Chapter 1

INTRODUCTION AND OVERVIEW

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INTRODUCTION

The increased use of coal has become the focus of a national debate over the need for energy and the desire to maintain a healthy physical and social environment,

U.S. reserves of coal are vast, and the technologies of coal production and combustion are well developed Thus coal offers a major alternative to U.S. dependence on foreign supplies of oil However, coal development has a history of exploitation and turmoil in the coalfields of Appalachia, of cities laden with soot and noxious fumes, and of destruction of land and water resources Although an extensive regulatory system and other pressures have ameliorated many of coal's historic problems, it still retains potential for damage Many believe that rapid development of U S. coal resources cannot be accomplished without unacceptable damage both to the natural environment and to the communities where coal mining and combustion occur

Federal policymakers face difficult choices in dealing with coal's adverse impacts. On the one hand, strict controls almost always result in higher costs of mining and using coal. These costs may inhibit demand for coal and slow its pace of development Also, efforts to control one adverse impact sometimes cause another. For example, the scrubbers used to reduce sulfur oxide (SOx pollution produce large quantities of sludge that represent a land use and potential water pollution problem. Finally, gaps in our knowledge of the importance and causes of certain environmental effects create doubt as to whether all required control measures are necessary or effective. Failure to adequately control an environmental or health impact, however, may result in adverse consequences that outweigh the costs of control, These consequences may not be fully measurable in dollars and may take years to occur. In addition, the public opposition to new coal mines and powerplants aroused by a failure to control environmental and health impacts may be a more significant deterrent to development than are high prices. On the whole, Federal policy has tried both to encourage increased production and use of coal and to lower its environmental, occupational, and social costs, The attempt to write legislation and regulations that balance these two goals has been marked by controversy, with extensive litigation between environmental and coal development interests as one result.

This report presents the results of a broad study of the mining and direct combustion of coal. There are three major themes, The first is to determine coal's potential contribution to future U.S. energy needs. Next is an assessment of the environmental and social impacts that may result from rapid coal development. Finally, there is a guide for policy initiatives that Congress may consider in addressing a variety of coal-related issues. I n addition, the report provides information on impacts and on new technologies that should be useful for legislative oversight of Federal energy and environmental R&D programs. It identifies those impacts that have escaped the regulatory system and those that have been only partially controlled. In many cases, it also describes the means available to eliminate or mitigate these impacts.

Assessment of adverse environmental impacts is particularly controversial because information is lacking in critical areas. Many important issues will not be resolved conclusively for many years. Nevertheless, decisions on economic, environmental, and social policy to be made over the next few years will be based on this incomplete information. Hence, some of this report's conclusions are tentative, based on an evaluation of the existing evidence. For those areas where the evidence is particularly controversial, alternative arguments are discussed.

quences of coal use with either the use of other fuels or with energy conservation. No alternative to coal development is free of adverse consequences; these must be taken into account before coal "place" in the overall U.S. energy picture can be determined. Second, the report does not provide a complete and definitive accounting of the costs and benefits associated with coal mining and combustion, Not all costs and benefits are known or knowable, Often, they cannot be measured in the same terms. Therefore, the report attempts to identify the uncertainties surrounding the impacts described. The existence of high levels of uncertainty, as well as the strong role that personal values play in gauging the importance of impacts, clearly has profound implications for policymaking.

The report is organized as follows:

- Chapter I I surveys U.S. energy patterns and alternative forecasts of national energy demand and coal supply.
- Chapter I II describes the coal resource base and mining and combustion technologies. It also describes technologies available to control air pollution from coal combustion,
- Chapter IV analyzes the factors that will affect coal production and use, including leasing, industry structure, labor relations, regulatory restrictions, physical and economic constraints, and public attitudes.
- Chapter V describes the environmental and public health effects associated with mining and combustion under the current regulatory system.
- Chapter VI describes the occupational health and safety aspects of mining and the socioeconomic effects on communities that can be expected from increased coal use.
- Chapter VII reviews current legislation regulating coal production and use,
- Chapter VII I analyzes policy dilemmas that accompany coal development and outlines Federal policy options in the areas of environment and health, community impacts, labor-management relations, occupational health and safety, and coal leasing,

OVERVIEW

This overview focuses on the elements of the report most useful to policymakers. It discusses the reasons for expecting coal use to grow rapidly and the manner in which that growth may occur. It then describes the expected environmental and social impacts. These impacts have been addressed by a number of Federal policy initiatives. Because such Federal actions will influence future coal development, they are discussed in the context of all other factors that will affect coal production and use. Finally, policy options are outlined that might be considered either to encourage coal use or to curb remaining adverse impacts.

Energy and the Role of Coal

The importance of coal must be gauged in the context of the energy system of which it is a part. Both the demand for energy in general and the supply of other fuels will affect the use of coal. Energy demand depends on the efficiency of use and the level of demand for goods and services that consume energy. Rising population and real gross national product will increase demand, while increases in efficiency of use in response to higher prices and Government policies will reduce it. Most estimates of energy demand in 2000 fall between 100 and 150 quadrillion Btu (Quads), compared with 73.1 Quads used in 1975, The upper end of this range is becoming increasingly unlikely because of a leveling off of population, rapidly increasing efficiency of use, and indications that many of the goods and services that consume energy are reaching saturation levels.

Coal's share of future energy demand will depend on its availability, cost, and attractiveness as compared to alternative fuels, Total U.S. petroleum and natural gas production cannot expand much and may well decline by 2000 unless ways are found to tap presently uneconomical resources such as geopressurized gas Thus oil and gas are likely to continue to be discouraged as fuels for powerplants, leaving coal and nuclear energy as the only two commercial options for electric utilities. Nuclear power will expand rapidly as reactors on order are completed, but further growth faces uncertainties in public acceptance, costs, schedules, and (possibly) uranium supplies. Specific site characteristics such as proximity to coal and environmental factors will affect future selections As coal and nuclear are generally competitive, policy decisions affecting one may well influence the other.

Oil, gas, and electricity will be coal's major competitors in the industrial and residential/commercial sectors. Solar energy and other new fuels have great potential, but economics and the logistics of expansion may delay extensive use until the next century. Coal use by industry will be increased by legal restrictions on future oil and gas use. Requiring smaller users to shift to coal will incur problems of high costs and less effective pollution control. New technologies such as fluidized-bed combustion (FBC), thoroughly cleaned coal, and synthetic fuels may be necessary if small facilities are to increase greatly their use of coal The residentiallcommercial sector will be especially deterred by the inconvenience of delivery, storage, and ash disposal. Without rapid growth in central heating plants, the residential sector will only Slightly increase coal consumption as long as other fuels are available

Achieving a 150-Quad energy supply by 2000 would call for a very successful oil and gas discovery rate, substantial imports, an upsurge i n orders for nuclear powerplants, and an all-out expansion of coal Problems with any of these would preclude such a rapid expansion of supply.

Most energy scenarios assume a rapid expansion of coal. By 2000, production could be two to three times the present level. The regional distribution of production (in millions ot tons) for this range is estimated as follows:

	Year 1977	1985	2000
Surface mines			
Appalachia	185	130-155	130-175
Midwest	91	75-95	95-135
West	141	415-495	700-1,005
Total	417	620-745	925-1,315
Underground mines			
Appalachia	205	225-260	380-505
Midwest	54	60-80	120-180
West	13	50-60	80-110
Total	272	355-400	580-795
Total			
Appalachia	390	355-415	510-680
Midwest	145	135-175	215-3-15
West	154	460-510	780-1,115
Grand total	689	955-1,145	1,505-2,110

The sharpest increases in coal consumption will be i n the West-Central and Mountain regions. All regions east of the Mississippi (except New England) will sustain a more gradual growth in their already comparatively high consumption. By 2000, consumption will be much more evenly distributed than now with all regions except New England and the Pacific States burning large quantities,

The actual level and distribution of production and combustion will depend largely on the costs of production, transportation, and combustion. Surface mining is generally cheaper than underground mining. Large mechanized mines exploiting thick seams enjoy substantial cost advantages over smaller mines working thin seams. For example, new, western surface mines might produce coal at $5/ton while an Appalachian underground mine could have production costs of $30. The increasing share of Western coal will keep average coal costs down, but transportation costs can be significant if the shipping distance is more than a few hundred miles. Thus, Western coal is not necessarily competitive with Eastern coal for a particular site. Combustion costs depend on coal characteristics and the technology to accommodate them. For example, boilers burning high-sulfur or high-ash coals require more expensive control equipment. Coal characteristics vary widely even within a seam, but can be characterized roughly by region, In general, Eastern coal has a high heat content but often has a high concentration of sulfur. Midwestern coal is slightly lower in heat value and higher in sulfur, while Western coal is lowest in heat value and sulfur. These factors are weighed by potential users. Policy initiatives affecting these costs (e. g., limits on sulfur emissions) influence decisions of whether to use coal and where to purchase it.

Environmental Impacts and Controls

if coal does indeed stage the comeback that has been forecast, it will return to prominence in a manner vastly different from the way it dominated national energy use in the past. The availability of pollution controls, better combustion techniques, and new mining methods, coupled with enforcement of a wide range of environmental protect ion requirements, should prevent a repetition of much of the environmental degradation — soot-laden cities, scarred landscapes, ruined and discolored streams — that accompanied coal development in the past. However, despite the laws and new equipment and techniques, large-scale coal development may still be accompanied by substantial environmental impacts. Some of these impacts could result from inadequacies in the enforcement of the laws or in the environmental controls. Other impacts may result from the failure to regulate a damaging pollutant or to specify an adequate level of protection from a regulated pollutant. These kinds of failures usually result from inadequate knowledge: the inability to recognize a subtle but important impact, to connect a known impact to its correct source, or to determine properly the quantitative relationship between impact and source.

This very real deficiency in our knowledge of environmental processes makes it difficult to determine whether current plans for coal development could cause unacceptable environmental impacts. Some of the more spectacular impacts that have been attributed to coal development — for example, the warming of the Earth's atmosphere by increasing levels of carbon dioxide (CO_2) (a possible long-term effect), or the thousands of premature deaths attributed to the particulate sulfate products of sulfur dioxide (SO_2) emissions (an effect said to be occurring now)— represent risks rather than certainties. Scientists disagree sharply on the extent of the risks, greatly increasing the difficulty of developing environmental policies. Part of this disagreement involves sharply differing opinions about the quality of data and the validity of analytical methodology. Part also involves more basic philosophical differences about the nature of "proof.': Because many environmental relationships are drawn from circumstantial and statistical evidence, considerable judgment must be used in determining when a "postulated" relationship turns into a "probable" one, and finally, into a "proven" one. The long fight to conclusively prove a relationship between smoking and cancer is a classic example; many environmental cause-and-effect relationships follow the same lines.

Finally, one additional problem with predicting environmental impacts is that their magnitude depends on the effectiveness of pollution control systems, and this can change. The regulatory systems often will respond to newly perceived environmental threats by requiring more stringent controls. Because it cannot be predicted how weil the future environment will be monitored, the extent to which ongoing research will discover new evidence linking particular pollutants to specific impacts, or how policy makers will respond to such evidence, the discussion below focuses on the effects of coal development under the current regulatory system and attempts to place the postulated, probable, and proven environmental impacts into perspective. However, virtually all of the most severe of the impacts described below are capable of being mitigated or eliminated by controls that are available today or are under active development.

Impacts on Air Quality

Although the mining and transportation of coal can cause local air pollution problems from fugitive dust (from mining operations, storage piles, and coal hauling) and noxious fumes (from smoldering mine fires), the major, national air quality impacts from large-scale coal development will come from the combustion portion of the fuel cycle— from coal-fired powerplants, industrial boilers and furnaces, and commercial space-heating plants. The air pollutants released in large quantities by combustion units include the oxides of sulfur, nitrogen, and carbon, as well as particles of ash that become entrained in the hot flue gases. Smaller quantities of trace inorganic elements, radionuclides, and hydrocarbons are also emitted; these are often adsorbed on the surface of the ash particles.

Of the major pollutants, SO_x and nitrogen oxides (NOx - in the form of SO_2 and nitrogen dioxide (NO,)– and particulate matter are controlled directly by Federal law. The present strategy for regulating these pollutants under the Clean Air Act combines a series of "local" control levels— incorporated in State implementation plan (S1P) requirements to meet National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD) requirements–with New Source Performance Standards (NSPS) that set nationwide emissions limits on large new pollution sources. In general, the regulations are directed at the chemical form of the pollutants as they are emitted from their source, and are focused on maintaining air quality requirements within a local air quality control region. Unfortunately, the pollutants are neither chemically nor physically static within the atmosphere. Most are subject to complex chains of chemical transformations, with the importance of each reaction depending on the presence of catalysts, intensity of sunlight, degree of humidity, and other factors. Physical processes are also at work, mixing the pollutants and at times carrying them far from their source until they are removed from the atmosphere by settling, by colliding with terrestrial surfaces, or by being "washed out" by rainfal1. Examples of long-range transport include instances of "hazy blobs" of urban pollutants crossing the boundaries of several States and persisting for periods of a week or more, and elevated levels of sulfate particulate in Pennsylvania that originate with SO_z emissions from a cluster of coal-fired powerplants in the Ohio River Basin that are alined with the prevailing wirids.

Two key problems are created by this long-range transport and transformation:

1. Areas can experience episodes of poor air quality caused by pollution sources that are outside their jurisdictional boundaries and thus essentially beyond their control under the current regulatory system.
2. The pollutants that may be present in the air and that may be doing the most damage are not necessarily the same as the pollutants being regulated. Controls on the "primary" emitted pollutants may not be effective on the "secondary," transformed pollutants.

A major reason why Federal regulatory strategy does not explicitly take these factors into account is that the analytical ability to trace pollutants from source to "receptor," through both chemical transformation and long-distance physical transport, is inadequate. Moreover, the identification and measurement of the physical impacts of these secondary pollutants are often disputed. To identify specific problems, each of the major pollutants, its transformation products, and its impacts **is** examined in turn.

Sulfur oxides have received more attention than any other emission from coal combustion, primarily because of the large quantity of emissions, the diversity and controversy surrounding its impacts (human health effects, acid rain, crop damage, etc.), and the great expense involved in S0x controls. Coal combustion is now, and is likely to continue to be, the major source of SO_x emissions in the United States. Although existing coal combustion sources will be coming into compliance with local regulations in the next few years and new sources will be subject to strict NSPS, the expected expansion in coal combustion should prevent total S0x emissions from continuing to decline significantly in the next decade and should cause them to rise (although slowly) thereafter.

The SO, that emerges from the stack of a coal-fired boiler is either removed (primarily by impaction in an area close to its source) from the atmosphere or transformed into sulfuric acid or to some other form of sulfate ion. These sulfates tend to be transported over a wide area and are removed predominantly by rainfall. Transport of sulfates over distances of hundreds of miles is not uncommon.

The major effect of the locally deposited SO_2 is to damage crops and forests during meteorological conditions that cause the "plume" (column of exhaust gases from the stack) to touch the ground. Lower plant species may suffer severe losses downwind of coal-burning facilities, while a wide variety of crops are damaged when other pollutants react with SO,. However, these effects should not increase greatly in severity on a-nationwide basis because of the relative stability of SO_2 emissions for the next few decades and because new powerplants will operate with SO_2 scrubbers.

The major effects of the sulfate transformation products are continuation and possible aggravation of the effects of acid rain (discussed below) and the possibility of major human health effects. Both of these are excel lent examples of research inadequacies; scientists as yet cannot credibly describe the relationship between emissions and the ambient concentrations that may occur far from the pollution source, and do not agree on the magnitude of the impacts. Improvement and verification of some existing long-range air pollution models may soon allow acceptable predictions of ambient concentrations caused by distant sources. This would still leave unresolved the prediction of the environmental and health impacts from these concentrations.

The estimation of human health effects from sulfates or from any air pollutant is extraordinarily difficult. Short-term tests on cultures and tests on animals can employ high levels of pollutants and thus can measure easily identifiable acute effects; however, the relevance of these effects to human beings is uncertain. Clinical studies utilize human subjects but only at low levels of concentration; the impacts that are measured are not easily translatable into estimates of more dangerous effects at high concentration levels or at low levels over long periods of time. Human epidemiological studies have tended to suffer from problems with heterogeneous populations, poorly measured pollution exposures, and multiple pollutants.

A series of epidemiologic analyses of the relationship between mortality rates and air pollution in several American cities has linked current levels of sulfate (and particulate) concentrations to tens of thousands of premature deaths yearly in this country. These analyses suffer from the generai problems associated above with most epidemiological studies as well as inadequate data on those population characteristics that might affect the death rate, and they have been rejected on these grounds by many health scientists. However, the arguments advanced by these scientists are inconclusive and have not invalidated the analyses. It remains a possibility that existing levels of air pollution are causing significant numbers of deaths. (Sulfate should be considered as a pollution indicator rather than as necessarily the prime cause, although presumably the causative pollutants are produced in association with the sulfate precursor, SO_2.) If the relationship between current levels of air pollution and large numbers of premature deaths were proven, or if it were perceived as proven by a politically significant portion of the population, future coal development could be substantially affected by demands for restrictions on development, deliberate shifts to alternative energy sources, or increases in pollution control requirements and cost.

Although coal combustion is now secondary to automobiles as a source of **Nitrogen** oxides, the present inability of coal-fired boilers to reduce their uncontrolled emissions by more than about half will yield a substantial increase— perhaps 20 percent by 1990— in total U.S. NO, emissions (unless more efficient controls are developed and used) despite further cleanup of automobile exhausts.

The threshold for almost all observed effects on ecosystems is well above the NO_2 levels in most U.S. cities, and the forecast increase in emissions should not cause significant new damage from NO,. However, NO, is a precursor of photochemical oxidants such as ozone and peroxyacyl nitrates (PAN). Oxidants are the most damaging air pollutants affecting agriculture and forestry in the United States. Elevated ozone concentrations caused by long-range transport from urban areas have become a regional problem throughout the United States, causing widespread damage to crops on both coasts. However, the relationship between NO_2 emissions and oxidant formation is not well understood; thus, although increased NO_2 emissions may be expected to cause some increased oxidant formation and subsequent ecosystem damages, the severity of this outcome is highly uncertain.

The transformation of SO, and NO, into acid sulfate and nitrate and the long-range transport of these acid products can damage the environment by producing acid rain. The transformation products of SO_2 and NO_2 may be the major contributors to the current acidity of rainfall over most of the Eastern United States. The resulting increases in the acidity of lakes have seriously degraded some aquatic ecosystems, Although acid rain has been shown to affect individual components of the terrestrial ecosystem, it has not been proven to affect that ecosystem to the same extent that it clearly affects aquatic systems. However, postulated associations of acid rain with some ominous trends (such as declining forest growth) and potential impacts (such as leaching of toxic metals and damage to nitrogen-fixing bacteria from increasing soil acidity) suggest an urgent need for more research on acid rain effects. The problem is especially important in the Northeastern United States. The Southwest, which will absorb substantial amounts of acid sulfate and nitrate, will not be as troubled because its soil and water are predominantly alkaline.

Because of the widespread use of electrostatic precipitators (ESPS) that remove large particles with high efficiency but are less efficient in controlling smaller particles, any ecosystem impact of particulate emissions from coal-fired powerplants will be caused almost exclusively by **fine particulate** and the **associated trace elements and hydrocarbons** that are adsorbed on their surfaces. Although total particulate emissions will be substantially reduced in the future as a result of strict controls on new plants and progress in obtaining conformance with State regulations for existing plants, emissions of fine particulate may increase unless controls are installed that are equally effective for al l particle size ranges.

The physical characteristics of fine particulate make them candidates for potential ecosystem and health damages, but virtually no data exist to verify such effects. Speculation about ecosystem damages is based on the potential for alteration of normal soil processes associated with nutrient recycling and with soil micro-organisms, as well as a small amount of evidence of trace hydrocarbon damage to aquatic systems. Similarly, there is a speculative potential for a human health impact based on the ability of fine particulate to penetrate the lung's defenses, and the coating of toxic materials on the particles. The same types of controversial epidemiological studies that have implicated sulfate as being associated with premature deaths have also implicated particulate.

in recognition of the possible health implications of increasing fine-particulate emissions, the 1977 Clean Air Act amendments require the Environmental Protection Agency (EPA) to study the health effects of fine particulates, associated trace elements, and polycyclic organic matter (POM) and to establish regulatory controls for these pollutants if necessary.

Both the fine particulate directly emitted from coal combustion facilities and the particulate sulfate that are the transformation products of SO_2 emissions are effective in scattering light and thus causing a degradation of visibility. The Southwest in particular would appear to be vulnerable to this damage, because regional shifts in power generation will add considerably to its pollution burden, and its vistas are an important resource. Although Federal PSD restrictions are designed in part to protect western visibility, the state of the art in predicting the visibility impacts of new coal-fired powerplants–or of any light-scattering particles — is not well advanced. Although visibility impacts may occur hundreds of miles from a large source, EPA has specified 50 km as the maximum distance over which current air quality models are credible for evaluating the effects of new pollution sources—and most modelers would consider this an optimistic assessment of the state of the art. Thus, the restrictions on visibility reductions will be difficult to enforce, until acceptable long-range transport and visibility models are available.

Most of the impacts discussed above would originate from large coal-fired powerplants or industrial boilers. Few predictions of energy growth expect major increases in coal combustion by small residential and commercial boilers or furnaces. Small boilers or furnaces, if poorly maintained, can experience incomplete combustion and generate elevated levels of hydrocarbon emissions. A major worry in such a situation would be increased generation of POM, some species of which are carcinogenic. Because these emissions would tend to come from low stacks, possibly in densely populated areas, special attention must be paid to these units if larger than expected growth of direct coal use occurs in the residential and commercial sectors.

Despite the serious uncertainties involved in identifying air pollution impacts and their causes, all but one of the major pollutants from coal combustion have sufficiently recognized impacts and means of control to have warranted Federal regulation of their emissions. The exception is **Carbon dioxide,** which at current and expected ambient levels displays no direct or immediate adverse impacts on human health or on the biota but may conceivably represent the greatest long-term danger from an increase in the use of coal or other fossil fuels. Fossil fuel combustion over the past century appears to be a major cause of increasing concentrations of CO_2 in the Earth's atmosphere (deforestation may be another major cause); CO_2 levels have increased 5 percent since 1958 alone. Some predictions show CO, concentrations as doubling by the middle of the next century. This could present a substantial risk of significant climatic change, because CO_2 in the Earth's atmosphere has a "greenhouse effect, " allowing incoming sunlight to warm the Earth's surface but trapping outgoing heat radiation. Effects of such a climate change, if it occurred, could include massive shifts in the productivity of farmlands as well as partial melting of the polar icecaps and flooding of coastal cities. Current gaps in our understanding of how climate is regulated and how CO_2 is cycled between its sources and reservoirs leave this issue surrounded by considerable uncertainty. Although the problem is widely perceived by the scientific community as potentially serious, some scientists believe that any effect would be overwhelmed by the natural climatic cycle that may be moving the Earth to a cooler future climate. A further critical aspect of the problem is the apparent lack of a practical CO, emission control technology for fossil combustion. Should control of CO2 be judged necessary, the available options are to reduce worldwide fossil fuel combustion (by energy conservation and switching to alternative energy sources) and to stop ecosystem changes (especially deforestation) that might be aggravating the problem.

As discussed above, each of the pollutants generated by coal combustion will have proven or postulated environmental and/or health impacts, even with the level of pollution control currently required by Federal, State, and local regulations. Our inability to assess accurately the level of impacts and their economic and social values leads to extreme difficulty in selecting appropriate levels 'of control. These inadequacies partially explain the Federal strategy of choosing the "best available control technology" instead of using an approach that would select control levels more oriented to weighing costs and benefits. Whichever approach is chosen, the selection of controls clearly requires an understanding of the control options and the associated costs and difficulties.

Feasible control options are available for three of the four major pollutants generated by coal combustion– particulate, SO2, and NO,. The fourth, CO2 can theoretically be scrubbed out of the flue gases, but the quantity of absorbent required and volume of waste products generated appear to be too large for serious consideration.

Control of SO_x emissions from large coal combustion sources can be accomplished by a variety of measures, including selection of low-sulfur coals, coal cleaning, flue-gas desulfurization (FGD), and several new combustion technologies. E PA's proposed NSPS for coal-fired electric utilities would guarantee that virtually all new powerplants would use FGD (scrubbers) to reduce S0, emissions. However, stringent control of new plants and achievement of full compliance with SIP requirements for existing plants will not substantially reduce the 30 million or so tons of S0x emitted annually in the United States, because the S I P requirements are often not very severe. Powerpiants, which have tall stacks, can in many circumstances emit very large amounts of pollutants without seriously affecting local air quality. In some instances, plants are burning relatively high-sulfur coal without controls even though they are in full compliance with their SIPs. Thus, there is considerable room for further reduction of SO_x emissions if such a reduction were dictated by national policy.

The scrubbers required on all new powerplants are expensive to build and operate. The scrubber system on a 500-MW powerplant might cost $50 million to $75 million out of a total plant cost of $400 million, and add 0.4 to 0.8 cents to each kilowatthour of electricity the plant produces. Furthermore, lime/limestone scrubbers, the systems that currently dominate the utility market, are throwaway processes and therefore generate wastes that are themselves considered a significant environmental problem. This problem is discussed in more detail in the next section.

Scrubber installations in this country have been beset by many significant operating problems, including extensive scaling of surfaces, failure of stack linings, corrosion and erosion of critical components, and plugging of orifices. The utility industry generally considers scrubbers to be an unreliable technology and an inefficient means of achieving control of S0x. There is available evidence, however, that U.S. utility operators can comply with proposed NSPS requirements for SO, removal efficiency and reliability. For instance, Japanese scrubber experience with medium-sulfur coal (the energy equivalent of 3 percent sulfur U.S. coal) and operating conditions similar to those in U.S. plants has been extremely successful, achieving reliabilities and control efficiencies in excess of 90 percent.

Alternative means of controlling S0x are available or under development for use on new and existing coal-fired powerplants. Some of the alternatives offer reduction in NO_x and/or particulate in addition to S0x control.

Further control of existing powerplants can be accomplished by using low-sulfur coal or coal that has been physically or chemically cleaned. Options that may become suitable for new plants include solvent-refined coal (SRC-1, the solid form, which is the only one considered in this report), combined-cycle powerplants using liquid and gaseous fuels from coal, and fluidized-bed combustion (FBC). SRC-I and FBC may also become useful in promoting environmentally sound coal use in smaller industrial and commercial units. Advanced electrical generation systems are undergoing R&D but do not appear to have the potential to make a serious impact on energy use for at least the next several decades.

The extent of application of these alternatives depends on their costs. Except for low-sulfur coals, state-of-the-art FGD systems, and mechanical cleaning systems now in use, the costs of the alternatives are speculative.

Control of NOx is currently accomplished by design modification and adjustment of operating conditions rather than using "add-on" controls. Effective techniques for minimizing NO_x emissions are staged combustion, which reduces excess air in the boiler, and burner designs which delay mixing of fuel and air. Combinations of these and other strategies have succeeded in lowering NOx emissions from large utility boilers by 40 to 50 percent.

Although gas-cleaning systems for NOx control are not currently used in this country, a number of processes are under development. The Japanese are the most advanced in this field. These processes included injection of ammonia or various solids into the combustion chamber, and scrubbing of the flue gases using absorbents such as magnesium oxide. Capital costs of these systems are said to be of the same order of magnitude as FGD.

EPA is developing a low-NO_x burner for coal-fired boilers that it hopes will be inexpensive and effective. (EPA hopes for an 85-percent emission reduction relative to an uncontrolled boiler.) If successful, the burner could, by the late 1980's, cut back sharply on predicted rises in NOx emissions.

High efficiency control of particulate has been a long-term practice in the electric utility industry, the dominant user of coal. Although mechanical or cyclone collectors were extensively used in the past, ESPs are the collection technology on most coal-fired utility boilers today. ESPs collect particulate by charging the individual particles and collecting them on plates to which a powerful opposite charge has been applied. They often can attain collection efficiencies of over 99 percent.

Requirements for control of SO_x emissions from coal combustion and resulting increased use of low-sulfur coal have created problems for ESPs. The ash particles from low-sulfur coal are usually of high resistivity and are not easily charged and collected by the ESP. Degradation of performance from a shift to low-sulfur coal can be extremely severe, with particulate emissions increasing tenfold or more. Designers of new powerplants have attempted to solve this problem by increasing the size of the ESPS or installing them at a hotter (lower resistivity) part of the exhaust cycle, or by using controls that depend on the mechanical rather than electrical properties of the particles. These "mechanical" controls include wet scrubbers and baghouses (fabric filters). Although these options may be available to some existing plants, many plants have space limitations or want to avoid large capital expenditures because of their limited remaining operating life. Flue gas conditioning, which involves the injection of a chemical into the flue gas to coat the particles and reduce their resistivity, may be an attractive option for such plants (although questions have been raised about increased gaseous emissions caused by these systems).

The proposed Federal requirements for particulate control are said to be too stringent to be universally met by ESPS. Compliance with the proposed requirements (a particulate NSPS of 0.03 lbs/million Btu of heat input) for utility boilers burning low-sulfur coal may require the use of baghouses. However, baghouses are a relatively untried technology for large coal-fired boilers. A few systems have been installed or ordered for such plants. The experience of these plants will be influential in determining the future direction of particulate control in the utility industry.

The choice of technology is particularly important in terms of controlling fine particulate and trace elements. ESPS are not efficient collectors of "respirable size" particles, and a continuation of current particulate-control technology could lead to substantial (and potentially dangerous) increases in fine-particulate emissions over the next several decades. Baghouses, on the other hand, can be designed to collect fine particles at greater than 99-percent efficiency.

Impacts on Land and Water

In contrast to the impacts of air pollution, most impacts of water pollution, solid waste disposal, and land disturbance are more concentrated geographically. They are controlled less by technological devices than by adjustments in operating procedures, and the degree of control obtained is often extremely dependent on local conditions. Thus, appropriate enforcement and careful monitoring are especially important to the success of controlling these impacts.

In the past, coal development in general, and mining in particular, were often devastating to both land and water ecosystems. The major damage from mining was caused by the acid drainage from both underground and surface mines, the lack of adequate restoration of surface-mined land, and the subsidence of lands overlying underground mines. Ecological damage also resulted from the heating of surface waters by powerplant cooling systems.

All of these impacts are now addressed by Federal legislation. As a result, some problems— in particular, acid mine drainage from large active mines, and powerplant thermal pollution — have been virtually eliminated as significant problems for future development. All of the others have been reduced, although substantive problems of enforcement and/or availability of effective controls remain. Also, some new problems may result from the regional shift of coal production to areas where little experience can guide new operations, and from the generation of waste products from air pollution control measures.

Mining.–Approximately 60 percent of national coal production comes from surface mines, and the proportion will not rise much. The use of new mining methods that integrate reclamation into the mining process and enforcement of the Surface Mine Control and Reclamation Act (SMCRA) should reduce the importance of reclamation as a critical national issue. However, concern remains that the combination of development pressures and inadequate knowledge may lead to damage in particularly vulnerable areas— alluvial valley floors in the West, prime farmland in the Midwest, and hardwood forests, steep slope areas, and flood-prone basins in Appalachia. Although most of these areas are afforded special protection under SMCRA, the extent of any damage will depend on the adequacy of enforcement of the new strip-mining legislation. Assuming strong enforcement of SMCRA, no major problems with acid mine drainage from active surface and underground mines should result from increased coal development. However, inactive mines may still present some technical control problems. Although a very small percentage of inactive surface mines may suffer from acid seepage, problems with underground mines should be the primary problem. Despite a long history of Federal and State efforts aimed at controlling acid drainage from inactive underground mines, some mining situations do not al low adequate permanent control once active mining and water treatment cease. A significant percentage of the mines that are active at present or that will be opened in this century will present acid drainage problems on closure, This problem may taper off as shallower reserves are exhausted and new mines begin to exploit coal seams that are deeper than the water table. Many of these mines will be flooded, allowing the seams to be shut off from the oxidation that creates the acid drainage.

Another impact of underground mining that will not be fully controlled is subsidence of the land above the mine workings. Unfortunately, there are no credible estimates of potential subsidence damage from future underground mining. Subsidence, like acid drainage, is a long-term problem. However, SMCRA does not hold the developers responsible for sufficient time periods to ensure elimination of the problem, nor does it specifically hold the developer responsible to the surface owner for subsidence damage. The major “control” for subsidence is to leave a large part of the coal resources — up to 50 percent or more — in place to act as a roof support, There is obviously a conflict between subsidence prevention and removal of the maximum amount of coal. Moreover, the supports can erode and the roof CO l lapse over a long period of time. The resulting intermittent subsidence can destroy the value of the land for development. A second “control” technique — longwall mining — actually promotes subsidence, but in a swifter and more uniform fashion. Longwall mining is widely practiced in Europe but is in limited use in the United States. It is not suitable for all situations,

Although all types of mining have the potential to severely impact ground water quantity and quality by physical disruption of aquifers and by leaching or seepage into them, this problem is imperfectly understood. The shift of production to the West, where ground water is a particularly critical resource, will focus increased attention on this impact. As with other sensitive areas, SMCRA affords special protection to ground water resources, but the adequacy of this protection depends on the state of knowledge about the problem and on the level of enforcement,

Impacts of Combustion and Waste Disposal. The major impact of coal-fired combustion sources on the land and water stems from the secondary effects of environmental controls — the effects of cooling tower blowdown and water consumption, and those of the waste products collected by air pollution controls.

Most powerplants built in the future will use closed-cycle cooling, so that thermal damage from once-through cooling systems will not be an impact of future coal development. However, the concentrated salts, or "blowdown," from these closed-cycle systems are discharged into the Nation's waterways. The dissolved solids discharged by coal-fired electric utilities, of which blowdown is the predominant source, are nearly **20** percent of the total national dissolved solids discharge. Although effluent limitations have been established under the Clean Water Act, increases in utility coal burning will play an important role in the expected substantial growth in the discharge of dissolved solids in the South Atlantic, Midwest, North-Central, and Central regions.

An additional impact of closed-cycle cooling systems results from their water consumption, which is approximately double that attributed to once-through cooling. Although the magnitude of consumption for a particular facility varies with location, a 3,000-MW powerplant can be expected to consume between 20,000 and 30,000 acre-feet per year (mostly for cooling). If a number of these plants are built in the arid portions of the West, their water requirements could exacerbate existing water problems in several river basins — for example, in the Upper Colorado and Yellowstone. Reduced flows can interfere with the rivers' assimilative capacity and in some extreme cases damage or destroy ecosystems from sheer lack of water. This problem is as much institutional as physical, because much of the water consumption in the West results from existing water allocation and pricing procedures that undervalue the water; the absence of a comprehensive Federal water policy hinders the resolution of these problems. Furthermore, technological means (dry or wet-dry cooling systems) are available to sharply reduce powerplant water consumption, although the systems are expensive and lower plant efficiency.

The impacts caused by the disposal of powerplant waste heat into the environment are relatively independent of the fuel source, although impacts from the current generation of nuclear powerplants will be somewhat higher per kilowatt than those of similarly sized fossil-fired plants because of the nuclear plants' lower efficiency. Thus, the effects of blowdown and water consumption should be attributed to electricity demand rather than specifically to coal use.

Both the particulate control devices and SO_2 scrubbers on coal combustion facilities produce massive quantities of wastes (projected to be approximately 80 million tons of ash and slag and 20 million tons of sludge by 1985, or fully half of the Nation's total noncombustible solid waste and industrial sludge), which can cause land use problems and environmental damage unless properly managed.

A 1,000-MW powerplant may require a disposal area of 500 acres or larger for a 30-year period, even assuming that the sludge is dried and the wastes are 20 feet thick. However, the land use problem posed by this requirement is eased by the likelihood that most new powerplants will be built outside of densely populated areas, where more land is available.

The major environmental problem associated with waste disposal is the contamination of surface and ground waters by leaching of trace elements from the ash and sludge. Although the ash contains by far the greater amount of trace elements, the fluid that is trapped in the sludge also presents a significant leaching problem for years after disposal.

The actual environmental damage caused by disposal of these wastes will depend on the form of the regulations and the firmness of enforcement of the Resource Conservation and Recovery Act (RCRA). Methods exist for reducing or controlling the potentially severe impact on ground water, but they are expensive and are likely to be applied only sporadically unless they are required by law; some may be difficult to monitor and enforce. These methods range from lining of disposal ponds and landfills, chemical stabilization of the scrubber sludge, and alteration of the chemistry of the scrubber (to create a more manageable waste), to utilizing regenerable scrubber systems and virtually eliminating the sludge portion of the problem altogether. Designation of ash and sludge as hazardous materials under RCRA would force use of these controls, but, according to the Department of Energy (DOE) estimates, could almost double disposal costs over present practices. (Industry thinks these estimates are too low.) A side effect could be to eliminate some present uses of ash, such as its use in roadbeds. Twenty percent of the ash produced by the utility industry is constructively used rather than being disposed. Even without a "hazardous" designation, however, a rigorously enforced RCRA will force substantial changes in present disposal practices to protect ground water.

Workplace and Community Impacts

Coal Worker Health and Safety

Coal mining has always been a hazardous occupation. The 1969 Federal Coal Mine Health and Safety Act addressed some work-related health and safety hazards, explosions and dust control in particular. But coal workers are likely to continue to suffer from occupational disease, injury, and death at a rate well above other occupations, and the total magnitude of these impacts will grow along with the growth in coal production.

The mine-worker health issue that has received most Congressional attention is black lung disease, the nonclinical name for a variety of respiratory illnesses of which coal workers' pneumoconiosis (CWP) is the most prominent. More than 420,000 Federal compensation awards were made between 1970 and the end of 1977, costing the Government more than $5.5 billion. The industry will pay a greater share of the compensation costs in the future as a result of the 1977 black lung legislation. Ten percent or more of working coal miners today show X-ray evidence of CWP, and perhaps twice that number show other black lung illnesses— including bronchitis, emphysema, and other impairments— some of which are caused, or worsened, by cigarette smoking. The prevalence of respiratory disease is probably less today than it was 10 years ago because about 50,000 older — and often disabled — miners have retired and about 150,000 new workers have been hired.

To prevent CWP from disabling miners in the future, Congress mandated a 2-mg/m^3 standard for respirable dust (the small particles that cause pneumoconiosis). This standard was based on British research done in the 1960's and is lower than any other country 's. However, critics now question the inherent safeness of this standard and the soundness of the British methodology. The safeness of the standard, which was based on mathematical probabilities, must still be confirmed by long-term epidemiological evidence. The Federal dust-sampling program, which is intended to measure compliance with the standard, is not a reliable indicator of daily dust exposure. Many opportunities for intentional and inadvertent sampling errors exist. Sampling is so infrequent and the timelag in reporting the results back to the mine so great that sampling has limited relevance to actual dust control. A monitoring program based on continuous sampling and immediate correction may prove to be a more useful approach. Because black lung compensation is costly and because several hundred thousand more miners will be employed in the next 25 years, it may prove useful to reassess the safeness of the dust standard and to evaluate alternative dust-sampling procedures.

If respirable dust is controlled effectively, CWP will be reduced and a major source of black lung disease will have been addressed. However, other sources and potential sources of miners' respiratory disability may require attention. Other coal mine dust constituents— the large dust particles (that affect the upper respiratory tract) and trace elements — deserve additional research. Toxic fumes from mine equipment fires and diesel emissions are hazards that may deserve regulation. Cigarette smoking increases breathing difficulties in diseased miners and probably should be discouraged in this work force. Under the most optimistic assumptions, it is estimated that 11,000 to 18,000 working miners will show X-ray evidence of CWP in 2000 and at least an equal number will exhibit other respiratory impairment. Even more retired miners will have CWP, and many will be disabled by it. If dust control is not effective or adequate, disease prevalence will be higher and more cases of CWP and black lung will be found.

Mine safety — as distinct from mine health — has shown a mixed record of improvement since the 1969 Act was passed. The frequency of mining fatalities has decreased for both surface and underground mines, but no consistent improvement has been seen in the frequency of disabling injuries. Coal worker fatalities numbered 139 in 1977, and disabling injuries approached 15,000. Each disabling injury resulted in an average of 2 months or more of lost time. The number of disabling injuries has been increasing as more workers are drawn to mining and accident frequency remains constant.

On the whole, surface mining is several times safer than underground mining. But some underground mines show safety records equal to or better than some surface mines. Generally, western surface mines are safer than eastern surface mines. As western surface-mine production assumes increasing prominence, accident frequency industrywide is likely to decline when expressed as accidents per ton of output. But this statistical trend may conceal no improvement or even a worsening of safety in deep mines.

Post-1 969 mine safety performance is related to several factors. High-fatality mine disasters have been reduced substantially. Operator compliance with Federal safety standards and frequency of inspection appear to be correlated with improved safety. Big, new mines that have been opened since 1970 tend to be safer than older, smaller mines. Greatly improved coal profitability in 1974 and 1975 coincided with the industry's two best years in reducing injuries. The emphasis on safe work by the United Mine Workers of America (UMWA) and Federal agencies were other important factors.

Labor-saving technology or different work processes may or may not improve safety and may conflict with improved health goals. The introduction of continuous miners in the 1950's raised productivity and lowered fatalities and injuries because the work force was reduced by 70 percent. But the new machines produced higher dust levels, which caused higher rates of black lung. Longwall mining systems appear to be more productive than other units and safer in terms of fatalities, but not in injuries. About half of the longwalls surveyed recently did not meet the respirable dust standard. Speeding up the pace of work to increase output is likely to increase accident frequency. Improved workplace relations and less absenteeism are likely to increase both productivity and safety.

Mine-safety analysis is made difficult by weaknesses in the recorded Federal data. Reporting practices are not uniform throughout the industry. Some companies have adopted light-duty policies (with respect to injured workers) that allow them to report fewer disabling injuries. Some companies probably do not report all injuries and illnesses. The Mine Safety and Health Administration (MSHA) has tightened its reporting requirements recently, and better reporting should result.

As more coal is mined and more miners are hired, the number of coal worker fatalities and injuries is likely to increase even if accident frequency improves somewhat. Depending on future coal production levels, between 157 and 187 coal workers are likely to be killed and between 17,400 and 20,800 injured in 1985. That represents a 13- to 35-percent increase in fatalities over 1977 and a 17- to 39-percent increase in injuries. I n 2000, between 259 and 371 coal worker fatalities are forecast and between 29,200 and 41,800 injuries. These estimates represent an 86- to 167-percent increase in fatalities over 1977 and a 95- to 180-percent increase in injuries. These calculations assume no underreporting and undercounting. The 25-year total (1976-2000) of mine fatalities may exceed 5,000 and injuries may exceed 500,000.

Reducing these numbers calls for action in several areas that may conflict with increased productivity. Federal policy should address three main issues:

1. reducing the number and frequency of disabling injuries,
2. assessing the safety costs of increased production and productivity strategies, and
3. reevaluating the effectiveness of existing Federal enforcement programs.

Equipment can be designed with improved safety as a factor. Broader Federal equipment standards could help. Western and Midwestern surface mining could be encouraged by Federal policy, but this emphasis would probably have severe employment and price impacts in the East. Predictable growth in coal demand and steady profitability might be encouraged to further enable companies to devote time and money to safety and . health. Federal inspections —the factor apparently most directly correlated with good safety— could be increased. More severe sanctions against chronic high-accident operations might be considered. More effective safety and job training, coupled with increased participation of coal miners in safety and health efforts, may also prove fruitful.

Community Impacts

Coal mining brings many diverse benefits and costs to coalfield communities. The private sector— mine operators, coal workers, and local business— benefits from steady coal output through profits, wages, and spendable income, respectively. Private production costs are paid by the mine operator. But when costs are externalized, mine workers and local private interests often pay them. These costs can be measured in dollars, human health, and environmental quality. Coal production also entails public costs and benefits. Local communities will benefit from population growth (at a manageable pace), more tax revenues, increased employment, and better services from wisely planned coal development. On the other hand, if growth is too rapid, communities may be unable to expand services fast enough. Even without much coal growth, the public costs of past mining in Appalachia are substantial and deserve redress. Chronic community underdevelopment exists throughout this region and may impede rapid coal growth in several dozen counties.

Coal development will occur in three different kinds of communities. Many Appalachian communities are hampered by the legacy of historical underdevelopment. Coal-based growth will continue the pattern of a "one-crop" economy with all of the costs and benefits of that mode of economic development. In other Appalachian communities and in the Midwest, coal will be mined in communities with diversified economies. The social costs of coal development are likely to be the least substantial there. In the West, coal development will create boomtown growth in some counties and towns. The extent of coal's social costs (both public and private) depends on the rapidity of development, the adequacy of existing public services, the ability of local communities to manage growth, the level of local public participation in coal development, the kinds of mines that are planned, and the attitudes of mine operators and the local citizens toward development.

East.–The Appalachian coalfields have produced more than 90 percent of all coal ever mined in the United States. Because they never experienced a sustained period of growth and profitability, operators were forced to cut costs simply to stay in business. Local jurisdictions were usually unable to raise sufficient tax revenue to provide adequate public services because taxes on coal might have handicapped the ability of local operations to compete. Roads, schools, water and sewage facilities, recreation, health care, and local public administration suffered from this unwillingness or inability to tax adequately coal production and undeveloped coal reserves. The cyclical nature of coal demand also made rational, public financial planning difficult. The lack of diversified economies made spendable income and public revenue in coal towns almost totally dependent on the whims of demand for local coal. For most of the 1920-70 period, overall coal demand stagnated, which meant that State and local tax revenues did not increase greatly even during the short-1ived booms. The company-town system, which was

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the main form of community socialization throughout most of the Appalachian coalfields, intensified community dependence on local coal sales. Many of today's coal towns began as company towns. They have yet to compensate for the public deprivations characteristic of their earlier underdevelopment. On the other hand, whatever public infrastructure exists today in these communities stems from coal development. Had coal mining not begun 80 or 90 years ago, these counties might have even fewer public services than they do today. They would have small populations and little industry. But they would also have few of the social costs of coal development.

No significant net increase in Eastern coal production is anticipated before 1985, although substantial production gains should occur thereafter. This interval can be used to plan how coal development can be managed best. Yet severe community overloads are already apparent in much of Appalachian coalfields, where the combination of existing inadequacies and thousands of new miners has overwhelmed the ability of communities to provide services.

Appalachia will experience two contrasting patterns in the early 1980's. Some communities where metallurgical or high-sulfur coal is mined are likely to continue to stagnate because of weak demand. Production will not increase, although the coal-related population may grow. Historical patterns of underdevelopment will continue. Two to three dozen counties may fit this pattern. For more than a year, 10,000 to 15,000 Appalachian miners have been working irregularly because of slack demand. Little has been done to encourage coal demand from these hard-hit areas or to plan the economic diversification of their economies (an even sounder long-term approach).

The opposite case will find boom-like conditions imposed on underdeveloped communities. Production and population will increase rapidly. Spendable income and demand in consumer goods will rise. Demand for housing and public services will increase sharply and may not be met. Local tax resources may not provide needed public services. Production and productivity may be slowed because of these shortcomings. In communities where underdevelopment is least, boom conditions are likely to be most readily accommodated. Several growth-related problems are worth identifying. Housing is crucial to expanding coal production. Both the supply and adequacy of coalfield housing are deficient. Most coalfield land is owned by coal producers or land-owning companies, which generally refuse to sell land suitable for housing. It is often uneconomic for them to sell the surface rights to coal-bearing land, and future liability for subsidence is also a constraint. Consequently, coal field housing supply is deficient and many areas have experienced severe congestion and inflated land and housing prices. Private builders and mortgage money are in short supply. The quick-fix "solution" to the lack of land and housing has been the mobile home. This is widely seen as less desirable than single-family construction. The lack of housing has made for long commutes between home and workplace, which may contribute to absenteeism. To increase housing **Supply, land** and mortgage money will have to be made available. In many places, a housing-construction industry must be assembled almost from scratch. Increased flood-control measures are necessary to permit building on valley floors.

Roads in the Appalachian coalfields are generally in poor condition. Most were badly constructed initially. The shortage of tax revenues and heavy coal-truck traffic have left them in a constant state of disrepair. Illegal overloading of coal trucks is widespread and contributes heavily to roadway destruction. To upgrade the 6,880 miles of coal-haul roads judged inadequate to meet the current volume of coal traffic would cost an estimated $4. l to $4.9 bill ion, with another $600 million to $700 million to replace inadequate bridges. Small fractions of these sums are now spent on maintenance, and even less on reconstruction and rehabilitation. Strict enforcement of maximum load standards is necessary to take full advantage of dollars used for road repair. Alternatives to coal-truck haulage such as overland trams, conveyor belts, and slurry pipelines would limit future road damage and inconvenience. Increased appropriations for road repair (whether raised by general taxes or user taxes) are likely to be a less cost-effective— but a necessary — option.

Other kinds of services and facilities are often inadequate. Many towns have limited water and sewage treatment systems — if they have any at all. This constrains the development of private housing. Health care services fall short of national standards. Recent refinancing of the UMWA medical plan appears to have weakened coalfield health delivery systems. Public administration is competent in some places, but planning, familiarity with assistance programs and sol id local development strategies are often lacking. Opportunities for recreation and education are often limited.

While some Appalachian coal communities will be able to handle rapid coal growth with little difficulty, many will not. It is difficult to quantify the implications for Eastern coal production of community underdevelopment. Common sense, as well as several recent studies, suggests that the ability of the East to produce more coal rests in part on controlling the future social costs of increased production and dealing with present inadequacies. To internalize fully the social and environmental costs of coal mining, coal will have to be priced to reflect its true costs of production.

Federal policy makers face difficult questions with respect to Appalachian coal development. The first is who should pay to rectify coal's accumulated social deficit. The general public? Current coal consumers? Coal operators out of their profits? State and local governments through coal taxes and general revenues? Second is the question of how to establish new patterns of economic development that will bring local social costs and benefits into balance. Policy makers may wish to examine alternative ways of accomplishing this end, such as economic diversification plans financed by revenues from coal development, public regulation of coal development, and better planning. No Federal policy now addresses these complex issues, although the Appalachian Regional Commission and the President's Commission on Coal are examining them. If serious breakdowns develop at the local level in the next few years, Congress may wish to consider this matter systematically.

Midwest.–Coal counties in the Midwest are likely to be in a better position to benefit from increased coal development than either Appalachia or the West. These counties generally have diversified economies, which have made them less vulnerable to coal's booms and busts. Because much of their tonnage will come from surface mines, the rate of population growth is not likely to be excessive. Because local tax revenues here were higher than in Appalachian counties, community services are generally better. As a rule of thumb, it has been found that where coal mining has been the single, dominant economic activity, communities are least prepared to manage rapid coal development. Counties where mining has been less prominent and economics more diversified appear to be more able to benefit from rapid development. Most of the Midwest fits into this category.

West.–Significant Western coal production is a recent phenomenon. Today, about 9,000 miners produce more than 20 percent of national production. Future growth will be rapid. Between 34,000 and 42,000 miners will be working in the West by 1985. Six States —Colorado, Montana, New Mexico, North Dakota, Texas, and Utah–are each expected to add 55 million to 61 million tons more annual capacity by 1987, according to optimistic forecasts. Wyoming may be able to produce more than 270 million additional tons by that year, although 147 million tons is a more plausible estimate. Depending on how much actual production occurs, from 6 to 11 western counties will experience population growth rates exceeding 5 percent annually. Four of these counties are in Utah, where underground mining (with its comparatively high labor requirements) will take place. Mercer County, N. Dak., and Campbell County, Wyo., are also vulnerable. If coal production matches optimistic Industry predictions, two Colorado counties and three Montana counties will also show 5-percent growth rates. Towns in other counties will also experience boom conditions.

Western towns have had varied degrees of success coping with rapid coal growth. Some, like Rock Springs, Wyo., reflect a range of social problems and genera l community breakdown. Others, like Gillette, Wyo., have muddled through the initial boom problems and are in the process of managing growth with some success. Western towns often find themselves short of housing, water and sewage treatment systems, health care facilities, and front-end revenues. With some exceptions, local tax revenues appear to be able to provide needed services in the long run, although revenue shortages may be felt during the first 5 years or more of rapid growth.

Indian coal development presents special issues. Although considerable tonnage may be mined from Indian reservations, relatively few new miners — perhaps several thousand — are likely to be employed there. Most are expected to be Indians already living on the reservations. Western tribes are now insisting on Indian-preference in mine employment in their reservations along with higher tonnage royalties. Boomtowns are not expected to occur on the reservations, although several reservation towns may show high population growth.

Boomtown conditions are not likely to constrain Western coal production goals. But Federal policymakers must face questions concerning equity of sacrifice, responsibility for controlling the social costs of private energy development, and responding to local demands for assistance. As in much of Appalachia, many western towns will need to deal with one-crop economies, rapid population growth, and revenue shortages.

Social Impacts of Transportation

Coal transportation can be barely noticeable, or it can create a major disturbance — depending on means used and the route chosen. About two-thirds of all coal is shipped by railroad. More fatalities result from coal transport than from mining. New routes may have to be selected to avoid populated areas. Grade crossings will have to be improved to prevent accident and disruption. Trucks are used for short hauls, especially in Appalachia. They contribute greatly to road deterioration, dust, and highway safety problems. Barges and slurry pipelines are probably the least disruptive modes but can be used only under special conditions. An alternative to coal haulage is electric transmission. Its major liabilities are the health and safety concerns of high-voltage electric fields (as yet unquantified) and the visual impact of towers and rights-of-way. The health issue is particularly controversial and requires considerable research.

Impacts on Coal-Using Communities

Coal mining can easily dominate local communities, but combustion facilities tend to be a much smaller— and more stable— part of community economic activity. When a coal-fired powerplant is built, several impacts occur— increased wage income and employment, side by side with more air pollution and disruption from transport. As the literature on the social impacts of powerplant operation is limited, this study surveyed public attitudes of residents near three large powerplants. In all cases, the respondents living within 3 miles of the plants found them objectionable. This attitude diminished rapidly with distance. The most widely perceived disadvantage was air pollution. The major perceived advantages were employment and the availability of energy. In general, slightly more than half the respondents found the plants to be reasonably acceptable neighbors.

Factors Affecting Coal Production and Use

All of coal's major supply factors — reserves, labor, capital, and industrial infrastructure— must be available to support greatly increased production. From time to time, each may become a short-term bottleneck, as in the case of a national strike. But none, either singly or together, is expected to hamper the mining of as much coal as can be sold over the next 25 years. However, attainment of the highest coal scenarios could be precluded by any of several factors. Many potential constraints will be alleviated in the normal course of events. Others may require special attention. These factors are discussed below.

Coal Availability and Leasing

Unlike other domestic fossil fuels, coal is still plentiful. In the East, most coal reserves are owned by producers or landowning corporations. About 65 percent of all coal reserves in the West, however, is owned by the Federal Government and can be mined by private companies only under Federal lease. The rest is owned by States, Indian tribes, or corporations. About 17 billion tons, or 5 percent federally owned coal resources have been competitively leased. This is far more than will be mined over the next decade in the West, but the characteristics of the tracts leased and the needs of the mining industry are such that further leasing may be required soon to meet production projections for 2000,

A leasing moratorium is now in effect while procedures are being devised to remedy past abuses. The Carter administration plans to end the moratorium in the early 1980's. In the interim, only leases necessary to maintain an existing mining operation or to meet existing contracts are issued. The new leasing program will emphasize public participation and environmental acceptability in the context of multiple-use land management. In addition, leases may be reorganized to reflect logical mining units, and they may be required to meet criteria of diligent development and continued operation. The terms of all existing leases will not be modified under the revised leasing program. This exclusion has drawn criticism from environmentalists, Indians, and others. With the resumption of leasing, coal operators will be able to plan with a degree of certainty that has been lacking in the recent past. Until Federal leasing policy is finalized, it is not possible to determine the extent to which the overall policy will encourage or constrain the development of coal reserves on public lands.

Industry Structure

The structure of the bituminous coal industry is complicated and dynamic. Although there are more than 6,000 operating mines, it has been estimated that there are only about 600 independent producers or producer groups. The 15 top coal operators mined about 40 percent of all domestic production in 1977, and between 40 to 45 percent of all utility consumption. Five of the top 15 producers are captives, owned by steel companies or utilities. The others are owned by horizontally integrated energy companies or conglomerates. Only two are independent coal companies. In the last 10 years, three trends have emerged and are likely to continue: 1) increasing concentration among companies selling in regional and specialized markets; 2) increasing utility-owned production (known as vertical integration); and 3) growing ownership of coal production by horizontally integrated energy companies.

Competition, price, and coal supply are matters directly affected by industry structure. industry advocates and critics disagree over whether or to what extent these factors have been affected by the changes in coal ownership. Although a number of recent studies have examined the competitive structure of the coal industry, none has focused the quantitative analysis properly or developed the case study information that would justify definitive conclusions. As coal production from utility-owned mines and energy-company mines is likely to increase faster than coal production nationally, the competitive implications of such ownership patterns deserves close analysis and monitoring.

Labor Profile

Today's 237,000 coal workers are a diverse group. More than 140,000 work in underground mines, while 65,000 work as surface miners. Others work on new mine construction projects, and in preparation plants, mine-related shops, or mine offices. About 2,000 are women. More than 10,000 are Black, Hispanic, or Indian. More than 90 percent live East of the Mississippi River, and most of those work in the Appalachian fields. Although about half of all coal production in 1985 and 2000 will come from west of the Mississippi, more than 80 percent of the labor force will work east of it. Most of this group will work in underground mines and in Appalachia. The work force is young: the median age for underground miners is about 33; for surface miners, about 37. As the current work force ages, job experience should increase. This should improve safety and productivity.

Between 65 and 70 percent of all coal workers are members of UMWA. They account for about 50 percent of total national production. The average annual income for most underground miners exceeds $1 7,000; for surface miners, more than $20,000. (Some miners who log a great deal of overtime can earn $35,000 annually, but they are exceptions.) Because of mining's high wage rates and certain social factors, the turnover rate industrywide is probably below average. However, where employment is not steady or where community conditions are perceived to be harsh, individual mines have experienced high turnover.

It is estimated that very little– if any– increase in net mine employment will occur between now and 1985. Although several thousand miners will retire in these years, a sufficient supply of younger workers appears to be available. By 2000, however, mine employment is estimated to increase by 45 percent to 110 percent over 1977 levels. Most of these additional workers will be needed in the East and should be available from indigenous coalfield populations. Labor supply does not seem to be a problem in the boom areas of the West because of high wage rates.

Labor-Management Relations and Collective Bargaining

Labor-management relations in the coal industry have never been very good for very long. This stormy relationship has been shaped by the structure of the industry, the level of coal demand, the level of competition among coal producers, the nature of the underground workplace, the social experience of the coal camp, and the history of the effort to unionize the work force.

One measure of the stability–if not the quality–of day-to day relations in the workplace is the level of wildcat strike activity. Miners engage in unauthorized work stoppages more than any other group of industrial workers; underground coal miners strike more than any other group. Over the last 40 years, coal miners have participated in wildcat strikes more frequently when coal demand was firm and employment security was high.

Wildcat strikes occurred with unprecedented frequency between 1973 and 1978 when coal prices more than doubled and demand was growing. These strikes usually begin at a single mine. Sometimes they spread quickly to many others when a disputed condition exists across the coal fields. Most wildcats are limited to one mine and arise over a disputed work condition, interpretation of the contract, or the miners' perception of harassment. Several were precipitated by widespread disgruntlement over broader issues — compulsory shift-rotation, pending black lung legislation, controversial school textbooks, gasoline rationing, the right to strike, the use of Federal injunctions against wildcat strikers, and cutbacks in medical benefits. Since the last contract strike, wildcat strikes have been much less frequent. Poor market conditions, improvement in the grievance procedure, and depleted savings are the probable reasons for the improvement. UMWA and mine management appear to be improving their ability to resolve disputes, which should lead to less strike activity in the future. Many miners are as opposed to the recent level of wildcat strike activity as are their employers because of the loss of income these shutdowns entail. But these strikes have always been a part of coal mining and may never be eliminated. There appears to be little that Federal policy can – and possibly should —do to stabilize this area of private enterprise. Harsh legal penalties against strikers do not seem to deter wildcat strikes in this industry.

Collective bargaining in the coal industry has usually been characterized by acrimony, strikes, cataclysmic rhetoric, and reluctant Federal involvement. The most recent contract impasse came in the winter of 1977-78, when for 109 days, UMWA miners struck their employers, their Government and, it can be said, their own negotiators.

The 1977-78 strike lasted almost 4 months because the Bituminous Coal Operator's Association (BCOA) insisted on a set of dramatic changes in the old contract. These changes—

involving health and pension benefits, the future of the UMWA Funds, whether management would have the right to fire and discharge strikers and absentee workers—were objectionable to rank-and-file miners although they were accepted by UMWA negotiators. BCOA members felt they were necessary to achieve what they called "labor stability. " The contract that was finally ratified incorporated many of the changes BCOA demanded. The ramifications of this contract —the attempted recall of UMWA President Arnold Miller, grassroot discontent, and health care changes — are still working themselves out. It is likely that UMWA members will demand major revisions in the current agreement in 1981.

The executive branch has had little success in mediating contract negotiations in this industry, Both the union and the operators balk at Federal intervention, and miners have little respect for Taft-Hartley injunctions. Short of nationalization of the industry or draconian labor controls, there is probably little that Congress can do to improve the negotiating/contract ratification process. It is essentially a private relationship in the private sector. Rising coal demand and continued prosperity for mine operators should improve the climate of negotiations. As more and more production comes from non-UMWA mines, the national impact of UMWA contract strikes should decline. This was clearly evident last year when, after the 3 '/z-month strike, no power shortages were recorded and only 25,000 workers were laid off.

The dynamics of collective bargaining and labor-management relations are very much in flux. One factor behind the development of western mines is the more tranquil labor situation in the West. Members of BCOA, which has negotiated industrywide contracts with UMWA since 1950, may jointly or separately decide to begin negotiating regionally or on a company-by-company basis. Observers disagree about whether denationalization of collective bargaining will reduce net lost time from contract strikes. High-income western miners may become more inclined to unionize in the future as working conditions and job security supplant wages as their main job concerns. Western miners have had a tradition of militant unionism, and it may be premature to conclude that western mines will necessarily be nonunion operations. UMWA contract strikes are likely to continue to affect most metallurgical and export production, and roughly half of Eastern steam coal output.

Productivity

Although productivity has declined since 1969, the evidence suggests that it has not affected the ability of the industry to produce as much coal as can be sold. Much of the explanation for the rise in productivity in the 1950's and 1960's has to do with mechanization (which cut the work force by 70 percent by 1969), the absence of workplace health and safety regulation, the lack of surface mining controls, the high level of job experience among miners, and the ability of the industry to externalize a variety of production costs. The hidden costs of rising productivity in these decades were unemployment, community stagnation, black lung disease, unreclaimed surface mines, and other environmental problems. Several factors have combined to reduce productivity since 1970. A principal one is that 44,500 UMWA miners– about half of the 1969 UMWA working membership, which represented 74 percent of all miners — retired in the 1970's. These retireees had key production jobs, for the most part, and their productivity was high. Overall, about 60 percent of today's coal workers have been hired in the 1970's. State surface mining regulations cut productivity, as did Federal environmental controls. The 1974 UMWA contract added an estimated 5,000 additional workers to the work force for training and safety reasons. The 1969 Act slowed down certain mining cycles to control methane, dust, explosions, and ground conditions. High prices in the mid-1970's encouraged more than 1,000 small, low-productivity mines to open. In addition, railcar shortages, absenteeism, and poor labor-management relations contributed to low productivity.

The decline in productivity seems to have bottomed out. As more and more production is mined by western surface mines, larger mines, and newer mines (both surface and underground), workers' productivity should increase gradually. Improved labor-management relations and more appealing community conditions should reduce absenteeism, thus raising productivity. An increasingly experienced work force should boost efficiency. Stable prices should discourage inefficient producers and prune inefficient mines. If the industry can lower its injury experience, a contributing source of poor productivity would be addressed. No technological developments appear to be on the horizon that will quickly and dramatically raise productivity, although several innovations, such as continuous face-to-portal haulage and continuous roof support systems, should help. The most promising area for productivity improvement is better job training and restructuring work relations.

Other Factors

Potential constraints on coal production include supplies of water, capital, and equipment, and transportation facilities. Although the United States appears to have an adequate national water supply to meet projected energy requirements in the near-term to mid-term future, severe local and regional shortages as well as institutional constraints on water availability could become problems. Although these problems could be alleviated through water conservation practices in a variety of sectors (e. g., energy, municipal, and agricultural uses), present water pricing and water rights allocation systems do not encourage these practices.

The availability of capital and equipment for coal development are market factors that should not become constraints if the industry remains economically sound. However, the availability of transportation facilities could impose local constraints on coal supply unless track conditions are improved and the supply of railroad cars is increased. Similar local transportation constraints are posed by inadequate coal haul roads and waterway systems.

Federal Coal Policy

Federal coal policy emphasizes two goals: more coal should be mined and burned, but more attention should be paid to controlling the environmental, health, and safety costs of doing so. Congress has enacted legislation to meet both objectives. Sometimes the objective of one legislative measure conflicts with the objective of another. Compromises and trade-offs are often made, either as part of the regulatory process or in litigation.

Much of the discussion about Federal coal policy quickly narrows to a discussion of regulatory restrictions on supply and demand. Lost in this process is the considerable effort given to helping industry produce coal and burn it. Federal research money for coal amounted to about $73 million for the Bureau of Mines and about $669 million for the DOE fossil fuel program in FY 1979. Loan money has been made available to "small" underground operators. Federal tax policy on depreciation and depletion encourages investment and reduces tax burdens. Millions of Federal tax dollars are spent annually on highway construction, inland waterways, and railroads that benefit mine-to-market transportation. The National Energy Act of 1978 promotes coal as a primary energy source. The Act significantly strengthens Federal authority to order combustion facilities to convert to coal by prohibiting the use of oil or natural gas in new facilities as well as the use of gas in existing facilities after 1990. However, the impact of the prohibitions may be difficult to ascertain because most utilities are not planning new oil or gas units. Where the prohibitions could have a major impact—on smaller industries — the amount of coal involved is not as great and exemptions are more easily obtained.

Significant Federal regulation of coal production and combustion is relatively recent, beginning in 1969 with the Federal Coal Mine Health and Safety Act. Although mine safety legislation had been enacted as early as 1910, it appears to have had little impact on fatalities and injuries. The 1969 legislation improved some mine conditions significantly, resulting in fewer high-fatality disasters and lower dust levels. It did not, however, specifically address injury-prevention and little improvement has been recorded since 1970 in this area. The 1977 amendments required training programs and tightened other aspects of the 1969 Act. To control respirable dust, methane, poor roof conditions, explosive conditions, and other hazards, the 1969 Act required mine operators to take extra safety measures and hire more safety-related personnel, which contributed to declining productivity. However, this is a very complex issue and it has not been demonstrated that the 1969 Act is the principal cause of the decline, although it has been a factor.

The Surface Mine Control and Reclamation Act of 1977 is designed to change coal mining practices that generate severe social and environmental costs and to prohibit mining in areas that cannot be reclaimed. The Act sets performance standards intended to prevent adverse environmental impacts, such as ground and surface water contamination and degradation of agricultural land quality. Operators must demonstrate, as a prerequisite to obtaining a mining permit, that the land can be restored to a postmining land use equal to or better than the premining use. In addition, significant constraints are placed on coal mining in the prime farmlands of the Midwest and in the alluvial valleys of the arid and semiarid regions of the West. Enforcement of these standards will play a critical role in determining the effect of the Act on coal production.

Much controversy exists over whether and to what degree the 1977 Act will impede coal production. Certainly, it will increase the costs of surface-mined coal. It may also hit small operators harder than larger companies. Productivity may be affected as more worker time and equipment are devoted to preventing environmental damage. It will be several years, however, before an accurate assessment of the impact of this Act can be made.

The major concerns in managing the environmental impacts of coal combustion are its effects on air, water, and land quality. General environmental management is regulated under the National Environmental Policy Act of 1969 (NEPA), which requires that all Federal agencies include a detailed environmental impact statement (EIS) in every recommendation or report on legislative proposals and other major Federal actions significantly affecting the quality of the human environment. Most major Federal coal-related programs (such as leasing) and federally permitted activities (such as construction of a powerplant) are subject to the EIS requirement. Although the EIS process has increased institutional awareness of the need to minimize adverse environmental impacts, it has been criticized for its alleged attention to procedure over substance-and for the time it adds to the beginning of a project. In 1978 the Council on Environmental Quality promulgated new EIS regulations that are designed to reduce paperwork and delays, improve EIS quality, and better integrate the EIS into agency decision making. These new procedures should remove most of the objections to NEPA and result in better decisions and greater environmental protection.

Federal policy toward air quality is implemented under the Clean Air Act Amendments of 1977, which will speed achievement of ambient standards and allow greater growth in the future since each new facility will limit its emissions as strictly as possible. However, the amendments do not reflect a consistent unified approach to some of the fundamental problems, and the overall effect of the Act is difficult to assess. Exemptions for smaller sources and the Amendments' failure to deal with pollutant transformation and transport may undermine the air quality protection intended to accommodate new large coal-fired sources. Coal-fired facilities may also require greater expenditures for pollution control equipment or be subject to stricter siting and other preconstruction review procedures; thus they may be at a competitive disadvantage relative to cleaner fuels. In addition to these increased costs, coal combustion may be prohibited near areas where air quality-related values are important, such as national parks and wilderness areas.

Similarly, water quality impacts of coal mining and combustion are regulated under the Clean Water Act, which requires coal mine and combustion facility operators to meet effluent limitations designed to achieve Federal water quality goals. The techniques for meeting these limitations are available, but may require mine operators to institute waste water treatment and may increase the costs of both mining and combustion.

The Resource Conservation and Recovery Act regulates the disposal of solid wastes from coal-related activities, including ash and scrubber sludge and mine wastes. If these wastes are listed as hazardous, RCRA will impose strict disposal and recordkeeping requirements that will significantly increase coal combustion costs. However, the environmental and health benefits from preventing the open dumping of these wastes are also substantial.

Implementation

Numerous departments and agencies are responsible for implementing Federal policies that affect the production and use of coal. Those with substantial roles include EPA, which regulates the byproducts of coal use through administration of the Clean Air and Water Acts and RCRA; the Department of Labor, which is responsible for miners' health and safety; the Department of the Interior, which administers SMCRA; DOE, which has the authority to order coal conversions and, in cooperation with Interior, administers the Federal coal leasing program; and the Council on Environmental Quality, which has primary oversight responsibility for NE PA. In addition, numerous interagency consultation and coordination requirements involve a variety of other departments and agencies in policy implementation.

Some critics of Federal coal policy argue that energy development is overregulated. Others contend that more regulation is needed, either because of the way agencies have interpreted their mandates or because conflicts or gaps among those mandates preclude the existence of either a coherent national coal policy or a coherent environmental protection policy. The major factors affecting implementation of such policies, in addition to those mentioned above, include the lack of comprehensive Federal programs for leasing, land use, and water resource management; the absence of workable mechanisms for resolving interstate or interregional pollution problems; and the focus on immediate problems to the detriment of long-range planning. These could hamper increased coal use in the short-term and midterm future.

In general, Federal policies that affect coal-related activities are not expected to constrain increased coal use in the long term. The requirements of the Clean Air Act impose the most significant constraints in the short term, both by limiting the number of available sites for combustion facilities and by substantially increasing the costs of combustion. However, the air quality benefits that will result should facilitate coal combustion in the long term. The cumulative effect of all other existing regulations may delay the construction of new facilities or the opening of new mines and will make both mining and combustion more expensive.

Future Policy

Each of the national energy supply and demand scenarios in this report involves a substantial increase in coal use over the next two decades. There is no doubt that the resource is physically present and accessible to sustain a high level of use over that period. It is also clear from an engineering standpoint that coal can be extracted, processed, and burned at a cost that will make it very competitive with other fuels. What is not clear is how the external costs, institutional and social constraints, and other nonmarket factors associated with coal use will affect the validity of the economic and technological analysis. At one extreme, increased coal use might pose such serious external costs to the environment and public health that strict limits on its use would be required. At a minimum, the process of reducing external costs — by increasing, for example, pollution controls and coping with internal constraints (such as labor-management conflicts)—will moderately increase the economic costs of coal utilization. Given the central place of coal in future U.S. energy planning and projections, the stakes involved in formulating a national coal policy are substantial.

The task of policy analysis in this area is to identify the potential problems and constraints and to examine the range of governmental policies that offer some promise of amelioration. There are three basic types of criteria for choosing among these Government policies: 1) national objectives concerning the timetable for and level of coal production and use, 2) political and normative values, and 3) pragmatic calculations concerning the absolute and relative efficacy of policies in stimulating production and use and/or minimizing adverse impacts.

National objectives concerning the magnitude and timing of coal use set the context within which coal policy is formulated. The mining industry should be able to double or triple its production by 2000 if current conditions continue. Existing and pending environmental, health and safety, leasing, and other legislative and regulatory requirements may be costly but otherwise appear to be compatible with greatly increased coal production.

Nevertheless, there are actions that will provide an additional margin of safety against the possibility that these supply projections are overly optimistic or that it becomes necessary to raise coal's fraction of U.S. total energy supply above the levels posited in this report. Many of these measures have merit independent of their potential effect on coal supply. The list includes efforts to: 1) mitigate the adverse community impacts that might constrain coal development, 2) address the causes of labor-management disputes, 3) anticipate and avert potential coal transportation bottlenecks by upgrading existing modes (e. g., railroads) and facilitating the creation of new ones (e. g., slurry pipelines), 4) expedite the formation of a leasing policy and the designation of eligible tracts, 5) streamline the permitting process for new mines, and (6) develop procedures for anticipating and accommodating potential objections to new coal facilities in order to avoid extensive litigation and delay.

Demand is more likely to be a constraint on coal development over the next two decades than is supply. While demand will probably be adequate to sustain all but very high energy scenarios, this is far from certain. Several broad policy options are available to strengthen the future market for coal. These include: 1) tax pressures and incentives to induce utility and industrial conversion to coal, 2) RD&D support for technologies (e. g., FBC and SRC) that can help make coal an acceptable fuel for small users, 3) RD&D support for improved, less expensive emission control technologies, 4) RD&D support for coal gasification and liquefaction technologies, and 5) higher prices for natural gas and fuel oil through deregulation or surcharges. It is most likely, however, that no significant policy initiatives will be required to reach plausible supply and demand projections. In sum, the targets discussed in this report regarding coal production and use for the remainder of the century do not emerge as a critical basis for sorting among legislative and regulatory options; both rapid growth and the current controls can be accommodated.

The choice between conflicting courses of action will often require subjective judgments concerning what is desirable. With regard to coal policy, the most important value conflict involves the relative priorities to be assigned to increasing production and to reducing adverse impacts. The existing legislation and regulations define a rough but discernible balance between these two value sets. Future policy may maintain that balance or shift it in favor of either production or impact amelioration. This choice lies at the heart of national coal policy. Specific dimensions of the choice include tradeoffs between: coal extraction and environmental quality, coal combustion and environmental quality and public health, coal extraction and the well-being of coal field communities, and coal extraction and workplace health and safety. A second value conflict arises over whether increased Government regulation is the appropriate way to achieve national energy policy goals, or whether the emphasis should be on broad guidelines (performance standards), negotiation, and mediation. Finally, if regulation is determined to be necessary, value conflicts will result from the allocation of decision making authority among the various levels of government: Federal, State, local, and tribal. Value judgments and priorities, then, play an important role in shaping coal policy choices.

Judging policy options also involves an assessment of the utility of different policies in solving the specific production, utilization, and impact problems associated with coal. Five major areas of policy concern have been identified, each with a potential for significant influence on efforts to expand the production and use of coal. They are: 1) environmental impacts, 2) community and social impacts, 3) labor-management relations, 4) workplace health and safety, and 5) leasing of Federal coal reserves.

Environmental Impacts

Environmental considerations are an important potential constraint upon a substantial in-, crease in coal production and combustion. The era of unregulated environmental impacts is clearly past for coal, as for other fuels. An elaborate, though still incomplete framework of legislation, regulation, and implementing institutions is in place. It constitutes a national policy system for managing the environmental impacts of increased coal use. The relevant control technologies are at various stages in their evolution from conception to maturity, but most have at least reached the point where a first-generation technology can actually be applied. Control technologies for combustion emissions are particularly important, and although existing technologies are far from optimal, the outlook is promising. In short, after the investment of substantial economic, technological, and human resources over recent years, the ingredients of a viable environmental policy for coal now exist.

Under these circumstances the paramount task of policy analysis is to identify ways that the existing policy system might be upgraded with regard to:

- gaps in present knowledge about the nature and magnitude of the risks to the environment associated with coal utilization,
- the performance and future prospects of specific control technologies and the means of stimulating improvements,
- omissions, inconsistencies, or disutilities in existing environmental laws and regulations,
- implementation of laws and regulations, and
- promising new policy innovations or instruments.

Community and Social Impacts

A comprehensive national energy program also may include policies designed to alleviate the adverse community impacts associated with coal development. These policies, if they are to be effective, must take into account two basic characteristics of the present situation. First, there is considerable uncertainty over the nature of future coal development impacts and the balance of benefits and costs that will accompany them. Second, value disagreements over what impacts are beneficial and what are adverse occur even where the nature of these effects is understood. Whether economic growth itself is to be viewed as a positive or negative phenomenon in particular localities is itself the subject of dispute. Nevertheless, a number of potential adverse community impacts can be identified including overloaded public services, hyperinflation, and various symptoms of social stress and instability. A number of general and specific policy measures designed to cope with these problems can be identified, ranging from, Federal grants to coalfield communities for public works construction to studies of ways to limit the corrosive impact of energy development on Indian tribal culture. Given the uncertainties and value disagreements regarding community impacts, there is a need for policies that seek to deal with the concerns of interested parties in a context where compromise is encouraged. This will occur if all parties affected by increased coal use participate in decisions about the location, timing, and scale of coal developments that directly affect them and if Federal policies are designed to distribute the risks, costs, and benefits of increased use equitably among al l affected parties.

Labor/Management Relations

Although recent instability in labor-management relations in the coal industry has been significant mainly at the local and subregional level, future instability could have significant implications for the national economy. Consequently, Federal policy makers may try to actively influence the situation. If so, their task is twofold: deciding how to ameliorate the causes of destructive labor-management conflict and lay the groundwork for a more constructive long-term relationship, and planning ways to cope with future strikes, should they occur.

Under present legislation the Federal Government can do little to alter directly the terms of labor-management relations. The principal causes of wildcat and contract strikes are the conditions of work and terms of employment. They are essentially privately determined matters. However, some policies can alter the context in which the unions and operators interact. These include measures designed to ensure steady growth in the demand for coal in major sectors of the economy. The recently passed National Energy Act contains a number of these provisions. A healthy market should ease the historic economic insecurity—of both operators and miners—that has been such a large factor in the industry's labor problems. Other promising actions are equally indirect and relate to the basic social, economic, and environmental ills that contribute to the miners' discontent. They include such diverse measures as improving dust monitoring and control within underground mines to restoring Appalachian trout streams.

In the event of another major coal strike the Federal Government would have an interest in promoting a settlement that is prompt and noninflationary, and one that establishes the basis for long-term labor-management stability. In pursuit of these objectives, five major strategies will be available: 1) reliance on collective bargaining with limited Government intervention, 2 collective bargaining with strong Government involvement, 3) use of Taft-Hartley with limited efforts at enforcement, 4) Taft-Hartley with vigorous enforcement, and 5) Government seizure of the mines. Each of these options has opportunities and liabilities that vary with the particular circumstances of a strike; however, as noted previously, past Federal intervention in coal field labor-management disputes has been counter-productive.

Workplace Health and Safety

Mining, particularly underground, is a hazardous occupation as measured by the record of work-related accidents and diseases. Any substantial increase in coal production inevitably will mean thousands of diseased and injured miners. The question facing policymakers is what modifications in or additions to existing standards and enforcement might minimize that number? Efforts to answer this question will focus on improved dust control, research related to the appropriate dust standards, and research on the effects of new pollutants and the synergistic impacts of multiple pollutants in terms of mine health. The major need in mine safety is to develop an accident-reduction strategy to limit the rising number of disabling injuries, which now amount to about 15,000 a year and result in 2 months or more lost time each, Improved safety and job training, education in different work practices, changes in management and worker attitudes, and new Federal safety standards for mine equipment are some approaches to this problem.

Leasing of Federal Coal Reserves

Western coal comprises roughly half of the Nation's coal reserves and the Federal Government owns 65 percent and indirectly controls another 20 percent of that resource. Consequently, Federal policy concerning the leasing of those reserves can have a substantial influence on the future of coal use. The most basic policy question concerns whether additional leasing of Federal coal lands will be required to meet projected increases in demand, and, if so, when and how much. The answer remains unclear; the 1977 amendments to the

Clean Air Act may have reduced the attractiveness of Western coal for utilities, and legal uncertainties surround the status of pending lease applications. In any case, recent litigation means that no new leasing will be possible until the early 1980's at best. Assuming that it will become necessary at some point to resume leasing, the Federal Government will have to decide to what extent private industry should be allowed to determine which lands will be made available. One option would permit operators to nominate those Federal lands they desire to mine and the Government to approve or disapprove the proposed lease. Under a second option the Government would identify areas eligible for leasing and industry would nominate specific tracts. Still another option would leave to the Government selection of both the areas and specific tracts for leasing. The comparative attractiveness of these options will depend on whether the principal selection criteria are reducing planning and administrative costs, minimizing environmental damage, increasing tonnage mined, forestalling litigation, or controlling adverse socioeconomic impacts. Whichever approach ultimately is selected, a number of specific issues will have to be clarified. They include definition of logical mining units, status of preference-right lease applications, requirements of diligent development and continued operation, estimated recoverable reserves, advance royalty payments, and the exchange of environmentally sensitive leased lands for other unleased Federal land. Some important institutional issues center on the division of leasing responsibility between the Departments of the Interior and Energy. The Department of the Interior has the overall responsibility for the leasing program, but DOE controls economic leasing terms and conditions.