repeal of the Powerplant and Industrial Fuel Use Act, which imposes prohibitions against the use of gas by certain new facilities for electric generation and industrial use. The Administration urges this action in the context of its concurrent recommendation that natural gas prices be deregulated totally.

Given today's economics, most utilities prefer to use coal in new baseload facilities; but changes in relative coal and gas prices could make the Fuel Use Act prohibition very costly. Even now, the economic appeal of using gas in some instances where the act is a barrier becomes obvious when the record of requests to DOE for waivers is examined. During the 1985 fiscal year, the number of such waivers involving high-efficiency combined-cycle turbines doubled as compared with the previous year.

Federal interference with the pricing of natural gas has been widespread. In the past, price controls on all interstate supplies discouraged producers from exploring for and producing new supplies; and they also caused much of the available supply of natural gas to be diverted to the unregulated intrastate market. By the 1970's, consumers across the

country began to suffer shortages of natural gas. The Natural Gas Policy Act of 1978 (NGPA) eliminated distinctions between intrastate and interstate markets and tried to provide production incentives through a complex system that decontrolled high-cost gas (about 6 percent of all supplies) and allowed a gradually rising scale of prices for gas developed from new sources. However, this led to a different set of market distortions: the production of lower cost "old" resources was discouraged. Naturally, many producers focused on the more expensive categories of gas that could bring them the best net return. Some consumers balked at the higher average prices, and the Nation as a whole faced the anomaly of oversupply and overpricing.

In addition, residual price controls on old gas and the complex regulatory system imposed on the industry encouraged anticompetitive behavior by pipeline companies. The refusal of these companies to transport gas for others, even when excess capacity was available, has contributed to the artificially high prices and large volumes of unmarketed gas.

The Success of Partial Decontrol. On January 1, 1985, wellhead price controls were removed from about half of all natural gas supplies. Many analysts had predicted that this would cause a "price fly-up," and there were even efforts to thwart this "partial decontrol" provision of NGPA. However, prices actually declined steadily in real terms after that partial decontrol, just as the Administration had predicted to Congress.

- The Purchased Gas Adjustment filings of 25 major interstate pipelines indicate that costs of gas at the wellhead fell from \$2.82 per thousand cubic feet in late 1984 to \$2.39 per thousand cubic feet in late 1985 (using constant 1984 dollars). This represents a decline of 15 percent.
- *Natural Gas Intelligence*, a trade publication, has reported separately that prices declined for gas on the spot market during 1985. In Texas and the Gulf Coast region, spot prices fell in real terms from a range of \$2.75 to \$3.29 per thousand cubic feet in early December 1984 to a range of \$1.80 to \$2.35 per thousand cubic feet in November 1985.

This downward trend in natural gas prices resulted from increased competition and greater pricing flexibility following partial decontrol.

The Need for Full Decontrol. Energy Department analysis shows that immediate full decontrol of all domestic natural gas supplies would result in the recovery of between 27 trillion and 48 trillion cubic feet of additional low-cost, old gas reserves. The action would add economic benefits of about \$28 billion to the U.S. economy over the first 10 years. The benefits would be achieved through lower consumer gas prices, greater fuel market efficiency, and reduced payments

for imported oil and gas, as well as from the higher domestic gas production itself.

The Department of Energy estimates that the wells in existence in the United States during 1985 are capable of producing between 3 trillion and 4 trillion cubic feet more natural gas than actually is marketed; and about one-third of the surplus is estimated to be lower cost, old gas. If these surplus supplies were produced instead of being shut in, natural gas prices would decline. Thus, regulations still constrain competition in the gas market and cause consumers to pay more for gas than they ought to.

Natural gas reserves in this country are larger than petroleum reserves. Developing and using more gas can make the United States less reliant on oil—which might otherwise have to be imported to a greater extent during the 1990's. At current prices, however, less gas is being consumed than producers are prepared to sell. A freely operating market would encourage producers to reduce their prices in order to sell the excess supplies. This is precisely what has occurred in the domestic oil market since oil decontrol became effective in early 1981.

Although the Administration favors legislative decontrol of natural gas prices, it also has proposed an administrative procedure by which the ceiling price on all old gas could be raised and incentive prices would be permitted for supplies from old fields that involve higher recovery costs. Final action by the Federal Energy Regulatory Commission on this proposed rule modification has been requested by June 1, 1986.

Transportation of Gas. Even with full decontrol of prices, the natural gas market will not be able to adjust most efficiently to changing market conditions so long as access to gas transmission facilities is limited. Free access to transportation services would give pipeline companies and their system suppliers additional incentives to renegotiate gas prices. If they failed to do so, and if system supply prices remained high, many consumers would be able to switch to alternative suppliers.

The Administration supports reforming the regulations that now allow pipeline companies to discriminate against all but their chosen suppliers in providing transportation services. By refusing to move gas that they do not own or have not contracted for themselves, the pipeline operators prevent local distributors and end-use customers from switching to lower cost gas supplies. To correct this situation, the Federal Energy Regulatory Commission has recently proposed a number of changes in existing regulations to promote greater competition among pipeline companies. The Administration's intention is to remove, as expeditiously as possible, all inefficient and discriminatory restrictions on access to the transportation capacity that is available.

III. AMERICA'S ENERGY TRIAD

A healthy energy future for the United States will require a balanced mix of resources overall, but for the next decade or two it will find three supporting elements pivotal and indispensable. These are conservation, coal, and nuclear power.

Had it not been for the Nation's wise and impressive adoption of economically justified conservation, the United States today would be in serious energy straits. Our country's huge coal resources will continue to give us the opportunity to have long-term security and strength. Nuclear powerplants offer a backbone of stability to the national electrical network through an ever-growing share of generating capacity.

The Administration has developed a consistent set of basic policies to deal with each member of this crucial triad.

Conservation—Our Largest Single Resource

Conservation contributes more to balancing the national energy ledger today than any single fuel source. If pre-1973 trends in energy use had continued, DOE calculates that Americans would have consumed about 29 quadrillion Btu's (quads) more of primary energy than they actually did in 1984. This compares with approximately 21 quads supplied that year by domestic petroleum, 20 quads of U.S. coal produced, and 18 quads of domestic natural gas.

Conservation has come chiefly from increased efficiency in the use of energy and from a shift in the Nation's mix of goods and services towards less energy intensiveness. The "energy productivity" of the U.S. economy (gross national product in constant dollars per unit of energy use) has increased 28 percent during the decade from 1974 to 1984; and it rose 14 percent in the last 4 years of that period alone.

As impressive as these conservation savings have been, substantial additional improvements will probably prove economically feasible through the year 2010, even if current energy prices remain stable or experience a moderate decline. This will not require large government outlays, and might even be hampered by them to some extent. As conservation takes hold, it does so by being the most cost-effective of all energy options in a great variety of circumstances within all energy-consumption sectors.

Aside from making sure that the Government itself uses energy in a cost-effective fashion, the Federal role in energy conservation is one of partnership with the private sector rather than of competition or tight supervision. The Federal

establishment carries on basic research, serves as a sounding board for new ideas, and will continue to do its utmost to let fuel prices reflect their correct relative levels—which encourages nationwide conservation most of all. Energy efficiency improvements will continue to come about mainly from individual decisions in the private sector; and these often require a weighing of capital costs (including interest and other charges for money) against continuing reductions in daily, weekly, and monthly bills over a period of years. Thus, success in reducing and stabilizing interest rates has been another important factor in conservation's success that is too often overlooked.

Conservation remains an important factor in the Reagan Administration's energy policy. It is a critical element in a balanced and diverse energy resource system. However, energy conservation differs fundamentally from most other energy resources in that it originates naturally in a highly fragmented fashion. Its success depends literally on actions by tens of millions of individuals and organizations, whose impulses and actions are inherently decentralized. Small actions by a multitude of people result in large cumulative effects.

The Administration supports numerous voluntary programs in behalf of conservation, but it has opposed compulsory efficiency standards. They can impose substantial unnecessary costs on the economy and on individual energy users when they are forced upon consumers whose ideas may not agree with those of abstract energy planners. Left to its own free choices, an informed public normally will decide on what is best for itself.

Conservation's Success. The market has worked, with minimal government intervention, to deliver energy conservation to a much greater extent than many analysts forecast during the 1970's. The responsiveness of conservation to decontrolled energy prices can be attributed to several factors:

- Conservation can be tailored to local, individual, or industry needs and circumstances.
- Conservation efforts face few of the licensing or other regulatory barriers found in large energy-production projects.
- Although some conservation actions involve new equipment and technology that can require large investments up front, many simple actions can reduce energy costs with little effort and with relatively little investment of money. For example, stopping up air leaks in a home—

or implementing better maintenance practices in a factory—can cost relatively little compared with immediate dollar benefits.

Many new conservation technologies can be developed and marketed quickly, but it may take a long while for some of them to penetrate the market fully. Capital stock turns over slowly in some cases because existing items (such as electric motors, boilers, and buildings) have long operating lives. It could well take 20 to 30 years to get full advantage of all the opportunities already recognized in the industrial sector.

Conservation opportunities that involve pushing back technology boundaries through generic research and development could take even longer. Nevertheless, they are important—because they offer our country the possibility of dramatic future improvements in energy use efficiency and in fuel substitution.

A Broad and Continuing Energy Ethic. It is virtually impossible to assign a precise economic value to the 29 quads of energy being saved each year now through energy conservation, because no one can determine the exact mix of fuels that is being replaced by greater efficiency and changes in use patterns. If all of this were oil, however, the annual replacement cost at today's prices would exceed \$150 billion.

Energy conservation is not something that could have been legislated into existence successfully in this country. Instead, it has been instilled by honest economics and competitive ingenuity. Now, however, many conservation measures can be expected to continue, despite a decline in world energy prices. This is the case either because they are long-term or permanent changes to capital stock (such as more efficient cars, better insulated homes, better glazed commercial buildings, and more efficient industrial processes) or because they represent behavioral changes (for example, more careful automobile maintenance, tighter management of industrial production techniques, and changed driving patterns).

Energy conservation in this country is broadly based. Each sector of the economy has contributed to the gain in energy efficiency:

- The residential sector has shown a very sharp decrease in energy use per household compared with earlier habits and trends, contributing almost 40 percent to the 29-quad total savings achieved by the overall economy in comparison with pre-1973 trends. Better insulated houses, improved appliance efficiency, and changes in household behavior have all helped.
- Within the industrial sector, improvements in energy efficiency account for approximately 30 percent of the economy-wide savings. Improved industry practices and changes in the industrial production mix have both been major contributors.
- The commercial sector has contributed about 20 percent of the 29-quad savings through improvements in building design, lighting, refrigeration, energy storage, and computerized management of energy use.
- In the transportation sector, increased auto and truck efficiency has been coupled with improved technical and operating efficiency on airlines to reduce the energy

used per mile of passenger or freight movement. This contributed the final 10 percent to the total savings, as compared to pre-1973 trends.

Because it takes time for proven conservation technologies to be adopted by both sellers and buyers, the Nation has not yet by any means seen the total impact of conservation decisions made following the oil disruptions of the 1970's. There are three strong reasons to expect continued improvements in energy use efficiency:

- Conservation actions by industry often are tied directly to efforts to improve productivity and competitiveness.
- Even at today's lower energy prices, many more cost-effective improvements remain to be made in new cars, homes, commercial buildings, and industrial equipment. The continuing development and introduction of new technology will increase the efficiency of performance and broaden the range of conservation options available in the marketplace.
- Even without those fresh efficiency increases in new cars, houses, and industrial equipment, the *average* efficiency of all energy-using capital goods will increase over time—by an additional 20 to 50 percent—as the stock continues its normal turnover and the more efficient technologies are implemented gradually.

The Role of the Federal Government. National energy policy views energy conservation as an essential component of the basic "energy triad." While the most effective means of obtaining real gains in energy efficiency is through the mechanism of the marketplace, it also is most helpful when some Federal research and development efforts focus on overcoming the basic technical barriers to the efficient use of energy.

Conservation does not mean sitting in the cold and dark. It means finding ways to eliminate waste; it means achieving technological breakthroughs that will lead to new approaches in the rational and effective use of energy resources by the marketplace. In this context, the primary role of the Federal Government is to provide a technology base that allows industry to make informed decisions regarding further development. It is a supportive and indirect role—not making choices for industry and consumers, but helping to provide the marketplace with a range of choices for them through selectively targeting R&D that can serve as a catalyst to the free market in responding to decontrolled energy prices.

Current Federal programs supporting conservation benefit the Nation in a number of ways:

First, the Government has funded conservation research and development programs, and it has used publications, seminars, and "hot line" programs to transfer the resulting new technology to the private sector. Its R&D contributions include ceramic materials for higher efficiency vehicle engines, which are beginning to enter the market. They include new designs for residential and commercial buildings, based on DOE's research and on voluntary guidelines for energy-efficient buildings. They include generic approaches to waste heat recovery, applicable in a wide variety of industrial processes. Fundamental DOE studies of how light and heat

are produced have led to ultra-efficient systems of illumination . . . and to windows whose optical properties make them many times more efficient than conventional glass.

These research and development programs make use of the combined capabilities of the national laboratories, universities, private research institutions, and industrial laboratories. They make the maximum possible use of cost-sharing participation by industrial partners, and they rely heavily on the private sector to identify and set priorities regarding research and development needs.

Removing institutional and economic barriers to wise energy use that have resulted from past government actions is another Administration effort that will help facilitate conservation through market actions. Deregulating oil and gas prices, encouraging the elimination of Federal procurement barriers to leaseback and shared-saving arrangements on energy-saving installations, and developing voluntary model building guidelines that encourage energy-efficient construction are a few examples of this activity.

Federal assistance to State and local governments and private organizations has provided a stimulus for conservation at the local level. DOE also provides technical assistance (including training in some instances) and organized forms of information exchange. It conducts a "National Energy Innovation Awards" program to recognize innovative State and local government actions.

The Federal Government tries to set a good example of energy conservation (while at the same time reducing Federal expenditures) by improving energy efficiency in government buildings and in general operations through the Federal Energy Management Program. Agencies have reduced their energy consumption per gross square foot notably (with the U.S. Postal Service showing especially valuable results), and they have achieved a 33-percent reduction in the use of petroleum-based fuels in buildings.

Related Benefits. Conservation throughout the Nation has some indirect effects that contribute to well-being beyond the elimination of waste and the rational and effective use of energy resources:

- Economic efficiency is normally increased when less energy is used, in response to price and other market forces, to produce a given product or service. This, in turn, contributes to greater U.S. competitiveness in international markets.
- U.S. reliance on foreign energy sources is decreased, thereby increasing U.S. security and improving our balance of trade.
- Reduced energy use puts downward pressure on U.S. and world energy prices, oil in particular. (In 1985, this country's economy was running on about 17 percent less oil than it did in 1978—a reduction that came despite a 7-percent increase in population and a 16-percent rise in gross national product.) This also reduces the overall cost of energy to other Western nations and to the Third World, because conservation savings in

the United States—the world's largest consumer of energy—exert significant leverage on world energy prices, production, and associated economic effects.

- Individuals' living standards everywhere are maintained at decreased costs.
- Negative impacts on the environment from all types of energy production and conversion are reduced.

Coal

This country's immense coal resources could satisfy its current level of consumption of this fuel until well into the 23rd century. Almost one-third of the world's total supply of recoverable reserves rests in massive deposits beneath 36 of the 50 States. The keys to full development of this U.S. coal—which represents about 80 percent of all our recoverable fossil fuel resources—lie in continuing to improve the way it is produced, delivered, and used.

There has been a good start. Since the 1973-74 oil embargo, coal's share of total U.S. energy consumption has expanded from 17 percent to 23 percent; and coal-fired powerplants now generate more than half of the Nation's electricity. Those plants produce about 20 percent more kilowatt-hours than they did as recently as 1980. Coal production in the United States has increased 50 percent overall since 1973, and production west of the Mississippi has more than tripled. Partial deregulation of freight rates has improved the financial and operational health of this country's railroads, which perform a crucial task in moving most of our coal. And a vigorous partnership between industry and government in research and development—allowing each to do what it does best—is advancing new methods of clean coal-burning and coal-conversion that promise eventually to expand this fuel's use in the residential, commercial, and transport sectors, as well as in industrial and electric-utility applications. With exports beginning to rise again, total demand for U.S. coal is projected now to be approximately one-third higher in 1995 than it is today.

From mine to ultimate consumer, the record of U.S. coal as an expanding domestic energy source owes much to technological innovation. For example, in the past 5 years alone, labor productivity in the coal industry has risen 52 percent for underground mines and 29 percent for surface mines. Contrary to stereotype, today's typical U.S. coal miner is a highly skilled, expertly trained professional—the most efficient worker of this type in the world. Furthermore, the gains in productivity have been accompanied by a safety record that has clearly been improving in the 1980's, despite rises in output. As for the effects of end-use, sulfur emissions have dropped more than 25 percent since 1970—even though coal-fired generation in this country has nearly doubled since then.

These healthy trends have not been achieved without problems. For one thing, the coal industry, like other energy industries, greatly expanded its production capacity during the late 1970's in response to projections of ever-increasing

Table III-1. Selected Projections of U.S. Coal Consumption and Production for 1985 (million short tons)

Organization and Year Projection Was Made	Consumption	Production
<i>Historical</i>		
Bureau of Mines (1974)	992	
Environmental Protection Agency (1974)	1,092	
National Coal Association (1980 or before)		1,051
Keystone (1977)		1,339
DOE Leasing Policy Development Office (1978)		1,116
Energy Information Administration (1980)	947	1,031
<i>Recent</i>		
Energy Information Administration (1984)	843	899
Data Resources, Inc. (1984)	824	901
Energy Information Administration (Oct. 1985)	818	886

oil prices. Gearing itself to numerous earlier estimates of even higher demand by this time (see Table III-1), the coal industry has developed more than 100 million tons per year of excess capacity. Some of this is likely to persist for as long as a decade. In addition, miner unemployment remains high, although localized. An estimated 17 percent of the coal-mining work force was idle in 1984.

The industry faces other uncertainties, too. These include the possibility of further environmental regulations (especially on the basis of concerns about acid rain, surface mine dust, and solid waste disposal), a rapidly changing coal transportation market, the complexities of forecasting electricity supply and demand, and the potential competition of foreign coal.

In establishing the National Coal Council recently as an advisory body, the Secretary of Energy has created an objective forum for discussing the full range of Federal coal issues. It includes representation from unions and mine operators, utilities and environmental specialists, railroads and port interests, academia, and the State and local levels of government. Its identification of issues and its recommendations for balanced solutions should prove helpful in many ways.

Basic Federal Policy. The Federal Government can exert significant influence in each phase of the coal market, from supply to transportation to use. In some cases, however, the Federal presence has been the problem rather than the solution. Sometimes less Federal involvement is in order; sometimes the Federal role needs to be redefined on almost a case-by-case basis—as in the instances throughout the coal market where responsibility is divided or shared by several agencies.

Without compromising national environmental, safety, and health objectives, it is the Reagan Administration's policy to take actions to facilitate coal use wherever it is an economic alternative to more expensive, scarcer fuels. Federal policies and regulations affecting coal development and use are thus constantly being weighed against one another in an effort to maintain the most appropriate balance among the multiple objectives of environmental protection, public health, economic growth, and reliable energy supply at reasonable cost. There may be more emotionally appealing ways of addressing such a complex assignment, but surely there is none that could be more honest, more responsible, and—in the long run—more effective.

This Administration's attitude toward research and development for coal is identical to that pursued in respect to oil, natural gas, and all other energy resources. Federal efforts focus on basic research that expands potentially useful knowledge of the physics and chemistry of materials and processes. In the case of coal, for example, this includes study of combustion characteristics, corrosion and erosion properties, and the phenomena of solids transport. Applied research helps to resolve additional broad generic problems that must be overcome in order to move ahead with actual engineering (that is, moving from the lab table to the stage of real piping and working mockups). The final government contribution is at the "proof-of-concept" level, generating enough data at the smallest practical scale (normally less than that of what is commonly called a "demonstration plant") to permit preliminary projections of economics, process efficiency, and environmental performance. The Department of Energy will continue to focus its efforts on the early stages of research, seeking increased industry cooperation in the support of applied technology development through proof-of-concept. Beyond the proof-of-concept stage, any Federal involvement would only skew the economics of a free market and actually discourage competition among industrial and commercial developers. It is up to them to evaluate and test economies of scale; it is certainly up to them to determine the best avenues for market acceptance.

All of these basic policy principles come into play in varying degrees within the three areas of most importance in tapping America's most abundant fuel—coal supply, coal transport, and coal use.

Converting Resource Into Supply. The most profound Federal involvement in coal is actual ownership of the resource in the ground. The Federal Government owns more than 30 percent of the Nation's coal reserves, including about half of the low-sulfur supplies. In the West, it owns approximately 60 percent of the coal reserves and controls access to another 20 percent.

The Western share of U.S. coal production has grown from 13 percent to 34 percent in just over a decade, and coal markets will be affected increasingly by the degree of access to federally owned mineral deposits. In sheer volume, there already may be enough coal under lease to meet projected near-term demand; but all of that coal is not necessarily available in the near term, nor is it necessarily the lowest in

cost or the most suitable environmentally. A forward-looking Federal coal-leasing program can have the important effect of restraining increases in coal prices, because high-quality Federal coal may be cheaper to produce than other deposits that otherwise would be produced to meet demand.

Numerous Federal health, safety, and environmental requirements also affect the cost of coal production (and even the viability of specific mining areas). These include "fugitive dust" control for surface mines, mine safety regulation, suitability criteria established by the Surface Mining Control and Reclamation Act, and the Black Lung program. Under current Administration guidelines, all these requirements are implemented so as to take full account of their effects on coal production costs and consumer utility bills, without undercutting their primary intent to safeguard the environment and the health and safety of coal workers.

Expediting the Movement of Coal. Transportation costs typically make up about one-third of the total price of delivered coal, but they can be as much as 75 percent of the total cost for Western coal, which often moves more than 1,000 miles from mine to utility, almost invariably by rail.

Federal policies have deregulated rail rates in competitive markets. This allows the railroads greater ratemaking flexibility, which has already contributed a more efficient and financially sound railroad system. At the same time, progress is being made in methods intended to protect "captive" shippers from excessive rail rates. For example, the criteria for determining whether a shipment is competitive and whether rates are reasonable have recently been revised administratively. In the long run, greater competition in coal transportation—including that from coal slurry pipelines—will reduce the need for regulatory intervention. Reasonable rates also improve the competitiveness of U.S. coal abroad.

The ability of U.S. coal to compete in both national and international energy markets can be further enhanced by selective improvements in deepwater seaports and inland waterways. Here the Reagan Administration believes that the fairest and most efficient way to decide on the priority and potential value of projects is by allowing their major beneficiaries to share costs more directly. It supports increased funding from States and localities to improve the waterway system, and it favors the principle of offsetting the initial costs of such projects through a form of "user charges."

Cleaner Coal for Wider Use. Finally, the Federal Government's role in the coal industry includes environmental regulation of end-use, which is administered by the Environmental Protection Agency (EPA). The Clean Air Act is *working*, but its air-quality requirements impose a significant direct cost on coal-fired powerplants. On average, compliance with air-quality regulations now requires as much as 20 to 25 percent of the capital cost of a new coal powerplant and reduces operating efficiency by about 5 percent.

Because powerplants now account for roughly 85 percent of domestic coal demand, environmental regulation of those plants' emissions is perhaps the single most crucial Government-controlled variable in determining the future of the U.S. coal industry. The Department of Energy's substantial

support of research on alternate methods of burning coal can eventually help to ease current problems, but meanwhile steps have been needed to produce an environment that encourages effective new options. By law, the EPA Administrator is charged with considering economic and energy impacts as well as overall environmental factors in the revision of standards for new powerplants and other facilities. The goal is to protect the environment while maintaining economic efficiency and growth. On a Btu-for-Btu basis, coal is the economic fuel of choice in much of this country for utility applications. With continuing success in technology development, it could also become the environmental fuel of choice with broader applications.

Private industry's response to the challenge of development within a freer market environment has been heartening. Some companies are already retrofitting commercial-scale boilers with the pollution-reducing technology of fluidized-bed combustion. Free enterprise is also bearing a major share of the first utility demonstration of the same technology from the ground up. One utility stands ready to commit tens of millions of dollars of its own to demonstrate a limestone injection system for sulfur control. The world's first combined-cycle generating plant to be integrated with a coal gasifier is already a reality—primarily on the initiative of sponsors, developers, and operators within the private sector.

For its part, DOE has maintained a fundamental research role in such generic areas as coal combustion, environmental control, and conversion to synthetic liquid and gaseous fuels. Working often in concert with industry or other private research organizations, the Department aims at developing a sound technological base from which new coal concepts can emerge.

There are major efforts to develop new materials, instrumentation, and technologies that can improve the capture of potential coal-based pollutants, including those suspected of contributing to "acid rain." Within this program, some new techniques are emerging that remove a higher percentage of both pyritic and organic sulfur from coal before it is burned. Other research seeks to improve the combustion process itself, so that many of coal's impurities will remain trapped inside the boiler where they can be disposed of more easily. A third aspect of study focuses on cleaning the combustion gas after it leaves the boiler or gasifier. The ultimate goal is not only to bring the final pollutant content down to purities that meet current air-quality standards, but also to achieve levels low enough to protect such end-use devices as combustion gas turbines and fuel cells. These levels would be lower than those required by air-quality standards in effect now.

The Department has concentrated much of its research attention on other new technologies that could boost coal's use in the light industrial, commercial, and residential markets. Coal accounts for only 10 percent of their fossil fuel consumption, but that share could be increased substantially in the long term by the potential fruits of ongoing research: smaller fluidized-bed boilers (suitable for apartment buildings, for example), materials that are more resistant to the

corrosive and erosive effects of coal solids, coal-based substitutes for certain feedstocks used by the petrochemical industry, and even some radically new coal-based fuel forms.

Coal-water slurries represent one example of a fuel form that has already moved from early government-industry research into more advanced stages of private sector involvement. Now mixes of coal and residual oil are being studied as refinery feedstock. Coal chars, pyrolysis products, and coals that have been chemically dissolved or converted represent other options still in the early research stages. Many of these, while potentially less expensive than premium-quality synthetic fuels from coal, will probably require changes in combustion hardware, so a companion effort in DOE's coal research program has examined the basics of various new boilers and other advanced combustors that will be able to handle them. At an appropriate stage, it will be up to private enterprise to design, produce, and market such fuel forms and equipment as prove economically competitive. If all works well, they should vie with gas- and oil-fired equipment for installation in light industrial complexes, factories, office buildings, schools, and hospitals.

Recent declines in world oil prices have forced a halt to many commercial-scale synthetic fuel projects, but the technology of converting coal to liquid and gaseous fuels still offers long-term potential for supplementing conventional energy supplies with fuels that do not require major changes in the Nation's transportation and end-use infrastructure. With this in mind, the Federal Government itself is pursuing a generic research effort to produce the scientific underpinnings of higher quality, less costly liquid fuels based on coal. In addition, the Department of Energy has been examining the entire coal gasification process, from feedstock preparation to downstream gas cleanup, in a "systems approach." This is expected to identify further ways in which efficiencies and environmental performance can be improved and costs can be brought down.

Nuclear Energy

Nuclear power is second only to coal as a source for this country's electricity, and it is projected to remain in that position at least until well beyond the year 2000. Nearly 100 reactors now operable in the Nation's commercial electric grid are furnishing energy equivalent to that which would be produced by burning nearly 2 million barrels of oil per day in utility boilers. Thus, nuclear plants complement coal in reducing U.S. dependence on imported petroleum; overall, utility use of oil has declined by more than 70 percent since 1978.

Since taking office in 1981, this Administration has done its utmost to ensure that this country will continue to have the free choice of peaceful nuclear power as part of a balanced energy supply mix. Some degree of success is evidenced by the nuclear generating record: power reactors supplied somewhat more than 15 percent of all our electricity during 1985,

with the share reflected in the NEPP reference case rising to roughly 18 percent or more throughout the 1990's.

About 30 additional nuclear units are expected to enter service in the United States within the next decade. Many plants that started up during the 1970's have already saved power consumers more in fuel costs than those plants cost to build and finance. On the basis of life-cycle costs, nuclear generating stations coming on line now are projected to offer more economical output in some regions than coal-fired units.

Yet problems exist in the nuclear sector of our electricity-generation industry. Numerous nuclear powerplants have been canceled during recent years (including some that were very close to completion). Although a clear majority of Americans favor the use of nuclear power, critics of the technology continue to take advantage of every opportunity in the tortuous regulatory process to delay licensing and commercial operation. Discouraged by construction stretchouts and the uncertainties of retrofit requirements (which cause costs to escalate), as well as by a surplus of total generating capacity arising from a temporary slowdown in electricity demand growth as prices increased, and by the wave of public apprehensions that followed the serious accident at Three Mile Island, no utility has committed itself to a new nuclear plant since 1978.

The Administration does not play favorites in regard to generating options for the future. It insists that a free marketplace gives the best guidance on where we should go from here as conditions change constantly. But the acceptance and growth of the nuclear energy option have been impeded artificially in the past by inefficiency in both economic and licensing regulation, by lack of government progress toward the issue of safe high-level nuclear waste disposal, by the lack of public understanding of how peaceful nuclear energy operates, and by the steady erosion—for several reasons—of U.S. ability to compete as effectively as it could and should in the world market of commercial nuclear technology and services.

To overcome these handicaps for an energy source that is essential to the Nation, the Administration is pursuing a fivefold strategy:

- To reform the process of plant licensing and regulation legislatively—encouraging standardized plant design and "one stop" licensing that ensures safety and environmental protection with a minimum of litigious complication.
- To push ahead with the deployment of an integrated geologic disposal system for high-level radioactive waste, including plans for monitored retrievable storage (MRS), so as to meet the mandate to begin accepting nuclear spent fuel and high-level radioactive waste by January 1, 1998.
- To concentrate R&D—with the full involvement of the private sector—on technology that can contribute to nuclear safety, standardized plant design, simplification of reliable operation, and advanced-concept plants.

- To call public attention to the fact that the U.S. nuclear industry is still the world's technology leader . . . and that the outstanding safety record of today's U.S. plants originates in redundant protective mechanisms and unparalleled programs of training and vigilance.
- Finally, to remove unneeded barriers to foreign trade for the U.S. nuclear industry and to restore this country's primacy in uranium enrichment services—in the interest of U.S. energy security, world energy stability, a better trade balance, and an even stronger international environment to resist the spread of nuclear weapons technology.

Legislative Modifications. In May 1985, the Administration proposed to Congress the Nuclear Facility Standardization Act of 1985. This bill would expand and focus public participation in the early stages of the licensing process, and it would encourage pre-approval of standard designs and suitable plant sites. It would unite the permission process for plant construction with the necessary reviews to grant an actual operating license—assuming that all conditions of the initial approval are met. It gives the Nuclear Regulatory Commission (NRC) procedural and evaluation criteria for considering any "backfits" that might be proposed on the basis of future experience and research.

Besides fostering improvements in nuclear powerplant safety, the Administration's bill offers a stable and predictable process that should encourage utilities once again to consider ordering new nuclear powerplants in situations where they represent the best means of increasing electricity-generating baseload—from the standpoints of reliability, economics, and environmental integrity.

The Price-Anderson insurance umbrella for claims resulting from a nuclear incident is a part of the Atomic Energy Act as amended; but it is scheduled to expire in August 1987. The Administration supports its renewal, with some updating.

Price-Anderson is not a subsidy to industry, but a public protection. It provides indemnification in the unlikely case of a severe accident at either DOE facilities or commercial nuclear powerplants. Drawing on resources which for commercial plants are contributed by private industry, it ensures financial protection for anyone injured by such an accident and facilitates prompt payment for claims through waiving defenses against suit by either Federal contractors or the nuclear industry (within appropriate limitations on liability). It includes coverage of facilities for civilian and defense spent fuel and high-level waste.

The Price-Anderson system provides a balance between the special financial protection provided to the public and the legal defenses relinquished by industry that would otherwise be available under tort law. Its limits of liability may require adjustment from time to time, but in any case Congress always reserves the right to review these if a current limit should be exceeded.

Radioactive Waste Management. The Administration and Congress have established the groundwork and a detailed blueprint for solving the longstanding national problem created by the accumulation of spent nuclear fuel and

high-level radioactive wastes—through passage and continuing implementation of the Nuclear Waste Policy Act of 1982 (NWPA).

Although nuclear power generation produces volumes of wastes that are small in comparison with those that come from other energy activities, nuclear wastes require special handling and storage because of being radioactive. Although such wastes have been safely stored for decades, concentrated fractions of them will remain significantly radioactive for thousands of years. Therefore, permanent disposal is necessary to provide reasonable assurance that the public and the environment will be protected adequately. For the good of the whole Nation, one or more States will be asked to host safe and permanent waste-disposal facilities. In the interest of operational efficiency, and to provide interim storage, at least one State will be asked to host a monitored retrievable storage facility.

In carrying out the NWPA, DOE is well on its way to selecting and fully examining three sites for the first deep geologic repository, and it is progressing satisfactorily with plans for a second. It will soon submit a proposal to Congress for a strategically located MRS facility as an integral part of the program. Even when extra time is required, the Department is following its statutory mandate to involve the public in the planning and development of these waste facilities, in order to promote confidence in the safety of the waste disposal technology. Nevertheless, DOE still expects to meet NWPA's goal of actually accepting spent fuel and waste no later than January 1, 1998. To prepare for this phase, it is also moving toward the development of a transportation system to safely move spent fuel from reactors to the waste disposal facilities—which will be operated by the Federal Government. The entire integrated waste disposal system is financed by user charges on those who produced the waste.

DOE has not overlooked the less stringent requirements of low-level waste disposal. Its support of regional compacts by States (and its continuing offer of technical advice and assistance in this matter) has contributed to the ratification of seven such compacts by Congress. More recently, when State implementation of the compacts was delayed, the Department encouraged the amendment of the Low Level Waste Policy Act to help ensure that the regional compacts will become fully effective in an orderly fashion over the next 7 years.

The Department is continuing its restoration of facilities that were radioactively contaminated by some of the earliest Government operations, as well as restoration specifically mandated by congressional action to solve special problems.

Research and Development. The unique research and development facilities and resources of the Department of Energy have been devoted in recent years to addressing and resolving fundamental technical and scientific issues on nuclear energy. The R&D is structured to complement industry initiatives, and its results are made available to the private sector for commercial implementation.

Since the decision by Congress to cancel the Clinch River Breeder Reactor, the Department of Energy has been re-evaluating its nuclear program options and reshaping its program directions. In addition to facilitating the standardization of improved light water reactor plants for evolving civilian energy requirements, DOE is at work on technology for some advanced nuclear reactor systems. These, too, should help to meet future needs for industrial, commercial, and residential energy, as well as those of national defense and other special applications.

At the request of the Secretary of Energy, the Department's nuclear research and development programs are currently being reviewed by the Energy Research Advisory Board, which is expected to complete its assessment in early 1986.

Improving Public Understanding. Commercial nuclear powerplants have amassed more than 900 reactor-years of safe, reliable operations in the generation of electricity. Naval nuclear propulsion reactors have completed more than 3,000 reactor-years of safe, reliable operations. This is perhaps the safest large-scale energy technology ever conceived by human ingenuity. Yet nuclear power clearly leaves some people skeptical or concerned.

The decision by the Institute for Nuclear Power Operations (INPO) to establish a national academy for training is one that should increase public confidence. Industry-wide training activities will be consolidated with the accreditation program already being managed by INPO.

While it is tempting to lay all responsibilities for the nuclear industry's problems on government regulators, overzealous environmentalists, and an overly fearful public, there has been enough evidence of problems in planning, management, construction, and operator training so that the industry itself must accept its share of responsibility. In fact, the industry has done so; and it is becoming an ever-more important contributor to the solution.

A difficulty that free enterprise can overcome only in part is the plethora of misinformation and misunderstanding about nuclear energy itself that has engulfed the general public for years. Our citizenry must be given the facts about the role of nuclear energy in American life, so that laymen can contribute to thoughtful decisions. The highest echelons of DOE will help explain the realities of nuclear energy to the American people in an unbiased way and in readily understandable terms, to allay unfounded concerns over this crucial domestic resource.

Making Goods and Services Available Abroad.

Because nuclear power will be an increasingly important source of energy to U.S. allies, who have fewer natural resource options, it is imperative that this country maintain technical leadership in nuclear power to influence world nuclear nonproliferation policies. Cooperative ventures and collaboration on scientific and technological development projects with our allies will continue where these are consistent with domestic programs and Federal budget constraints.

Nuclear energy products and services represent at least a \$6 billion international trade market for this country. Agreements for peaceful nuclear cooperation with foreign countries should be encouraged—wherever appropriate nonproliferation safeguards are in place. Besides improving the U.S. trade balance, this should strengthen the domestic nuclear industry, whose continuing leadership is in the best global interest.

As one step toward the goal of improving the competitive position of U.S. industry in world markets, Congress has recently assented to an agreement submitted to it by the Administration for civil nuclear cooperation between the United States and the People's Republic of China (PRC). This agreement—which was debated extensively by legislators—will enable the U.S. nuclear industry to compete for nuclear powerplant projects in the PRC, without undercutting U.S. nonproliferation policies.

Uranium Enrichment. 1985 was a year of difficult, yet necessary, business decisions in regard to the Federal Government's provision of uranium enrichment services. On the basis of the best technical and economic assessments available, the technology of atomic vapor laser isotope separation was selected to meet the needs of the 21st century. Private-sector participation in the future application of this technology will be encouraged. Work on the less competitive gas centrifuge enrichment program was ended, at a multibillion dollar saving to the taxpayers; and current gaseous diffusion production facilities were adjusted to meet anticipated demand—at further savings.

These decisions are consistent with the strategy of achieving a competitive price structure and developing the world's most advanced uranium enrichment technology. The Nation should exploit its technological advantages in this field in a way that will ensure maximum flexibility for growth to meet the market of the future.

Supplies of Uranium. Enriched uranium must start with feedstocks. The Atomic Energy Act requires the Department of Energy to monitor regularly the viability of the domestic uranium mining and milling industry. This is intended to ensure a stable and reliable source of uranium supplies to domestic electric utilities and to the national defense establishment. The latest annual assessment concluded that the U.S. uranium industry had lost commercial viability in 1984, so the Secretary of Energy took three steps aimed at alleviating some of the problems it faced:

- DOE is granting many of its enrichment customers greater flexibility in selecting the degree of enrichment services to be ordered from the Department. Granted the current price of feedstock and enrichment, the net effect should be to increase domestic purchases of natural (nonenriched) uranium.
- DOE postponed for a year an earlier plan to feed some of its own uranium stockpile into the enrichment plants.
- The United States Trade Representative was asked to examine the facts and implications of current uranium imports. If action under U.S. trade laws is appropriate, it will be taken promptly and effectively.

IV. SOURCES OF DIVERSITY AND LONG-TERM SUPPLY

Gradual depletion of some of the United States' more limited energy resources, such as conventional petroleum and natural gas, need not condemn this country to imminent energy scarcity. Electricity can satisfy many end-uses, and do so with minimal reliance on oil and gas. In addition to hydroelectricity, other renewable forms of energy will provide an increasing variety of satisfactory replacements for the potentially scarce fuels. And, finally, there are alternative sources for the convenience of the liquid and gaseous fuels to which the U.S. economy and living standards are adjusted.

Electricity

The electric utility industry has been a leader in reducing U.S. dependence on foreign oil. Between the oil embargo of 1973 and the end of the 1970's, power companies collectively reduced their consumption of oil from about 17 percent of their total input of primary energy to 10 percent. Since then they have slashed their use of oil to less than half of even that modest share; and now more than 80 percent of all electricity production in the United States comes from the most secure components of our energy resource base—coal, uranium, and renewables.

Electricity and the primary fuels used to produce it have experienced substantially different demand patterns in recent years. The total consumption of primary energy in 1984 was virtually the same as it had been in 1973, but electricity demand grew nationally by one-third over that same period. Most current projections show the demand for electricity growing in rough proportion to the growth in the Nation's economy for the foreseeable future.

Little has occurred during the past 2 years to modify the assessment in the 1983 National Energy Policy Plan about the future sufficiency of electricity supply. Given the range of demand growth projected, a substantial amount of new generating capacity is expected to be needed nationally over the remainder of the century—with some regions requiring new generating capacity much sooner than others. Unfortunately it is still generally the case that traditional regulatory practices do not provide the electric utility industry with proper incentives to engage in major new capital programs. The most significant energy issue facing the Nation during the next decade and a half may prove to be how to develop a cost-effective solution to this problem.

Responses to Rising Demand. The ratio of annual growth in electricity demand (adjusted for weather) to real GNP growth has remained steady or risen at about 0.6 to 0.8 since February 1984. Although this ratio, based on a 36-month rolling average, is somewhat lower than was projected in the 1983 National Energy Policy Plan, these latest data confirm that there is still a significant positive correlation between economic growth and increasing demand for electricity. Between 1984 and 1985, U.S. electric generation grew more rapidly than the GNP.

Most long-term projections of future electricity demand growth are still running in the range of 2 to 3 percent per year. The NEPP-5 reference case projects it at 2.5 percent per year—compared to a GNP growth projection of 2.9 percent annually to the year 2000. It is worth underscoring the point that the NEPP projection counts on substantial gains in conservation (including better load management), which tend to restrain projected growth in capacity requirements.

If these projections prove correct, the Nation will need between 100 and 300 gigawatts of new capacity over the remainder of the century, in addition to the 70 gigawatts under construction in late 1985. This new capacity will be needed to replace obsolete units as well as to satisfy demand growth. In some regions, capacity beyond what is now in the construction pipeline could be required by the end of the 1980's. In other regions, this need may not be felt until 1995 or later.

Before new capacity is brought on line, utilities that wish to avoid or postpone further capital commitments will meet additional demand by increasing the utilization rates of existing generating units that are not operating now to the maximum extent they might. Currently, much of this "unused capacity" consists of oil-fired units, which have been operating on average at very low capacity factors. However, any significant return to reliance on such units would have the detrimental effects of permitting operating costs to rise unnecessarily and increasing the Nation's dependence on foreign oil.

The average citizen (and electricity ratepayer) is not likely to be concerned about potential supply problems that are 5, 10, or even 15 years in the future; but the Nation's leaders and policy-setters must not be complacent. Some of the future supply requirements can be met by sources other than the traditional central-station facilities that are the mainstay of our existing electric power system. These "nontraditional" sources include the following:

- Cogeneration
- Conservation and load management

- Renewable technologies
- Expanded power imports
- Expanded interregional transmission links
- Plant-life extensions

Cogeneration is not a new source of electric power generation. However, the combined effects of higher electricity prices, tax benefits to cogenerators, and the "avoided cost" pricing principles sponsored by the Public Utility Regulatory Policies Act (PURPA) have brought on a rapid expansion in actual and planned cogeneration facilities over the past few years. This is especially true in regions where the existing power system is fueled largely by oil or gas.

However, there is increasing concern in some States that too much of this cogeneration is gas-fired—designed to minimize capital investment and maximize electricity output from the cogeneration system rather than to improve overall economic efficiency. There is also some question as to whether the pricing schemes applied under PURPA in some States accurately reflect the true avoided costs. (It appears that prices are set higher than avoided costs in some instances, and in other cases at levels higher than required to secure the investment.) One way to reduce these regulatory problems is to reduce the restrictions on the types of technology (as well as the kinds of operators) that can qualify for avoided-cost pricing under PURPA.

Regardless of how these issues are resolved, however, it is now clear that cogeneration capacity is likely to expand considerably. Projected additions to cogeneration capacity between 1981 and 1990 have been estimated at 11 to 13 gigawatts* (out of a total of about 100 gigawatts of new electricity supply of all kinds likely to be added nationally during this period). Beyond 1990, the range of possible cogeneration additions varies greatly, depending particularly on assumptions about the rates that utilities will be paying for cogenerated electricity.

Utility-sponsored programs of *conservation and load management* can also offer an economic alternative to traditional supply in some cases, but the magnitude of this potential contribution is still quite uncertain. The use of electricity is expected to become more efficient in any case; and the NEPP projections of electricity sales assume that substantial conservation will take place independent of utility actions. The growth rate for sales of electricity in the reference case projection (2.5 percent per year from 1984 to 2000) is a *net* figure, which would be about half a percent higher without embedded conservation.

Utility companies are pursuing conservation and load management in a serious and determined manner. The approaches are increasingly sophisticated and focused—in the sense that these programs are being designed and implemented to produce demand patterns that are most appropriate for the current and projected supply of each specific utility

service area. An important and difficult question is how much *additional* conservation and load management utilities can stimulate in their respective areas at long-term costs that are competitive with the various options of added generating capacity. Many utilities today are experimenting with a wide range of demand-management programs, but it will be some time before the effects can be assessed.

Renewable technologies are projected to make an important contribution to electricity supplies for the Nation over the rest of this century and beyond. As shown in Table IV-1, the grid-connected electricity supplied from these resources is projected to grow some 50 percent from 1984 levels to be 5.5 quads by the turn of the century—approximately one-seventh of the total supplied.

Currently, the bulk of grid-connected renewable energy electricity is produced by hydropower (about 95 percent in 1984). Despite the growth of other renewable technologies for central electricity generation, hydro will remain predominant for many years. Other renewable resources making smaller but important contributions in the marketplace today include geothermal, biomass, and wind energy, in that order.

Power imports from Canada have grown sixfold since 1970 and are expected nearly to double again by the mid-1990's. As noted in a recent study,* Canada has roughly 25 to 30 gigawatts of untapped hydroelectric potential, 5 gigawatts of tidal power potential, and significant nuclear power potential. It is not clear, however, how much of this electricity will be available to the United States on a firm basis, or at what price. Over the long term, the level of electricity imports from Canada will depend on negotiations between U.S. utilities and their Canadian counterparts regarding the risks and economic benefits of imported power in comparison to domestic alternatives.

Although U.S.-Canadian electricity trade is a relatively small portion of total electricity consumption, it shows signs of continuing to increase through the mid-1990's; and its regional significance should not be discounted. New York State, for example, now purchases almost 17 percent of its electric energy requirements from the provinces of Quebec and Ontario.

DOE projects that electricity imports from Canada could reach 75 billion kilowatt-hours by 1995, as compared with 39.7 billion kilowatt-hours in 1984. To the extent that future purchases of Canadian electricity continue to be economically preferable, the United States should continue to consider them as a positive contribution to its total energy supply.

Expanded interregional transmission within the United States also may offer opportunities for the next several years to help meet requirements for electricity in certain areas. However, much of the present oversupply is located in the central industrial portion of the country, where continuing demand growth is projected. Thus, it is uncertain how long

**Industrial and Commercial Cogeneration*, Office of Technology Assessment, Congress of the United States, February 1983; and *Sensitivity of Cogeneration Projections to Avoided Cost Assumptions*, Applied Energy Systems, Inc. (sponsored by the Department of Energy, forthcoming).

**Trading in Power: The Potential for U.S.-Canadian Electricity Exchange*, Northeast-Midwest Institute and Canadian Institute of International Affairs, 1984.

Table IV-1. Renewable Energy Inputs to Electricity Transmission Grid, 1970-2000
(quadrillion Btu's)

Generation Type	Historical			Estimated	Projected		
	1970	1975	1980	1984	1990	1995	2000
Large hydro (>80 Mw)*	2.65	2.77	2.47	3.03	2.73	3.07	3.38
Small hydro (<80 Mw)	—	0.36	0.38	0.39	0.40	0.42	0.44
Geothermal	0.01	0.07	0.11	0.15	0.32	0.53	0.68
Biomass (wood and waste)	—	0.01	0.02	0.03	0.04	0.17	0.29
Wind	—	—	—	—	—	0.26	0.69
Solar thermal**	—	—	—	—	—	—	—
Photovoltaic**	—	—	—	—	—	—	—
Ocean thermal	—	—	—	—	—	—	0.03
Total renewables	2.66	3.21	2.98	3.60	3.49	4.45	5.51
Total energy input for grid-connected generation	16.3	20.3	24.3	25.7	30.9	35.1	39.1
Percentage renewables	16.3	15.8	12.3	14.0	11.3	12.7	14.1

Source: *National Energy Policy Plan Projections to 2010*, a technical report in support of the National Energy Policy Plan, 1985, Tables 3-13 and B-1.

*The fluctuation of Btu input from renewables (both historically and in the NEPP projections) comes from variations in rainfall and mountain snowpacks—which produce anomalous annual figures for hydroelectric power. The up-and-down statistics for percentage contribution emerge in part from changes in the pace at which coal-fired and nuclear powerplants are added to the existing base.

**Negligible totals nationwide, even in the year 2000.

the present regional differences will remain. In addition, a recent study prepared under the auspices of the North American Electric Reliability Council* concluded that the transmission grid linking the Midwest with the electricity demand centers in the eastern United States is already fully loaded.

Extending plant life is certainly an option many utilities will consider to meet rising future demand. In some cases, it involves no lead time and relatively little capital outlay, and there is less risk that the costs will be recovered than there might be in ordering new generating capacity. However, keeping old plants in service beyond normal retirement dates has some potential drawbacks in comparison with introducing the latest technologies. Older plants may have higher operating costs and may be less reliable. Further, they generally are more polluting than their likely replacements.

From a policy perspective, the challenge associated with all traditional and nontraditional resources is to allow them to achieve their respective economic shares of the electricity market without forcing reliance upon any that are not economic. For most nontraditional sources, the past few years have seen a flurry of activity and some real progress. At the

same time, problems remain. The same uncertainties and regulatory practices that today inhibit electric utility investment in general will also inhibit utility investment in non-traditional options—especially the more capital-intensive alternatives.

Nontraditional resources will not be capable economically of carrying the entire burden of demand growth plus providing replacement for obsolete capacity through the year 2000. Accordingly, substantial amounts of new generating capacity using traditional technologies (both fossil and nuclear), will be needed to meet future electricity supply requirements. It is this simple reality, coupled with the growing importance of electricity in the Nation's energy economy, that makes coal and nuclear power part of our country's essential "energy triad."

Financial Condition of the Industry. The financial condition of the electric power industry has improved over the past several years. Both authorized and realized rates of return have risen, both in nominal and in real terms. The phenomenon of "attrition" (a shortfall of realized earnings as compared with authorized earnings) has been substantially reduced. It has dropped from the 3-percentage-point range in the early 1980's to an average of less than 1 percentage point today.

*ECAR/MAAC *Interregional Power Transfer Analyses*, ECAR/MAAC Coordinating Group, June 1985.

After years of decline, the industry's bond ratings have been improving on average. Internal generation of funds is increasing for the industry as construction programs wind down and new plants are put into service. By early 1985, the average return on equity had risen to more than 14 percent.

The mean market-to-book ratio for utility stocks during the first half of 1985 was the highest since 1972. For many companies, this ended a longstanding disincentive to the issuance of new stock; and the higher utility stock index can be traced in part to the Reagan Administration's success in curbing inflation and easing the threat of future inflation.

All this indicates that the industry's *general* financial crisis has abated. However, financial problems continue for those companies that have major facilities under construction—or in operation, but not yet in the rate base. Several of these companies, both public and private, are still teetering on the edge of bankruptcy.

The generally improving financial picture for those electric power companies that have minimal ongoing construction programs may represent more of a transformation of the issue than a resolution. Today, it is not the industry's current financial circumstances that are of primary concern; rather, it is the inadequate market incentives to undertake capital investment for the future.

The threat of regulatory "prudency" reviews in the future for all major investments stands as a powerful disincentive to any new utility commitments—as do the possibilities of renewed attrition and a lower quality of earnings. All in all, a perceived imbalance in the risk/reward relationship confronts many utility managers who must decide when to risk new capital to ensure the long-term adequacy and efficiency of the Nation's electric power system.

The Public Utility Compact. The Nation is witnessing the disintegration of the traditional "public utility compact," whereby utilities and their investors were assured an adequate real rate of return on invested capital but, in return, were not allowed to earn more substantial profits. As regulatory matters stand today at the State and local levels, premium rewards for utility companies are still ruled out, but the risk of seeing adequate returns replaced by substantial losses has become very real.

Furthermore, this is taking place in an era when the populace has become so reliant on electricity that consumer groups and many individuals have come to regard it as an entitlement—a "right" that cannot be denied. This outlook prompts a reluctance on the part of some customers to pay the full cost of electricity in rates. Thus, public expectations collide with the new realities of those utilities whose costs are increasing legitimately, sometimes making those utilities the scapegoats in a "no win" situation.

There have been several cases in recent years in which regulators have retrospectively evaluated the wisdom of utility decisions to build new capacity that turned out to be "excess" by the time it was completed. In some cases, the regulatory body that is now refusing to let such new capacity be included wholly or partially in the rate base (from which "allowable" returns are calculated) is the same one that issued

the certificate authorizing the construction to begin, or approved the raising of funds for the plant's construction. There also have been cases in which utilities undertook construction of new plants, then canceled them before completion (with the approval or even urging of regulators), yet subsequently were not allowed to recover costs or to earn a return on their investment.

Regulatory second-guessing has substantially increased the risks involved in undertaking new capital investment. Without an offsetting increase in the prospective rewards that such investment might bring, utilities can be expected to avoid or minimize additions to generating capacity. And they will be particularly reluctant to invest in facilities with high capital costs, long construction times, or any special uncertainties associated with regulatory approval or operating performance. This means they may tend to steer clear of base-load plants in general in favor of adding capacity in smaller increments. In conventional technology terms, this equates to combustion turbines—which use oil or gas rather than coal or uranium, and which generally offer lower efficiency and higher fuel costs. This might not benefit customers in the long run.

The Problem of Rate Shock. The phenomenon of "rate shock" has caused severe problems for some utilities and their customers over the past several years. Traditional rate regulation places the full value of a new facility into a utility's rate base and then allows the utility to charge consumers enough to return a percentage of that base each year for depreciation (return of capital) and earnings (return on capital). As a result, consumers pay considerably more of the capital costs of a new facility in its early years of service than they do as the plant ages and is depreciated. As the value of the rate base gets smaller, the associated charges to consumers go down.

This front-end loading of capital charges, coupled with recent escalations in plant costs (especially for those whose delays in construction kept capital tied up without any return during years when the cost of borrowing was high), has led to requests for unusually sharp rate boosts when new facilities have been placed into service. One rate-regulatory tool that can be used to counteract the rate shock phenomenon and help stabilize electric power markets is the inclusion of "construction work in progress" (CWIP) in the rate bases. This practice introduces the inevitable rate changes to cover new capital additions gradually. It combines the advantages of greater price stability, more accurate (that is, more market-like) price signals, and improved cash flow for utilities at a time when their cash needs are the greatest. The Federal Energy Regulatory Commission's (FERC) inclusion of CWIP in the rate base is a sound regulatory practice that tends to help ensure an adequate and efficient long-term electricity supply system. Unfortunately, relatively few utility commissions at the State level have followed FERC's example in this regard.

The changing price environment that currently characterizes electric power, especially where "rate shock" is being experienced, has strained relations between State and Federal

regulators. FERC's decisions on wholesale transactions are being challenged increasingly by States. At a time when electricity transactions are becoming increasingly interstate (and wholesale) in nature—thus expanding the Federal role in electricity rate regulation—State authorities are pressing for fuller control over any transactions that have a direct effect on their constituents. Allocations of cost among utilities from several States who cooperate in building and operating large plants have been a special source of contention.

Electricity Regulation at the Crossroad. The old public utility compact has been broken, and there appear to be at least two basic paths that regulation might take in order to reach a workable new arrangement. One path would return essentially to the old bargain of controlled returns and minimized risks. Some States are taking this path by instituting procedures to expand the direct public role in long-term planning of electricity supplies. This puts a greater share of the responsibility on the public authorities, and thereby (presumably) minimizes future risk to the utilities. Some utility executives are supporting this expanded public participation in the planning process as a precondition to their putting new capital at risk for the production of electric power.

Another path would rely more heavily on market forces to make the fundamental planning decisions in electricity generation and transmission. Risks and rewards would be balanced by allowing investors to receive the full benefits of decisions to invest capital in electric power production, but this path offers no protection if such decisions do not work out. There is growing evidence that some investors are willing to operate on these terms. In fact, PURPA offers essentially this kind of investment opportunity to cogenerators and small power producers; and—as mentioned earlier—the response has been substantial. Although PURPA implementation in some States has been inconsistent, it shows something of the nature of free capital response to a non-cost-based rate regime in electric power. If PURPA were “opened up” to cover all types of plants and to admit any responsible investor who was willing to risk investment in generating electricity, the results might be dramatic.

The decision on which path to take rests in part with the Federal Government (for wholesale trade) and in part with each of the 50 States (for retail trade). If the first path is chosen (restoring the old limited-risk/limited-reward compact), the challenge would be to find rate-regulatory practices that are better adapted to a commodity whose costs may be increasing generally, and that offer the needed financial incentives for capital investment while still providing incentives for utility companies to build and operate their systems efficiently. The challenge of the second path would be to find opportunities for free-market forces to direct the capital and operating decisions in what has traditionally been thought to be a quasi-monopolistic area.

The process of change in electric power regulation is much more likely to be evolutionary than revolutionary. The States (and FERC) are functioning now as laboratories, some placing more emphasis on improved regulation and expanded

public planning while others pursue more market-oriented solutions.

During the past decade or so, too many rate decisions and regulatory practices have run contrary to national energy interests. In some way or another, the rate-regulatory bodies that set electricity prices in this country must find ways to balance the needs of both consumers and investors while ensuring adequate incentives for steps that will keep future supply and demand matched reliably at an appropriate level for a healthy society.

Federal policy will continue to place major emphasis on market-oriented reforms in electric power regulation, just as it has in oil and natural gas markets. To the maximum extent practicable, the Administration believes that the Nation should rely on market mechanisms to resolve the problems that an undue reliance on regulatory mechanisms has produced. This is why DOE has modified its administration of the Fuel Use Act so as to interfere as little as possible with private-sector fuel choices.

As noted earlier in this document, the Reagan Administration has proposed that the most appropriate long-term action would be to repeal the Fuel Use Act. It also suggests that the Holding Companies Act of 1935 has outlived its usefulness; that act, too, should be repealed.

The marketplace is the best mechanism to resolve the competing claims of various power system advocates and economic forecasters. It is the best tool to restore the risk/reward balance in capital investment. However, this policy is tempered with the realization that electric power supply bears special public responsibilities and that public authority over it is widely dispersed.

In response to a recent notice of inquiry from FERC, requesting ideas for making its rules on electricity sales more efficient, the Department of Energy has urged that Federal regulation of wholesale power transactions allow as much flexibility as practicable in voluntary transactions between utility companies—especially if it can be ascertained that these transactions are adequately disciplined by the free market. Where regulation continues, DOE has urged FERC to adopt practices that simulate market outcomes. These might include marginal-cost pricing, time-of-day rates, and more flexible voluntary access to transmission capacity.

The competition among fuels, technologies, and (increasingly) utility companies is also pertinent to relations among States. Some States may opt for more future generating capacity at a higher cost; others may wish to add less capacity at a lower cost. Those who guess wrong and build too much will clearly bear that burden. Those who guess wrong in the other direction and build too little should expect to pay value-based rates rather than a cost-based rate for their power purchases. Just as utilities have been affected and continue to be affected by decisions about new construction, States have been and will continue to be affected by the kinds of decisions their regulators make.

Renewable Energy

Renewable energy is an inherently secure source of supply for the United States overall, even though hydropower

(which, with wood burning, provides most of the renewable energy we can realistically expect to use for some time) may fluctuate considerably from year to year because of changes in precipitation. In 1984, renewables of all kinds provided about 14 percent of the Nation's electricity (because of an especially good year for hydro), and 9 percent of the total domestic energy supply. In the future, the United States is projected as being able to count more on other renewable technology options: geothermal energy, wind, solar-thermal, passive solar, photovoltaics, biofuels, and even energy from the ocean—which could have specialized significance for an area like Hawaii. Collectively, these technologies offer a significant long-term opportunity for greater flexibility and diversity in the energy supply system, thus promoting both competition and stability within the marketplace.

The domestic renewable energy resource base is enormous, perhaps hundreds of times larger than current domestic energy consumption and far above projected national energy requirements. Obviously, a significant portion of this resource base will remain economically unrecoverable for the foreseeable future; but use of renewable energy is expected to increase rather steadily—with the rate of growth depending upon such factors as the willingness of industry to undertake investment risks and on the uncertain price of competing energy sources.

Part of the reason for projecting a steady rise in output is that the Nation's resource base for renewable energy is extremely diverse. It includes:

- The kinetic energy content of wind and falling water.
- Direct sunlight incident upon the vast surface area of the United States.
- Convertible energy content that is available in the enormous annual production of organic feedstocks.
- Thermal energy available from geothermal resources.
- The potentially useful energy equivalent of the temperature differential in ocean thermal gradients.

The Pace of Growth. By the end of this century, domestic energy supplies from renewable energy are projected to be nearly double the 1980 levels, with increasing contributions from technologies that are now in the R&D phase. By that time, renewable energy is projected in the NEPP reference case as supplying nearly 13 percent of the total domestic supply of primary energy—rising to 15 percent by 2010. Even these estimates (a total of about 10.3 quadrillion Btu's by the year 2000 and 14.5 quads by 2010) may understate the contribution of renewable energy somewhat, because firm statistics on most nonutility applications of renewables (including decentralized solar installations) have not been generally available and because so many factors affect the rate of market penetration.

As noted in the preceding section on electricity, renewable technologies are projected to make a significant contribution to U.S. power-generating potential. Between 1984 and the year 2000, the electricity supplied to the transmission grid from these resources is projected to increase from 3.6 quads to 5.5 quads. However, the rate at which the renewable electric technologies will expand is expected to approximate

the rate of growth in total sales of electricity. This means that the *percentage* of grid-connected generation supplied through renewables would remain relatively stable.

Currently, hydroelectric power supplies about 95 percent of renewable-source electricity connected to grids, but other renewable technologies for electricity generation are growing:

- Geothermal generation has multiplied about 15 times in 15 years, and it now represents more than 4 percent of all renewable-based U.S. electricity.
- The recent and projected growth in wind power is also especially striking. Approximately 1,000 megawatts of wind turbines were expected to be on line in this country by the end of 1985.
- The biomass contribution (especially biomass-fueled cogeneration) can be considered significant despite its small size—because of special potential for the future in regions where sizable amounts of agricultural waste exist.
- Central-station solar installations are still quite small in the national context; but several experimental facilities—employing photovoltaic arrays, solar-thermal collectors for large-scale generation, and improved geothermal technologies—are now connected to commercial grids in California. These are providing essential experience on costs, maintenance needs, and power-conditioning requirements.

Role of the Federal Government. The Federal renewable energy program has undergone a successful transition from a broad sweep of demonstration and commercialization activities to one that is oriented essentially toward R&D. Industry participants have a clear field now to undertake the activities they do best—such as market development and analysis, product development, and financing.

A specific Federal contribution is to assist in research and development that has potentially high payoffs, but which is relatively basic and does not offer proprietary profits to private industry. The strategy of the renewable energy program in this Administration has been to develop (in cooperation with the private sector) a reasonable range of potentially viable energy technologies. The goal is to provide the economy with a broader selection of competitive energy supply choices. The approach has been to concentrate Federal attention on scientific and engineering research that promises a better understanding of the characteristics of renewable energy resources, of the technologies for collecting and converting these resources to useful forms, and of the generic materials sciences to support industry development of reliable and efficient systems. To this end, Federal funds will continue to be focused on university and national laboratory research while encouraging increased cooperative R&D with industry in bringing emergent technologies from the laboratory to the point of development that will lead each participant to its own product-specific technology.

Some important resource characteristics that influence performance and reliability of several technologies are still under study. For example, spectral analyses of insolation are

critical to the design of durable, high-efficiency, frequency-sensitive photovoltaic cells. New instrumentation techniques for measuring direct, global, and total insolation are also needed to understand better how these phenomena relate to conversion efficiency and to the degradation of solar collectors.

Collaborative research between the private sector and the Federal program suggests that renewable energy technologies will be able to compete more broadly in decades to come, as improvements occur in system efficiencies, useful life, and materials development that can now be foreseen. Current DOE research ranges from increasing the efficiency of multijunction crystalline solar cells to developing tailored airfoils for wind machines that will enable industry to increase their energy capture and fatigue lifetimes appreciably. In the case of "solar buildings," further development of the technology base is possible in regard to the durability, transmissivity, and size of materials, the spectral balance and spatial distribution of lighting, and the efficiency of natural transport phenomena in moving conditioned air throughout structures.

Some Reasons for Optimism. Starting from a fairly low level of research and industry activity 10 years ago, renewable energy technologies have made remarkable progress in research and in market development:

- Under concentrated sunlight and research conditions, photovoltaics are achieving 35 percent efficiency. (Only a few years ago the maximum attainable efficiency was about 10 percent.)
- Geothermal powerplants, once limited to a few specific locations, are now under construction in six States, using advanced technologies in flash steam and binary systems.
- The costs of power generation by commercial-size wind machines, given the tax credits that have been available, dropped from between \$1.00 and \$1.50 per kilowatt-hour in 1975 to between \$0.10 and \$0.15 per kilowatt-hour in 1985—a 10-fold decrease. From 1980 to 1985, wind machine availability also has increased from 50 percent to more than 90 percent.

Renewable technologies such as photovoltaics, solar-thermal, wind, ocean, biofuels, geothermal, and hydropower represent a diverse palette of options. In various manners they generate electricity, provide thermal energy, or offer solid, liquid, and gaseous fuels. Often they can be assembled in modules, providing flexibility in size and application. Furthermore, the geographic distribution of renewable resources is such that many localities within the United States can call upon at least one renewable resource. For example, the entire West Coast enjoys the benefit of hydropower energy generated in the Northwest. There are active solar markets in States with widely differing climates—including Arizona, Colorado, Florida, and New York. Passive solar heating techniques are being incorporated by an increasing number of builders *throughout* the United States—although the total magnitude of its contribution is inherently difficult to measure. Biofuels—such as energy from municipal solid waste,

alcohol fuels for transportation, and biomass for cogeneration projects—fill energy requirements in many regions.

The flexibility of renewable energy technologies allows direct matching of available energy resources with specific end-uses. For example, photovoltaics produce electricity directly from solar insolation; biofuel conversion can produce electricity, or it can yield solid, liquid, or gaseous fuels; and organic matter produces thermal energy directly in many instances. All these options mean that renewable resources may find uses in every major energy-consuming sector: residences, businesses, industries, and vehicles.

Finally, the modularity of much renewable energy equipment allows it to be added in comparatively small increments. This results in shorter lead times, fewer planning uncertainties, and comparatively smaller capital outlays over relatively short time periods. In rapidly changing and uncertain energy markets, this modularity offers significant economic benefits to both energy producers and consumers. It permits a ready matching of supply and demand requirements.

The Significance of Exports. A multidepartmental Federal effort is being made to enhance U.S. exports of renewable energy technologies. Their competition in international markets has long-run strategic implications for the level of oil demand in less developed countries, for the U.S. balance of trade, and for technological leadership by this country. The Committee on Renewable Energy Commerce and Trade, created by the Department of Commerce under the Renewable Energy Industry Development Act (Public Law 98-370), is working to eliminate barriers to such exports by developing mechanisms to educate foreign buyers, developing data bases to ease the cost of export marketing, and establishing trade fairs for U.S. products. Broadening the market potential for U.S. firms involved in various forms of renewable energy should have domestic implications as well. Production in greater volume can help to cut manufacturing costs, sharpen the technology itself, and generally make renewable energy more competitive in domestic energy markets.

Alternative Fuels

More than 75 percent of the Nation's end-use energy is consumed now by vehicles and equipment that are capable *only* of using liquid or gaseous fuels. Even though industrial use of coal is projected to increase, and although further electrification of the economy can be based largely on direct coal-burning and nuclear generation, the share accounted for by liquid and gaseous fuels seems likely to remain above 70 percent into the next century.

In absolute terms, the reference case projection for NEPP shows the Nation deriving between 10 and 15 percent more energy from liquid and gaseous fuel forms in the year 2000 than it does now—even excluding consumption by electric generating systems. With petroleum and natural gas

representing the smallest part of our domestic resource base, a key question obviously is: Where will it all come from?

Research and development in the production and utilization of other gaseous and liquid fuels are key elements in achieving the diversification needed for a stable energy future. Thus, although the Administration's basic policy is to let market forces determine the rate and direction of alternative fuels' commercial deployment, the Department of Energy continues to direct a limited program of supportive R&D.

A separate entity, the United States Synthetic Fuels Corporation, awarded financial assistance under its congressional mandate to three demonstration projects using commercial equipment. One of those projects involves the integration of coal-gasifying equipment with a combined-cycle utility turbine, another deals with synthetic gas alone, and the third has to do with heavy oil recovery.

Research at DOE has ranged from investigating selected elements of advanced production technology for shale- and coal-derived fuels to characterizing material and operational problems for alcohol fuels in vehicles. The eventual commercial development of such fuels, whether it involves a large-scale production facility for shale oil or the retail marketing of methanol made from natural gas, is best left to the marketplace. As individual alternative fuels become more competitive economically, market-based decisions regarding their production and utilization can and will be made. Ethanol based on grain, for instance, is already commercially significant as an additive to conventional, petroleum-based gasoline. However, it is clear that, without subsidies, most alternative fuels cannot yet compete in the market for anything beyond specialized use and testing. This is particularly true for "synthetic" fuels (defined statutorily as excluding those produced from biomass). There the necessary subsidies amount to several billion dollars for almost any project of the size generally regarded as "commercial."

The Administration has chosen to concentrate instead on certain smaller projects and on research and development in promising technologies for synthetic fuels that are not yet ready for commercial-scale use. By helping to develop the basic knowledge needed for the safe and efficient expansion of a sound synthetic fuels industry, this approach lays a firm foundation for the point in the future when various "new" fuels become competitive. That time has clearly been delayed by recent drops in the world price of crude oil.

Of the three commercial synthetic fuels projects for which DOE assistance was approved in 1981, one was canceled by its private sponsors at no cost to the Government, and another has received no Government funds because it has not produced commercial quantities of fuel. The third, the Great Plains Coal Gasification Project, is producing pipeline gas on a commercial scale; but the project currently is being operated by the Department because its industrial sponsors ended their participation and defaulted on approximately \$1.5 billion in federally guaranteed loans. DOE is still looking at various options for the eventual disposition of this facility.

The Department's work on alternative fuels in general is built around a *market* determination of winners or losers. Ethanol, methanol, and compressed and liquefied natural gas (CNG and LNG) are all commercially available, with production and utilization technology largely developed already. The Environmental Protection Agency and other potential regulators have taken steps recently to clarify the health and safety requirements that will be relevant in the use of these fuels, thus reducing some uncertainties that might impede their penetration of the transportation market. DOE continues to carry out various legislated programs for production subsidies on ethanol, to conduct limited research and development on technical barriers affecting methanol, CNG, and LNG use, and to manage the methanol demonstration program in the Federal motor vehicle fleet. DOE also will continue to provide an important forum for the exchange of information and ideas on technical and policy issues related to alternative fuels across the board.

V. SOURCES OF UNCERTAINTY

One great defect of trying to follow the earliest national energy plans, built around numerical targets rather than principles, was that numbers are constantly changing. The United States imported only about half as much oil in 1985 as had been projected for this year by the National Energy Plans of 1977 and 1979. The 1981 NEPP projections of the world oil price in 1985 were nearly double the level that ultimately prevailed this year. Because of changing circumstances, even the midrange projections for 1985 that were made just 2 years ago for the fourth NEPP proved to be off by an appreciable amount.

Various sources of uncertainty are still on the horizon. For example, policy planners need to be wary of possible changes in the international vista. They must recognize that relations between energy and the environment are still evolving. They know that the practical fruits of research and development defy any effort to harvest them on a fixed schedule.

The International Context

The overall goal of U.S. international energy policy is to maintain a stable and secure world energy environment, recognizing the interdependence as well as the independence of nations, and the need to accommodate (or bolster, whenever possible) broader national security interests. The international context is typically volatile, but its energy aspects have clearly improved in the 1980's.

In the 12 years since the Arab oil embargo, there has been a fundamental restructuring of the way in which energy is supplied and used in the world economy. The free world's dependence on Mideast oil—and its vulnerability to interruptions of those supplies—has declined dramatically.

The sharp oil price hikes of the 1970's—coupled with increased reliance on market forces to determine supply and demand, and with reduced reliance on government regulation and other intervention—have resulted in lower world oil consumption and increased consumption of energy from sources other than oil. In 1984, oil accounted for about 46 percent of total free-world energy demand, compared with about 53 percent in 1974.

Non-OPEC oil production has increased steadily, primarily in the North Sea, Mexico, and the Soviet Union. Production is also up noticeably in Brazil, Egypt, India, Malaysia, and Oman, among others; and new oil resources are under development in such places as Colombia, Yemen,

and China. Moreover, the production of crude oil and natural gas liquids in the United States has increased by more than 8 percent since reaching its most recent low point in 1976.

The combined effects of declining oil consumption and non-OPEC production gains have been dramatic. While OPEC's share of world crude oil production was falling from 56 percent in 1973 to about 30 percent in early 1985, non-OPEC crude production was increasing by 50 percent. OPEC crude oil production fell during 1985 to its lowest level since 1967—to only about half its 1977 peak.

As a major producer and consumer of energy, the United States has an important leadership role in continuing to enhance international energy security. The Reagan Administration has acted to promote a strong, viable energy industry within a free-market economy—in an effort to ensure that this country need never again become as vulnerable to foreign supply disruptions as it was in the 1970's. U.S. vulnerability to disruptions is *not* simply a function of the oil import level. To reduce vulnerability, the Nation has dismantled the controls that caused the gasoline lines, built a Strategic Petroleum Reserve (SPR) of nearly 500 million barrels, diversified its energy base, taken a leadership role in creating and sustaining the International Energy Agency (IEA), and maintained a strong role in the Nuclear Energy Agency (NEA) and the International Atomic Energy Agency (IAEA), as well as undertaking numerous bilateral initiatives.

The United States' international energy security policy is based on and reflective of its domestic energy and economic policy strategies:

- Reducing government intervention, to allow markets to function more freely.
- Promoting a balanced and mixed system of energy resources through diversification to coal, nuclear, and new technologies.
- Diversifying supply sources, with emphasis on more trade among members of the Organization for Economic Cooperation and Development (OECD), and on greater development of indigenous OECD resources.
- Encouraging greater international stock buildup and coordination of plans among IEA members for early stock drawdown in the event of a major supply disruption.
- Improving international collaboration on research and development that relates to energy, through early

consultations and joint program planning to promote economic efficiency.

Cooperation Through the International Energy Agency. The United States has worked within the International Energy Agency to develop a consensus on issues of energy trade and cooperation. At the July 1985 IEA meeting, the Ministers agreed—at U.S. urging—that countries with restrictions on the importation of refined products should remove these barriers “expeditiously,” that all countries should refrain from imposing any additional barriers, and that the IEA will “closely monitor” this agreement by tracking member-country product imports. The Ministers also agreed:

- To maintain adequate oil stock levels; to coordinate early use of stocks in case of a crisis.
- To implement all aspects of the Agency’s 1983 “Conclusions” on natural gas supply security.
- To expand further—on an economic basis—the production, use, and trade of coal.
- To negotiate an agreement on streamlined licensing procedures for nuclear plants, standardized designs for such plants, and nuclear waste management programs.

With regard to research and development, the IEA Ministers agreed that enhanced international collaboration would increase common energy security and the cost-effectiveness of research. New actions are anticipated in connection with the clean use of coal, in advanced techniques for exploiting energy resources, and in energy-technology information systems. These will supplement the ongoing activities in fossil fuels, renewable energy, fusion technology, and greater energy efficiency. Such collaboration should be most effective when it begins at an early stage of the R&D activities, so the member countries have committed themselves to the concept of jointly designing new programs, and of allocating research tasks among themselves in advance.

Other Multilateral Coordination. The United States also works through the Nuclear Energy Agency and the International Atomic Energy Agency to promote a safe and reliable international nuclear industry, to advance non-proliferation goals, and to increase international cooperation on spent nuclear fuel storage and nuclear waste disposal. The United States continues to support the development and improvement of an international nuclear nonproliferation regime, which has been strengthened by the success of the Nuclear Non-Proliferation Treaty Review Conference held in Geneva during August 1985. Such an effective program is essential if the dual goals of increased U.S. nuclear trade and the prevention of the spread of nuclear weapons are to be achieved. Strong support is being given by this country to the safeguards and other programs of the IAEA. For example, the U.S. Government’s recent, carefully constructed agreement to allow U.S. companies to supply nuclear equipment to the People’s Republic of China (PRC) ensures that the PRC will receive advanced nuclear technology only under adequate safeguards. (There was already ongoing cooperation between the two countries in other energy fields; and this is also being nurtured.)

This country opposes any form of multilateral producer-consumer dialogue on energy trade—formal or informal. Such meetings would inevitably deteriorate into confrontations and sterile debate on pricing and production policies—topics best resolved in the marketplace.

Bilateral Consultations. Through consultations with individual energy-producing and energy-consuming nations, the United States continues to point out to its trading partners the value of the free market in providing a productive and stable energy milieu. Wider markets are being opened in this fashion for U.S. technology and for our petroleum products, coal, natural gas, and uranium enrichment services.

U.S. energy trade with Japan is being promoted through a U.S.-Japan Energy Working Group, which meets about twice each year to discuss trade prospects for oil and oil products, coal, natural gas, and other energy sources. The U.S.-Japan Energy Experts meet before each Working Group meeting to prepare information and recommendations. A U.S.-Korea Energy Subgroup also discusses energy trade and cooperation regularly.

The United States has recently signed agreements with the United Kingdom and with Italy to cooperate on a number of fossil fuel research and development projects. This country has agreed specifically to exchange data with British research institutions—an agreement that will include the United States’ Office of Scientific and Technical Information at Oak Ridge and Britain’s National Coal Board. During 1985 the Department of Energy also agreed to an exchange of research and information on coal combustion with Australia, Canada, and the Netherlands.

In the nuclear area, there is substantial international cooperation of long standing. In regard to nuclear fission, joint work that is consistent with domestic program interests is continuing, via many bilateral agreements, on improved safety and safeguards, advanced reactor technologies, fuels and materials with potential applications to breeder reactors, waste disposal, and decommissioning. Within Federal budget constraints, these efforts will go forward. This Administration also supports the joint design efforts that have begun in such areas as thermonuclear fusion, high energy physics, and breeder reactors.

The United States is also collaborating on nuclear waste disposal with those that do not produce nuclear weapons, including Sweden, Switzerland, Canada, the Federal Republic of Germany, Egypt, Indonesia, the Netherlands, Mexico, Korea, and Taiwan.

Canada/Mexico Outlook. The international energy policy of the United States involves special considerations in respect to our two closest neighbors.

Canada is currently the only country exporting natural gas to the United States. These imports supply nearly 5 percent of the total U.S. annual consumption of gas. In recent years, Canada’s market share in the United States dropped substantially because of noncompetitive pricing practices. However, during the past 2 years both governments have announced policies aimed at reducing each government’s role in the market and restoring competition in the natural gas industry.

In the past year alone, contracts renegotiated under the revised Canadian export policy have increased Canadian gas sales to the United States substantially. Comparing the first 9 months of 1985 with the same time period in 1984, Canadian export sales have increased approximately 27 percent. The Canadians project that by 1990 their annual exports to the United States will return to about 90 percent of authorized volumes.

As noted in the section of this document dealing with electricity, an increasing volume of energy is also being imported from Canada in the form of electricity. In 1984 this amounted to 1.6 percent of total U.S. electricity consumption. While 1.6 percent is not a significant amount overall, far larger portions of their respective electricity requirements are being purchased from Canada by certain regions of the United States. So long as such purchases continue to be based on free economic choice, the Administration regards this as a healthy expression of mutual confidence between good neighbors—potentially beneficial to both.

Mexico is one of the oldest suppliers of petroleum to the United States. Since 1982 it has also been the largest—providing an average of more than 750,000 barrels per day, or about 15 percent of the import total in most years. Generally, the outlook for Mexican exports of petroleum to the United States is for continuation of current levels. Mexico's policies to conserve existing reserves, to promote international market stability, and to limit its dependence on the U.S. market are factors that constrain any sizable increase in oil supplies to the United States, at least in the near future.

Emergency Preparedness. The objectives of this Nation's energy emergency preparedness policies have international ramifications. By ensuring the security of U.S. energy systems, supplies, and resources against potential threats—including disruptions in world oil production, acts of hostile governments, natural disasters, sabotage, and terrorism—the United States is prepared to ensure adequate energy supplies in emergency conditions for defense needs and for our treaty obligations, while minimizing negative effects to our own economy.

The Strategic Petroleum Reserve is central to the U.S. strategy, and the Reagan Administration has increased the amount in storage to nearly half a billion barrels—more than four-and-one-half times the amount stored in December 1980. As noted in the section on oil, this is enough oil to replace approximately 120 days of all U.S. oil imports at current rates.

The Administration announced last year its policy of early sale of SPR oil in large volumes in the event of a supply disruption. This procedure would substantially reduce the hoarding and panic buying that helped create shortages and drive up prices during the past two oil disruptions.

The Department of Energy is examining and testing a variety of drawdown strategies to ensure that SPR oil can be made available to private oil users as soon as any serious supply disruption takes place. For such a policy to succeed, coordination with IEA partners is crucial, and IEA members in July 1984 agreed to a mechanism for coordinating the

early drawdown of emergency oil stocks and complementary measures, and on the need to improve their oil-stock positions. The Administration supports continued planning and readiness tests for an energy emergency, and DOE regularly participates in NATO and other military mobilization tests.

Because of the wide and unpredictable range of possible threats faced by the Nation's energy systems, DOE is now developing a flexible system to respond to energy emergencies of any type. The Administration continues to place primary reliance on the marketplace to respond to disruptions of energy supplies. This is coupled with policies and procedures for:

- Using the Strategic Petroleum Reserve most effectively.
- Fulfilling U.S. commitments to NATO, the International Energy Agency, and other allies.
- Coordinating with State governments and industry.
- Assuring Congress, State and local governments, and the public that they will receive timely, accurate information concerning the situation as it develops.
- Coordinating the policies and programs of the various Federal departments and agencies in the event of an energy emergency.
- Ensuring the adequacy of energy supplies to meet defense needs.
- Assuring the Nation that military and diplomatic responses, should they become necessary, are based on the best available assessments of the nature of the energy emergency and the ability of the United States and of its allies to cope effectively with the situation.

Environmental Effects of Energy Production and Use*

It is possible to progress toward energy and environmental goals simultaneously, and the United States is becoming more effective at doing just that. For example, a wise energy course for the Nation is to encourage the use of coal because of its abundance; yet burning coal has prompted apprehensions about emissions of sulfur dioxide and nitrogen oxides (both pollutants associated with acid rain concerns) and particulate matter. At present, both energy and environmental objectives are being advanced, as shown by the actual data of the 1980's. Between 1980 and 1983, nationwide coal use in electric powerplants *increased* by 10 percent while electric utility emissions of sulfur dioxide *decreased* by 10 percent. Furthermore, these trends have persisted generally since the early 1970's, following the implementation of the Federal Clean Air Act and the impacts of the first "energy crisis." Similar trends apply to total coal consumption and total sulfur dioxide emissions.

After World War II, this country experienced increasing emissions of pollutants. Since about 1975, however, that

*This section will be supplemented by a technical report to be issued separately.

situation has been reversed for a variety of air pollutants, as Figure V-1 shows. These gains were accomplished while domestic energy production and use were adjusting to the requirements of a growing and changing economic base and to major structural adjustments in energy supply and demand.

U.S. environmental protection programs have long been recognized internationally as effective pioneering achievements, and this country continues to lead the world. For example, the Western European nations are now engaged in debates over how to control nitrogen oxides, volatile organics, and lead compounds from automobiles. Results anticipated from their most stringent proposals approximate the U.S. regulations adopted for 1981 model-year automobiles.

Among the most universally debated new environmental concerns have been past and present practices for the disposal of toxic and hazardous wastes. Legislation in 1976, which was extended in 1984, set up a strict regulatory framework for accounting for and disposing of hazardous wastes. Thus, the present and future production and disposal of hazardous wastes should not be the threat to human health and surroundings that some past waste disposal practices became.

Time and time again during the past decade, communities have found a legacy of danger that arose subsequent to past waste disposal that was believed in its time to be appropriate. Because of these discoveries, national legislation in 1980 (to be expanded in 1986) has been developed to allow authorities

to find again and clean up old dumps and landfills that have become present dangers.

The Federal Government is determined to demonstrate leadership in this area. For example, over the next 2 years the Department of Energy will survey all of its land holdings, including some that may have dumps that were in use 40 years ago. This survey will identify all potential health and environmental threats that exist because of past and present waste disposal and pollutant releases. DOE will carry out corrective action where necessary.

The coming years will see an extensive debate on how the States and the Nation can best protect the quality of groundwaters. This debate is expected to lead to development of effective underground monitoring systems, so that leachates from environmentally unacceptable waste disposal sites can be identified and remedial cleanup initiated.

Environmental regulation often increases the cost of energy production and use. It has delayed or even prevented energy-related projects, sometimes with good reason. By limiting flexibility, past environmental regulation has also affected some choices of fuel and technology in ways that were detrimental to energy security and regional economic stability. A small difference in the degree of required environmental improvement associated with one pollutant may prevent industries from using a new technology that has several advantages over conventional technologies for several pollutants. Clearly, emerging technologies will depend on a more flexible regulatory response.

Balancing Diverse Goals. Experience with the results of environmental regulations has shown that they can be effective, but they are expensive. According to Environmental Protection Agency (EPA) estimates, Federal regulatory programs have imposed costs on the U.S. economy of \$820 billion since 1970.* While analysis of many environmental regulations estimates benefits above costs, the method or degree of regulation in some other cases would not appear to be justified, considering the great costs.

The electric utility industry provides an example of how a strict new regulation set by legislative requirements can cause greater use of older, more polluting units (although other factors also contribute). The Clean Air Act requires utilities to install expensive scrubbers on all units built after 1978. Because the increasing costs of new plants—including capital, interest, and the cost of flue-gas desulfurization equipment—give the utilities added incentives to extend the useful lives of older boilers, it is estimated that the majority of utility sulfur-dioxide emissions until the year 2010 will be from these older plants. A more effective control program would be to reduce sulfur-dioxide emissions from all units, using least-cost measures to achieve justified benefits of sulfur-dioxide reductions.

Figure V-1. National Air Pollutant Emission Estimates, 1940-83
(million short tons per year)

*Cumulative capital and annual cost for air and water pollution control, 1970-84. *The Cost of Clean Air and Water; Report to Congress, 1984*, Environmental Protection Agency (EPA-230-05-84-008), May 1984.

Recognizing the often high cost of environmental benefits, EPA is aiming to increase environmental protection while energy and economic goals also are being attained. It is developing more efficient regulatory processes that are generally divided now into risk assessment (that is, development of information on risks) and risk management (that is, implementing programs to reduce risks and maintain them at acceptable levels).

While regulatory management models deserve refinement, steps also should be taken to perfect the legislation that authorizes these environmental regulatory programs. Here are three examples of changes if the principles of balance and procedural efficiency are applied to elements of the Clean Air Act during the ongoing congressional reauthorization. New source permits (Best Available Control Technology) might be set that are equivalent to already established New Source Performance Standards for large facilities, speeding the permitting process and simplifying early planning. Procedures for protecting clean-air-quality areas from significant degradation could also be streamlined without weakening protection. The "bubble" concept of managing air emissions might be applied more widely to cut both local-area pollution and the associated control costs. EPA has initiated use of bubbles or emissions trades for some instances between older emissions sources. Further, EPA is developing new policies that may provide increased use of bubbles that are within the current authorities of the Clean Air Act. Through legislative action, this innovative concept for reducing control costs can be extended, with no sacrifice in environmental protection.

In situations where there is a need to balance energy and environmental goals, it is appropriate to apply cost/benefit and risk analyses encompassing the full spectrum of national and regional interests. That requirement was formalized for all Federal regulation (not just in relation to the environment) in Executive Order 12291 (issued February 17, 1981). It can be summarized by quoting just a few words from its general requirements: "To the extent permitted by law, . . . regulatory action shall not be undertaken unless the potential benefits to society for the regulation outweigh the potential costs to society." Simple to state . . . continually challenging to implement. But it is succeeding.

Improved Environment Through Multiple Fuel Options. Environmental protection means more than environmental regulatory and legislative programs alone. The Administration's concern for environmental integrity is also reflected in its policy for increasingly free competition among energy sources. Programs for each fuel cycle have potential to improve the environment and reduce human exposure *as well as* to meet energy goals.

For instance, the full deregulation of natural gas would increase supply and use of this especially clean fuel. Emissions from future economic growth could be moderated; and, in facilities where fuel substitution occurred, pollutant emissions would be reduced.

Federal efforts to increase coal use include major research efforts to make the new coal-using technologies cleaner as

well as more efficient. Coal-use R&D efforts are not only for larger new industrial and utility boilers, but also for smaller applications such as commercial heating units. They also are directed at developing more cost-effective retrofit technologies.

Broad use of nuclear powerplants would also facilitate electricity production with greatly reduced air pollutant levels and with smaller volumes of bulk waste as compared to conditions when only fossil fuels are available. Progress in effective management of the nuclear wastes continues.

Further reductions in emissions and effluents also will be seen as more renewable energy options become commercially viable. Furthermore, by reducing energy production needs overall, economically sound energy conservation clearly lessens most of the associated environmental impacts. In this latter connection, concerns about air-quality levels within rooms and closed areas with reduced ventilation are also being addressed. Mitigation processes and equipment are available now, and they are being improved. Focusing on fundamental understanding and basic technology, the pertinent Federal R&D program has dealt recently with more than how to control pollutants after formation. Many of its more promising developments are initiatives to redesign products and manufacturing processes; many of these will minimize the production of pollutants to begin with.

Cogeneration of electricity has enjoyed considerable success whenever favorable pricing for it has been available under the Public Utility Regulatory Policies Act. Its use could be further stimulated if these plants could derive some environmental credit for their increased energy efficiency. This could be achieved by specifying allowable emissions on the basis of useful energy output rather than on the *input* of energy to the boiler. Cogeneration installations might very well increase—increasing national energy efficiency. In endeavoring to protect the environment, it is important to examine (and strive to minimize where feasible) the total impact from the full spectrum of operations—from fuel extraction to atmospheric emissions.

The Acid Rain Issue. Careful analysis should precede the enactment of all new environmental regulations if they are to be effective and efficient. It is equally essential to have a clear understanding of causal factors; and this is why, for example, the Reagan Administration has increased funding for acid rain research each year to the present, the midpoint of a 10-year research program mandated by the Energy Security Act of 1980. In 1986, government-wide funding of such research will continue to increase—to a level nearly 5 times the amount budgeted 4 years ago.

While there is a consensus that much of the eastern United States and southeastern Canada are experiencing acid deposition from natural and manmade sources at rates in excess of that expected from a pre-industrial atmosphere, there is no agreement on whether the acidity of precipitation has been increasing or decreasing in recent years . . . on the extent of damage to terrestrial and aquatic life . . . on whether existing

controls on acid deposition precursors* are adequate . . . or on whether the benefits of another emissions control program is worth the costs. For these reasons, the Administration believes that a better understanding of the acid rain phenomenon is needed before new decisions can be made on whether, when, and how to increase further the control of pollutants that contribute to acid deposition. The Administration continues to support a strong acid rain research program, accelerated efforts to develop improved control technologies, and mitigation programs such as liming for waters that are known to be acidified beyond a certain point. The Administration has pledged to craft and support an appropriate control program as soon as the research program provides the information needed to do so. Five years of research have been productive, in that quite different insights exist now as to the extent and trends of threats and the likely impacts of various pollutant-control proposals.

Summary. It is important that the past gains in air and surface water protection be maintained, and that similar programs be fully developed for waste control, protection of groundwater, and reclamation for surface-mined areas. Several of the Administration's agencies are instituting major new programs to characterize and mitigate problems from past waste disposal practices at their facilities. However, it is equally important that future environmental gains be made based on efficient, cost-effective programs that have been subjected to detailed analyses of costs, risks, and benefits for all national goals and interests.

Research and Development

Examples of success stories from the pursuit of Federal-private research programs in energy are sprinkled throughout this document. A much fuller summary account of them is given in the annual reports of the Department of Energy. Almost any newspaper or news magazine is apt to contain descriptions of how the scientific and engineering innovations of a freer marketplace are making the U.S. energy outlook stronger, more stable, and more secure daily. Yet true technological breakthroughs cannot be penciled in on the calendar in advance. The rate of new *technical* discovery is highly uncertain, just as is the rate of new energy *resource* discovery.

What is the Federal Government doing to optimize the odds of good progress in respect to energy R&D? Overall, this Administration set five basic objectives:

- To advance scientific and technical knowledge, which is the foundation for technological innovation.
- To support academic research for the development of basic knowledge.

- To sponsor cooperatively with industry long-term, high-risk research efforts that are unlikely to be undertaken alone by the private sector.
- To help train scientific and technical personnel by supporting university research programs.
- To facilitate the effective transfer of technology, making the results of research and development available widely and promptly in the marketplace.

Research and development are financed and conducted by private firms as well as by the Government. When R&D efforts pay off, the United States as a whole becomes more competitive in international markets. Its national security and quality of life are enhanced.

Federal funding for basic scientific research related to energy increased over the past 5 years; and meaningful R&D has been directed to all sources of energy services—renewables, conservation, fossil, nuclear, fusion, and alternative fuels—focusing as well as on the effects of energy activity upon human health and the environment. Besides the expected areas of engineering, chemistry, physics, and materials science, it embraces the geosciences, biology, and applied mathematics.

Research and development of energy technologies usually advance through successive phases: basic research, applied research, proof-of-concept, process development, and commercialization. At each phase, a judgment must be made about the level and pace of Federal support. At each phase, progressively larger investments of money and talent are required, with funding requirements increasing most sharply in the later phases of large-scale demonstration plants and commercialization.

This Administration's policy from the start was to focus on the earlier phases of the process, calling on the market to determine the economic feasibility of the later, more expensive phases. This approach enhances Federal flexibility and responsiveness. History has shown that the Federal Government does not have the necessary expertise, motivation, and approach to do the best job of selecting the exact mix of technologies that will finally gain market acceptance.

The most productive areas of concentration for Federal research and development are those in which private investment is not available and where the incentives for it are severely limited or nonexistent—despite opportunities for important gains if programs reach identifiable goals eventually. In such areas, private firms cannot normally count on competitive rates of return on investment. Without them, they do not invest; and if it were not for Federal action, the opportunities would be lost to the Nation.

Traditionally, the results of government R&D are transferred to the private sector through a variety of mechanisms that include publications, symposia, advisory boards, peer reviews, Federal laboratory access, and good patent policy. Besides making the data from federally funded generic research and development activities readily accessible to private entrepreneurs, innovators, businesses, and industry, these government activities also facilitate transfers of technology within the private sector.

*Sulfur dioxide, nitrogen oxides, and volatile organic compounds. See Figure V-1.

All of this country's domestic resources should be considered in a balanced and mixed energy system. Another part of Administration strategy, however, is to foster and develop the related technology that may be needed to use these various resources in effective and environmentally acceptable ways.

Federal research will continue to draw on the creativity and insight of the Nation's total scientific resource, through several thousand individual projects carried out at laboratories, universities, and other research facilities throughout the United States.

A program of basic research that simply strives for excellence serves another important national purpose. It provides needed opportunities for our youth to excel in various scientific disciplines, and it helps ensure that the Nation will have the technical talent to explore many scientific and technological frontiers.

Supercomputers, high energy physics, basic properties of materials, and biotechnology are areas where knowledge should especially be pursued. Research in magnetic fusion, breeder reactors, and advanced solar energy systems should be continued—either until they become practical energy sources, or until it is clear that they will not be . . . and that there are no compensating scientific benefits to be gained

from continued research in a given area. Until such bounds have been tested, serendipity (that is, discovering something quite valuable that wasn't the specific original goal of the quest) is a worthwhile and not uncommon outcome of study that should not be discarded lightly.

The Nation has already derived beneficial "spinoffs" from Federal support of basic research and development in high energy physics, nuclear physics, basic energy sciences, magnetic fusion energy, and biological and environmental sciences. Recent research has advanced the technology of superconductors; it has improved understanding of high-temperature alloys for both energy and nonenergy applications. Research on diagnosis and treatment through nuclear medicine has changed the whole practice of the healing arts, by reducing the need for invasive procedures and exploratory surgery—making hospital stays shorter, less painful, and less dangerous.

Basic research should continue this productivity, by broadening our understanding of fundamental processes and by adding to the available technological base. This, in turn, is likely to continue laying groundwork for improved or new energy technologies to be developed by the private sector. Only the *timetable* is—and must remain—a source of uncertainty.

VI. SUMMARY OF CURRENT PROJECTIONS

Wide swings in the cost of imported oil over the past dozen years have made U.S. energy forecasting a very difficult and imprecise task; but world markets appear to have established bounds on the value of energy resources—especially oil—in relation to other economic goods. The large oil price increases of 1979-81 proved to be unsupportable. Oil consumers found ways to use less oil while resuming economic growth. Fuel switching, increased non-OPEC production, conservation, and better management of energy use have continued the downward pressures on world oil prices.

At its peak in early 1981, the price of imported crude petroleum was nearly \$46 per barrel (in 1984 dollars), but that appears to have been far more than the world economy was willing or able to pay. OPEC's sales shriveled; and its oil production dropped from a high of about 31 million barrels per day during the late 1970's to less than 23 million barrels per day in 1981 and to a current level of about 16 million barrels per day. Meanwhile, the OPEC share of world oil production has declined from a high of 56 percent to only 30 percent. Oil prices are down about 40 percent in real terms from the 1981 peak, and they appear to be headed even lower within the next few years.

Artificially high oil prices accelerated market responses that promise long-lasting effects on the world energy system. Results of the ensuing search for additional energy resources suggest a much broader worldwide distribution and abundance of economically recoverable oil and gas than had been estimated earlier. In addition, the high oil prices encouraged powerful new price-restraining conservation trends—the full effects of which will be realized only over a couple of decades, as stocks of automobiles, houses, and energy-consuming industrial machinery are gradually replaced by more efficient models. Beyond 1990, increasing demand on energy resources by the economies of the world, improved standards of living, and growing populations all are expected to exert fresh upward pressures on energy prices. The net result is likely to be gradually rising prices in the 1990's, unless they can be offset by further advances in the techniques of resource recovery and use. This general trend, involving a balance of conflicting price pressures, is expected to continue into the next century. In the United States specifically, free-market efficiency should stimulate energy production, conservation, and the continuing process of innovation and technology improvement—making it easier to meet the continuing national goal of adequate energy supplies at reasonable costs.

The specifics of future energy prices, production, and consumption are very uncertain. The projections here (summarized in Figure VI-2) do not purport to represent Administration policy or the views of the President or the Secretary of Energy, but are presented in compliance with Public Law 95-91 as projections derived from mathematical modeling processes. For comparison purposes, the actual source and use data for 1984 have been depicted in similar graphic fashion in Figure VI-1. Future projections produced in conjunction with the fifth National Energy Policy Plan are being published in far more detailed tabular form, with comparable historical data, as a separate technical report, *National Energy Policy Plan Projections to 2010*.

A different set of projections, using different assumptions and its own approach, also is published each year by the Energy Information Administration (EIA), an independent unit within the Department of Energy, in its *Annual Energy Outlook*. One notable difference between EIA's projections and those for the 1985 National Energy Policy Plan is that the latter include historical data and projections for biomass (chiefly wood)—which thus far have produced a discrepancy of 2 to 3 quads in a typical year. NEPP also makes long-range projections for specific individual energy sources whose contribution now is quite small (for example, wind, solar, and the like).

The projections summarized here involve a considerable amount of judgment. As with other government and private projections, it is impossible to correctly anticipate all the important qualitative factors that might influence future energy markets—such as political events, consumer behavior, or policy changes. Therefore, to make the NEPP study more useful as a point of departure for understanding future energy developments, it developed several alternative scenario projections based upon different assumptions about economic growth, energy resources, and energy use trends. For the sake of simplicity, only one set of projections (the "reference case") is cited here.

Despite all the uncertainties, the NEPP reference projections and most other recent private and government energy studies tend to agree in their views about certain future energy trends:

- World oil prices will probably fall in real terms until the late 1980's, barring a significant oil supply disruption. Beyond 1990, the outlook becomes increasingly uncertain.

**Figure VI-1. U.S. Energy Sources and Uses in 1984
(quadrillion Btu's)**

Figure VI-2. Projected U.S. Energy Sources and Uses in 1995 (NEPP-5 Reference Case)
(quadrillion Btu's)

- The powerful energy conservation forces set in motion by the oil price increases of 1973-74 and 1979-81 will continue, especially restraining oil use. Despite temporarily declining prices, the long-term expectation of a resumption in price increases makes energy *conservation* as important as individual elements of energy *supply* in determining the U.S. and world energy future.
- Oil-price increases have provided—and will continue to provide—the key incentives for developing energy resources other than oil.
- The recent decline in world oil prices tends to make investment planners more cautious about the potential for future price breaks as well as price increases.
- Under all but extreme assumptions, the United States and most of the rest of the world will remain net oil importers, with OPEC a major source of supply for at least the next 20 years.
- Extensive additions to electric generating capacity will be required to meet the projected growth in demand for electricity over the next 25 years.

Energy Price Projections

As a result of the unexpectedly low demand for oil and increases in production by non-OPEC countries, world oil prices have declined since 1981. Demand for OPEC oil lessened because of increased non-OPEC oil production, oil conservation, fuel switching in response to successive price increases, lower industrial activity caused by a brief worldwide recession that followed the last round of OPEC price boosts, and worldwide drawdown of crude oil and petroleum product inventories. The key price question now is: How are current market conditions and trends likely to evolve, both in the near and longer term?

The NEPP model projects future oil prices to fall (in real terms) until the late 1980's, and then to rise. This means that, although quoted prices might fluctuate in the near term, the average real price (excluding any general inflation that might take place) is expected to be lower for several years. In the NEPP projections, oil prices are represented as following a relatively smooth path, but past experience suggests that the most likely price path will be more variable. Energy prices respond to economic conditions, unusually cold or warm weather, and other events that directly affect world oil demand and supply. Thus, each smooth price scenario should be viewed as an average of many equally plausible but variable paths. Year-to-year fluctuations are important, because they can increase the uncertainty of consumers and producers about the true state of long-term price trends. In any given year, the world oil price could be considerably above or below its underlying long-term trend.

Always using 1984 dollars, here are some highlights of the 1985 National Energy Policy Plan projections:

- By 1990, the world oil price is likely to be between \$20 and \$26 per barrel. This would be much lower than the \$42-per-barrel average real price that prevailed in 1980.
- Demand for OPEC oil is projected to increase for a while as world economic activity expands. OPEC exports are projected to increase from around 12 million barrels per day during 1985 to about 18 million barrels per day by 1990.
- Beyond 1990, world oil prices are extremely uncertain, but are projected in constant-value terms to reach between \$26 and \$34 per barrel in 1995.

In the longer run, the NEPP economic model portrays prices of this limited and nonrenewable resource as continuing to climb, but the emergence in the early 21st century of unanticipated technological changes may render the projections of dubious value.

All NEPP price projections show demand for OPEC oil exports after 1990 within the 17- to 25-million-barrel-per-day range. Higher demand for oil, unless met with a significant increase in OPEC production capacity, would run up against increasingly strict supply constraints, possibly leading to sharp price increases.

U.S. Energy Trends (Reference Case)

The NEPP-5 reference case assumes that this country's gross national product (GNP) will rise at an average rate of 3.9 percent annually from 1985 to 1990, increasing at a slower rate (2.3 percent) during the two decades beyond that. It assumes no major changes in existing environmental regulations or in the tax incentives provided by current law, but it does assume the acceptance of certain elements of current Administration policy: comprehensive decontrol of the natural gas market, increased rates of leasing Federal lands for energy development, and a focus of Federal research and development efforts on long-term development rather than subsidized commercialization. On this basis, the following directions are projected for the consumption and production of primary energy and for changes in the inputs for generating U.S. electricity:

Primary Energy Consumption. Historical U.S. energy consumption is readily explained in terms of energy prices, economic growth, and increased energy efficiency in response to higher prices. From 1950 to 1973, energy consumption increased by about 3.5 percent annually, or about the same as the growth in real GNP. After the sharp declines in 1974 and 1975 in response to the oil price shock, consumption increased again. It peaked in 1979 at about 81 quadrillion Btu's (quads) but declined thereafter, reflecting the response of increased energy efficiency to higher world

oil prices and full decontrol of oil in the United States. By 1983, consumption was down to about 73 quads.*

Although energy prices have been a major determinant of energy production, consumption, and trade, several other factors also have had significant effects. Pressures to maintain and improve environmental conditions have contributed to considerable fuel switching and to the decline of certain energy-intensive industries. The perceived risk of some technologies, such as nuclear power, likely will also continue to affect the Nation's future energy options. Structural changes in the U.S. productive economy—due in part to international competition—are yet another factor. While all these factors to some extent may be expressed in terms of capital and fuel costs, their total long-term impact on the size and composition of our energy system is far too complex to project exactly. At any rate, there always seems to be *some* link between GNP and energy use, even though the ratio of the relationship may change because of other factors. In 1984, total energy consumption in the United States was about 5 percent above that of 1983 (rising from 73 to 77 quads) in response to the demands of an expanding economy, which grew 7 percent.

Primary energy consumed between 1984 and 1995 in the reference case is projected to increase by about 1.8 percent per year. Thanks to technological conservation (ranging from better insulated buildings to more energy-efficient production methods and motor vehicles with higher mileage performance), this increase is significantly less than the projected 3.2-percent annual rate of U.S. economic growth during the same period. Nevertheless, assuming a healthy economy, this would amount to an increase in primary energy consumption during the period 1984-95 of about 20 percent—to 93 quads.

From 1960 to 1977, the United States increased its reliance on imported oil steadily. Imports peaked at just below half of this country's petroleum consumption in 1977, when a net influx of some 8.6 million barrels of foreign oil daily accounted for 24 percent of all the energy of all kinds used in the United States. After the reactions by consumers to higher oil prices and by domestic producers to oil market decontrol reversed this trend, net oil imports accounted for only 13 percent of total U.S. energy consumption by the end of 1984. By 1995, with real prices having been down for some time, U.S. net oil imports (by then about 6.8 million barrels per day) are projected to represent about 15 percent of total energy consumption.

*NEPP figures differ consistently from those that appear in the *Monthly Energy Review* and most other publications of the Energy Information Administration, in that EIA restricts itself to commercial energy sources, whose use can be measured precisely. NEPP also includes estimates of the dispersed use of renewable energy—primarily wood, both for home heating and as a fuel source in the forest products industry.

Energy Production. In 1984, domestic oil production (including the liquids retrieved from natural gas plants) reached 21.2 quads. This was the highest level since 1973. The combined production of oil and natural gas was about 39 quads, accounting for roughly 60 percent of total U.S. energy production (including fuelwood). Increased investment in oil and gas development is expected to maintain domestic production between 38 and 40 quads per year to 1990, after which oil and gas are likely to become increasingly difficult to find and develop at current prices unless there are unexpected discoveries of large quantities of oil or new technologies for enhanced recovery.

Coal production is projected to increase in absolute terms more than any other fuel between 1984 and 1995. In 1984, coal production increased about 14 percent above 1983 to reach a record level of almost 20 quads. By 1995, it is projected to reach about 26 quads, a further increase of 32 percent. This will result primarily from the increased market for coal in the generation of electricity. By 1995, nuclear energy is projected to increase by slightly more than 80 percent and renewable energy by nearly one-third, but both of these are building on smaller present bases. The joint contribution by 1995 from nuclear powerplants and from all types of renewable energy sources (including hydroelectricity) is estimated by the NEPP model at 15 quads.

Primary Inputs to Generate Electricity. Continuing a longtime trend, an increasing amount of primary energy is projected as being devoted to the generation of electricity for end-use in that form. In 1960, only 18 percent of the Nation's primary energy (including that of hydropower dams) went into generating electricity. The share had risen to 33 percent by 1984, and now it is projected to rise to 38 percent by 1995.

Coal's share of electricity generation is expected to vary only slightly between 1984 and 1995. Nuclear expansion is expected to slow temporarily in the early 1990's, once facilities now under construction are completed. However, the nuclear *share* of all electricity inputs is projected to increase—from 14 percent in 1984 to more than 18 percent by 1995—as those new plants become operational. The total amounts of oil and natural gas used to generate electricity in 1995 are projected to be about the same as they were in 1984, but this means that their percentage share would decline. The share of electricity generation provided by all renewables (hydropower, geothermal, wind, wood, and solar) is expected to remain fairly constant (at about 13 percent) between 1984 and 1995. During this period, however, hydropower's contribution to renewable electricity production at central station sites is expected to drop from about 95 percent to roughly 75 percent. The other one-quarter of total renewable electricity generation would come from all other renewables—with geothermal and wind energy vying for second place as the most important contributors in this category.

VII. PUBLIC COMMENTS ON THE NATION'S POLICY TOWARD ENERGY

In accordance with Title VIII of the Department of Energy Organization Act of 1977, the Department solicited public comments for consideration in preparing the 1985 National Energy Policy Plan through a *Federal Register* notice on July 31, 1984. The Department received 275 letters from Members of Congress, Cabinet and sub-Cabinet agencies, Governors, State and local government officials, trade associations and industry representatives, public interest groups, university and research organizations, and private citizens. In addition, 124 people testified at a series of seven public hearings that were held across the Nation—in Seattle, Los Angeles, Washington, D.C., Lincoln (Nebraska), Boston, Cincinnati, and Atlanta—during December 1984.

The commenters covered the full range of energy-related issues, offering both broad policy guidance and specific programmatic recommendations. Transcripts of the hearings and copies of the letters are available in the Department of Energy's Freedom of Information Office Reading Room in Washington, D.C. The comments, which do not necessarily reflect the views of the Administration, can be grouped into five broad issue areas and are summarized below:

Conservation

Commenters raised conservation topics more often than any others. Some commenters supported continued Federal funding of residential conservation and energy-efficiency programs, especially weatherization and improved conservation information programs. Some respondents expressed support for an extension of the conservation and renewable energy tax credits. Other commenters favored a more market-based approach, with market forces providing the necessary encouragement of the public's use of conservation measures.

Fossil Fuel and Environmental Issues

To support the strategy of a balanced and mixed energy resource system enunciated in the fourth National Energy Policy Plan, some commenters suggested development of Outer Continental Shelf oil and gas resources and Federal

eminent domain for coal slurry pipelines. Encouraged by the declines in natural gas prices since partial decontrol took effect on January 1, 1985, some urged full deregulation of natural gas. It also was suggested that energy policy development should include recognition of the long-term supply potential of conventional and unconventional natural gas sources.

Various commenters stressed that the National Energy Policy Plan should continue to acknowledge environmental concerns as an integral part of energy policy. Of particular interest was increased research into the problems of nuclear waste disposal and acid rain.

Renewable Energy

Some commenters suggested increased Federal funding for research in renewable energy, with specific support for development of biomass alcohol fuels to aid municipalities in solid waste disposal. However, other commenters supported primary reliance on market forces to guide the development of electricity generation based on renewable resources.

Emergency Preparedness

On the topic of emergency preparedness for an oil supply disruption, commenters ranged from those who favored no or minimal intervention in the market system to those who would increase the scope of emergency preparedness programs. There was general endorsement of the Strategic Petroleum Reserve in principle, although some commenters urged greater sensitivity to regional differences in import dependence—suggesting in some cases the development of regional reserves and Federal support for minimum inventory requirements for the oil industry.

Nuclear Energy

In the nuclear energy issue area, some commenters urged nuclear licensing reform and the removal of other institutional barriers to revitalize the nuclear industry; but others charged that the industry had already received too many benefits. Support was expressed repeatedly for extension of

the Price-Anderson insurance provision of the Atomic Energy Act of 1954. Greater attention to research for safe and permanent management of radioactive wastes was emphasized, and support was expressed for additional Federal expenditures for research and development in advanced small modular reactor technology.

The process of developing national energy policy benefits from a wide range of views on energy issues presented by commenters. The Department of Energy values the diverse insights offered and will continue to solicit public comment on national energy policy issues.