September 22, 1977

COAL CONVERSION : COSTS AND CONFLICTS

INTRODUCTION

In his April 20th energy message, President Carter indicated that one of the cornerstones of his program would be the undertaking of a widespread conversion of our nation's industrial and utility boilers from oil and natural gas to coal. In light of the fact that from 80% to 90% of our nation's energy endowment consists of our coal reserves, this policy would appear to be logical. There are, however, considerable difficulties attendant on the implementation of such a program. Existing environmental regulations in the areas covered by the Clear Air Act and by recent surface mining legislation will make the acquisition of additional supplies of coal and their utilization far more difficult than in the past. This is particularly true of regulations governing the allowable levels of suspended particulants.

The amount of capital which will be required for expanded coal production is staggering. For the period between 1978 and 1985, it is conservatively estimated that this cost may be well in excess of $100 billion. Another consideration is that there are serious questions as to the availability of the human resources necessary to accomplish the goal of expanding production to 1.2 billion tons annually by 1985. There will be a tremendous increase in the demand for skilled tradesmen, miners, engineers, and other occupational specialties. At present, it is uncertain whether they exist in sufficient numbers to accomplish such a massive undertaking as is indicated by the projected increase in coal production. It should be noted that the coal industry will be competing for these skilled workers with other energy industries which are also attempting to expand production within the same time frame.

Addressing the questions surrounding coal conversion will be of primary importance in the coming months. Because the House and Senate have not as yet come to conference, there is still some uncertainty as to the exact nature of the final version of the coal conversion requirements. Whatever the final form, however, it will not change the essential nature of the problems created by this dramatic shift in our energy mix. These problems must be solved if our nation is to fully utilize this promising energy resource. To a large degree, it will be the resolution of such concerns which will determine whether the promise of coal is to become a reality.

AIR POLLUTION STANDARDS

One of the primary characteristics of coal is that it is a singularly dirty fuel. This fact was recognized in the President's energy message by the requirement that all facilities utilizing coal employ what is termed "The Best Available Control Technology" (BACT). Generally, this term is used in reference to "scrubbers." These are devices which remove the sulphur dioxide from smokestack gas. Requiring the installation of these pollution control devices will be among the most controversial aspects of the re-emphasis of coal. First, they are extremely expensive. For example, it has been estimated that the cost of installing a scrubber for a coal-fired utility plant is around $100 per kilowatt[1]. Secondly, scrubbers are notoriously inefficient, often operating properly as little as 70% of the time.[2] Finally, there is some question as to whether or not they are necessary. It has been suggested in some quarters that the use of such pollution control measures as tall stacks and intermittent production techniques would serve as well in many parts of the country, and at a far lower cost. Regardless of what means are ultimately employed to control emissions, it is unlikely that the current standards under the Clean Air Act can be met. One of the main reasons for the difficulties surrounding compliance with the standards contained in the Clean Air Act is found in the fashion in which those standards were developed. Under the language of the original Clean Air bill, there was a very tight deadline for setting the allowable levels for the six major pollutants. To a large degree, the standards were based on the Chess study. This document, which has been the subject of great controversy, remains, however, the basis for our national standards.[3] It has been argued that these standards are so stringent that they are impossible to meet, at least in some categories. This point of view has become increasingly credible with the advent of court decisions which deal with the concepts of "non-degradation," and "non-attainment."

Non-degradation is a term used in reference to certain areas of the country which have pristine air. Many of these areas are found in the South and Southwestern United States. Current policy, following various court decisions, does not allow the development of facilities in those areas which would produce pollutants in quantities sufficient to degrade the air quality. Due to the strictness of the national standards, this policy has amounted to a virtual ban on the construction of any major facility in these areas.

Non-attainment refers to those areas which have failed to meet the national ambient air quality standards for one of the six major pollutants. It is important to note here, that exceeding any one of the six will lead to an area being categorized as a non-attainment area. In these areas, no facility which contributes significant amounts of the pollutant in violation of the standard may be constructed. The impact of these policies on coal conversion becomes evident when the extent of non-degradation and non-attainment areas are examined.

For example, take the case of suspended particulants (which are background dust). With the use of coal, a fairly high level of suspended particulants is likely to be emitted. This, under current policies, would be expected to preclude the construction of any major coal-fired facility in a non-attainment area for suspended particulants. As a result, this standard is likely to be a serious barrier to the construction of such facilities virtually anywhere in the United States. With the exception of Southern Florida and a few isolated areas located primarily in the far west, every Air Quality Control Region in the United States, including all of Alaska and Hawaii, is in violation of the ambient air quality standards for suspended particulants[4]. Furthermore, there is little hope that these areas will ever be brought into compliance. The reason for the difficulties with suspended particulants stems from the fact that background pollution is normally included in computing the amount of air pollution in a given region. Background pollution is that which normally occurs in the environment from natural causes. For example, there are large amounts of dust (suspended particulants) generated naturally in the Great Southwestern Desert. In this instance, the dust is sufficient to violate the national ambient air quality standards. As a result, it is a non-attainment area.[5] Therefore, you could not build a major coal-fired plant in the middle of this uninhabited desert. This problem with background pollution is not limited to suspended particulants. For example, an effort to construct an oil refinery in Virginia was stopped because that area was in violation of one of the ambient air quality standards. This would not seem to be a problem, except that the reason the area was in violation was that the air contained large amounts of swamp gas generated by decaying vegetation in the Great Dismal Swamp. In fact, under the current regulations, there is no possibility that the area will ever be brought into compliance.

If coal utilization is to take place on the scale intended, some sort of analysis of the national ambient air quality standards must be undertaken. Questions as to whether the standards are realistic or whether they are even concerned with the proper pollutants must be answered. Also, some effort must be initiated to determine what sort of balance between environmental and economic interests should exist. Pollution control technology is highly capital intensive. As our nation proceeds in its efforts to diversify its energy mix, such capital consumption should be carefully examined to insure that its expenditure is warranted in view of capital needs in other energy-related endeavors.

SURFACE MINING

A second area of major concern regarding the relationship of the widespread use of coal to the existing framework of environmental legislation is found in the new surface mining law. Whereas the Clean Air Act affects our ability to burn coal, the surface mining law affects our ability to mine it. It is doubtful that coal will be produced in sufficient quantities to meet the 1985 goal given the framework of the current surface mining law.

An initial impact of the surface mining law is that it will remove a significant portion of our coal reserves from potential production. One study has indicated that somewhere between 2% and 6.5% of total reserves will be affected.[6] More significantly, these reserves represent between 6.2% and 20.7% of our total strippable reserves. To put these percentages in perspective, they account for as much as 28.3 billion tons of coal.[7] This is nearly 24 times the 1985 production goal. In addition to the reserves, which will be withdrawn from possible production, there is also concern that current production may be hampered by the law's somewhat ambiguous language. As currently constituted, the language allows for a very broad spectrum of interests to be afforded standing in the courts. As a result, parties which have no real interest in the operations of a given mine may be allowed to sue operators to prevent the initiation or continuation of surface mining. It is quite possible that lengthy litigation will cause mine operators to shut down. Examples of this sort of occurrence may be found in the nuclear energy field, where lengthy litigation caused by environmentalist suits have led to a virtual moratorium on new orders for nuclear facilities. Just as with nuclear power, the potential exists for a small group of environmental extremists to create serious and costly delays, ultimately resulting in a diminishing of the ability of our nation to provide the electricity necessary to meet projected demand.

Another provision of the surface mining law which holds considerable potential to reduce recoverable reserves is the provision that allows the owner of the surface land to withhold consent for mining of the subsurface. It has been estimated that this provision could be responsible for the removal of as much as 8.5 billion tons of coal from our reserves.[8] While it is true that the degree to which these reductions in reserves occur will depend on interpretations of the law, past experience with such interpretations in the courts tends to lend credence to the concept that the impacts will be severe. Along the same line, other areas of this law contain numerous ambiguities which may lead to regulatory or judicial decisions contrary to the actual intent of the Congress. Ultimately, such decisions may have a far greater effect on mining operations than any of the specific sanctions written into the statute itself. One area, however, is certain to cause considerable difficulty: the permit process. It has been suggested that the permit process written into the new surface mining law is the most complex application process ever designed. While this may be an overstatement, there is little doubt that it will add considerably to the lead time in opening or expanding mine operations. One of the main problems with the process is the deep involvement of the federal government in each of the steps along the way. Mine operators already complain about bureaucratic delays, and these new requirements can only add to them. While it is difficult to put a price tag on such matters, there have been several attempts made at estimating what they will be. The range of estimates is tremendous, with various mine operators estimating that the cost of obtaining a permit to surface mine coal may rise from $20,000 to as much as $80,000. In a similar vein, there are widely disparate estimates as to the total cost which can be attributed to the surface mining legislation. The lowest estimate comes from the TVA which reports that the cost would likely amount to $4 per ton of coal.[9] This would mean that the cost through 1985 would be in the neighborhood of $15.5 billion.[10] Other estimates, which place the cost at as much as $10 per ton would raise that figure to $38.8 billion. Only one thing is certain: the cost is going to be high.

THE GREENHOUSE EFFECT

Recently a new concern has surfaced with regard to the widespread use of coal. This concern is centered on what has been termed "the Greenhouse Effect." The phenomenon derives its name from allegations that its ultimate effect will be similar to that of the glass in a greenhouse. It should be noted at the outset that a great deal of the statements concerning this phenomenon are based on either speculation or at best a marginal data base. As a result, it is still uncertain as to whether or not the effect will really occur, much less whether or not its impact will be severe.

What advocates of the existence of the Greenhouse Effect contend is that the immense amounts of carbon dioxide which will be generated by the widespread burning of coal will eventually find their way into the upper atmosphere. Currently, heat radiated by the Earth is able to penetrate this upper atmosphere and escape into space. As the barrier of carbon dioxide thickens, it will become increasingly difficult for this heat to escape. Ultimately, the effect will be to raise the mean temperature of the earth by several degrees.

With this increase in the mean temperature, there will supposedly be a number of adverse effects on the world's weather patterns. Part of the reason given for this is that the polar ice caps will begin to melt. This will in turn cause a rise in the amount of moisture in the atmosphere, and with it an increase in rainfall. It also will affect many of the air currents which, at present, cause existing weather patterns.

Since the advent of the industrial revolution, there has been a measurable increase in the amount of carbon dioxide in the atmosphere associated with the increased use of coal. The actual impact of this increase is speculative. Further, it will be several decades before any major impact would occur from such a phenomenon. Therefore, it is probably safe to assume that for the short run, this phenomenon should not be of great concern. For the long run, however, some sort of study is probably in order to determine to what degree, if any, the generation of carbon dioxide will inhibit the earth's ability to dissipate heat.

THE TRANSPORTATION OF COAL

There are three major modes of transportation currently employed to move the bulk of our nation's coal: rail, barge, and truck. In terms of proportionate share, railroads move the overwhelming majority of coal (66%).[12] Of the remainder, barges move 11% and trucks 11%. There is a considerable difference, however, in the length of the hauls for each of the three main carriers. Rail transport has by far the longest hauls. Barge traffic along our inland waterway system also hauls relatively long distances, with the average being around 480 miles.[13] Trucks, however, are used almost exclusively for short hauls, generally averaging in the neighborhood of 50 miles.[14] Also, trucks are employed for the most part in hauling coal to electric utilities.

Of the three types of transport, the most attention has been focused on the railroads. This is in large part due to the difficulties experienced by carriers in the northeastern corrider in recent years. Questions as to the state of the roadbeds, the availability of hopper cars and locomotives, and as to the ability of the railroads to obtain the financing to make necessary improvements have all cast doubt on the railroads' ability to meet coal transportation needs. At the same time, even critics of the railroads recognize the vital role they must play if widespread use of coal is to become a reality. It is, therefore, useful to examine the current condition of our rail system, and the capital requirements associated with upgrading it to meet the transportation needs accompanying the switch to coal.

RAIL TRANSPORT PLANT AND EQUIPMENT

Basically, there are three components contributing to the capital requirements associated with the improvement of our rail system to carry additional coal. The first of these is the construction of new and replacement hopper cars. These cars are virtually the only type used by the railroads to transport coal. Depending on when they were built, hopper cars can carry anywhere from 55 to 100 tons of coal. At current levels, the cost of constructing one is around $30,000 and their average life span is 30 years. In recent years, there have been some reports of shortages of these cars. These shortages, however, have been the result of inefficient allocation rather than actual physical deficits. It should be noted, that other commodities are also carried by these cars, and compete for them to a degree.

Due to current poor allocation, there is considerable flexibility in the current turnaround time experienced by hopper cars carrying coal. Currently, the average is thirteen days.[15] It is believed that this time can be reduced to a considerable degree, and as a result, significant increases in the volume of coal transported can be experienced without correspondingly large increases in the number of hopper cars in existence. Regardless of the improvements in hopper car utilization, however, some new car capacity will have to be added. Further, a considerable number of cars will have to be purchased to replace those which are reaching the end of their useful lives. One aspect of hopper car utilization, which has not been fully considered, is the transportation of lime and limestone for the scrubbers (which will be employed to meet the environmental regulations concerning coal use). An average of one ton of limestone must be provided for each four tons of coal. Most of this lime and limestone will be transported by truck, but the railroads will still have to carry a certain amount of it. The movement of lime and limestone does not lend itself to the use of unit trains as does the movement of coal. Therefore, the utilization of hopper cars for this purpose will be less efficient than in the case of coal.

It is possible, by extrapolating from an actuarial curve of the age of existing hopper cars, to make a determination of future hopper car needs. If one assumes that the turnaround time can be reduced from the current thirteen days to 6.1 days, there will be a need for 35,100 additional cars to carry coal. These are cars over and above those currently owned by the class 1 carriers, utilities, and other coal carrying interests.[16] There will also be a requirement for 2,494 new cars to carry lime and limestone.[17] The railroads will need to acquire 157,038 hopper cars to replace those which are currently carrying coal and which will reach the end of their useful lives,[18] and will have to replace 9,915 cars to maintain the capacity to carry limestone.[19] It should be noted that these figures are for the period of 1978 through 1985. This means that the railroads will have to obtain a total of 209,247 hopper cars between 1978 and 1985 to move the coal projected for production over this period. The cost of these cars, assuming a $30,000 per unit purchase price, will be $6.3 billion in 1977 dollars.

Hopper cars are not, of course, the only consideration. The railroads must also acquire the locomotives to move them. As a rule, these are 2,400 horsepower diesel units, costing around $500,000 each. Roughly 4,230 of these units will be required to carry the additional coal under the new energy initiatives.[20] Some 265 will be required to carry limestone.[21] This means that there will be a total of 4,495 locomotives needed by 1985, at an approximate cost of $2.2 billion.

Some observers have expressed concern over the ability of the railroads to obtain sufficient new and replacement cars and engines due to lack of capacity in the industry to construct them. While it is true that few railroads have in-house capacity at present, there is little information to support this contention. Without expanding current capacity, the manufacturers of hopper cars could easily handle the additional demand. The only possible problem may be in the area of castings due to the numerous closings of small foundaries. In the case of engines, domestic producers feel confident that they can meet the demand for the additional equipment. Rolling stock has enjoyed an extemely low default rate, so the financing of such equipment should be no real problem. Where they may be some problem is in the area of track renovation. The major problem concerning the upgrading of track is focused on the lines which serve the Midwest. These are commonly referred to as the "Granger" lines stemming from the fact that they were initially constructed to handle primarily agricultural traffic. These lines have suffered considerable neglect. Also, many of them are in relatively poor financial condition. As a result, they are likely to experience considerable difficulty in obtaining the initial financing for track repair. Once their track is upgraded, however, it is likely that the advent of coal will turn them into paying lines.

Most of the coal carrying lines in the northeast corrider are in fairly good shape. The "Chessie" system, which includes the Chesapeake and Ohio, is among the most profitable lines in the country and, since it already carries a large amount of coal, it is equipped with the heavier track necessary for unit trains. Conrail, which would also carry a large percentage of the coal traffic in the northeast, is also in fairly good shape. Conrail received a $2.1 billion subsidy from the federal government to improve its roadbeds, and will do so with or without the advent of coal.

The total amount of capital necessary for renovation outside of Conrail is difficult to estimate. A study by Tom Dyer Associates in Boston, Massachusetts estimated the cost of renovation at more than $8 billion. Other estimates have placed the cost at as much as $12 billion. A more accurate picture with regard to coal may be obtained by looking at the Ex Parte 305 reports. These are reports filed by each railroad and includes the amount of deferred maintenance for each line. While there is some inconsistency in the reporting, they probably constitute as clear a picture as any of the minimum work necessary to carry the additional coal. This figure is around $3 billion. In summary then, the total cost of improving our railroad system to cope with the additional coal which will be produced if the energy goals are met will be $11.5 billion. This figure represents $1.3 billion for new hopper cars and $5 billion for replacement hopper cars for a total of $6.3 billion; $2.2 billion for new locomotives, $3 billion for track renovation. Surprisingly, this enormous capital investment is actually the smallest portion of the total investment which the widespread use of coal will require. Much higher costs will come from such areas as boiler conversion and surface mining legislation. Without this investment, however, increased coal use will simply be impossible.

FUEL CONSUMPTION FOR COAL TRANSPORTATION

One aspect of increased coal consumption which has not been widely considered is the amount of petroleum which will be consumed in the course of transporting the coal. The energy efficiency of the three main modes of transporting coal vary widely, with barge and rail transportation approximately equal, and with trucks being far more energy intensive. Barges consume from 540 to 680 btu's per ton-mile, railroads from 536 to 791 btu's per ton-mile and trucks from 2,518 btu's per ton-mile to 2,800 btu's per ton-mile.[22] This makes trucks roughly four and one-half times as energy-intensive as either barge or rail. Trucks, however, are necessary for certain types of hauls, and their use will likely continue. If the current shares of tonnage do not change substantially with increased use, then the total additional petroleum required to transport the additional coal will be the equivalent of 38.5 million barrels of oil per year. The aggregate cost of this between 1978 and 1985 will be in the range of $2.6 billion dollars in current terms. More important than the cost is the possibility that our coal transportation system could be vulnerable to disruptions caused by interruptions of our oil supply.

SLUDGE REMOVAL

An aspect of coal which affects both transportation and the environment is sludge removal. One of the by-products of smokestack gas scrubbers is a viscous substance commonly referred to as sludge. This substance contains calcium, sulphur compounds, fly ash and a number of other pollutants which are removed prior to the smoke entering the atmosphere. Sludge is referred to in two fashions, wet and dry. The only difference between the two substances, not surprisingly, is that dry sludge has had most of the water removed. The disposal of sludge is becoming a major problem as scrubbers are installed on an increasing number of facilities. It is estimated that an average scrubber on a 1,000 megawatt electric plant generates one foot-acre of sludge each eight hours.[23] According to FEA data, there will be an estimated 45 million tons of sludge generated each year by 1985,[24] and an estimated 300 million tons per year by 1998.[25] The costs of disposing of this substance have been estimated at anywhere from $4[26] to $22.10 per wet ton.[27] Commonwealth Edison is currently experiencing a cost of $17.10 per wet ton for sludge disposal.[28] Between 1978 and 1985, it will cost $2.2 billion to dispose of the sludge generated by coal-fired facilities.[29] Hopefully some commercial use will be discovered for the substance in the long run, but if not, it will present a major problem for generations to come.

BOILER CONVERSION

The entire thrust of the re-emphasis of coal is aimed at encouraging industry and electric utilities to burn this fuel instead of oil or natural gas. In 1978, these users will consume approximately 1.8 billion barrels of oil,[30] and 8.2 trillion cubic feet of natural gas.[31] Elimination of this portion of our total demand for these fuels would obviously be of great assistance in coping with the shortages so frequently predicted. Also, both oil and natural gas have an alternative use as petrochemical feedstocks. It has been suggested that this use is of such great importance for future generations that they are actually too valuable to burn. Regardless of the merits of this argument, it is a fact that additions to reserves have been diminishing under the current system of price controls. It would, therefore, appear that shortages are quite possible. As our dependence on foreign oil increases, so does our vulnerability to embargo. The logic behind coal conversion is apparent. What is not certain, however, is whether or not we can accomplish widespread conversion within the time framework generally advocated. Constraints of capital, manpower, and manufacturing capacity may hamper efforts to convert. To a large degree, the extent to which these constraints are alleviated will determine the success of this program.

One of the current problems in assessing the feasibility of coal conversion is that it is, as yet, not clear which version of the program will be enacted. The House-passed measure is far more stringent than that passed by the Senate. Both differ in substance from the Administration's original proposal. In the Senate version, boilers with a capacity of 250 million btu's or better would have to convert from burning oil or natural gas to coal. There are currently, roughly, 2,200 boilers with a 250 million btu or better capacity in the United States,[32] of which 1,452[33] are currently fired by oil or natural gas. Some of these are what is termed "coal convertible," however, the overwhelming majority are not. Most of those which do possess the capability of converting to coal were originally coal-fired and were later converted to burn oil or gas. For the most, these are older units with a mean age in the range of 20 to 22 years[34] out of a useful life of 30 years. The boilers which were built to burn oil or natural gas are far more recent for the most part with a mean age of 12 to 15 years and similarly to the coal-fired units, a useful life of 30 years. The cost of boilers in this category ran from $2 million to $4 million when they were installed. In the instance of the coal fired boilers, their age mitigates against conversion of the existing facility. For most companies it will be far more economical in the long run to replace them. In the case of the newer boilers which were originally built to burn oil or natural gas, it is simply impossible to convert them to burn coal, so they too will have to be replaced. Because of the requirement that all new coal-fired facilities use scrubbers, the cost of replacement facilities will be much higher than the original price of the units being replaced. A 250 million btu boiler currently costs around $10.5 million to install,[35] including pollution control equipment. This does not consider the added facilities which will have to be constructed to store coal, and to remove sludge produced by the scrubbers. There is also a cost associated with the unamortized capital which results from the curtailed life span of the units being replaced. Assuming that two-thirds of the units to be replaced were originally built to burn oil or natural gas (this is probably low) and the remainder were the older units which were originally coal-fired, then the cost of the unamortized capital would be slightly over $1.8 billion. The cost of replacing 1,452 units excluding unamortized capital would amount to $15.5 billion.

In addition to converting industrial boilers, utilities will also have to convert to coal under current legislative proposals. The conversion of utility boilers is of considerable concern, as many of them have recently converted to burning oil and gas from burning coal as a result of EPA regulations. In some instances, facilities which have only recently completed the conversion from coal are going to have to begin reconverting back to coal. In many cases, additional problems will be encountered due to the fact that many of the companies which converted from coal sold the land which had served as coal storage or converted it to other uses. They will now have to obtain additional property, or reconvert property to re-install such facilities. Another space problem is associated with the required scrubbers. These devices are extremely large, and some utility stations do not have room to install them. One instance reported in Virginia described the quandry a utility operating under a conversion order found itself in when it became apparent that the only way it could obtain adequate land to install a scrubber would be to purchase surrounding homes and tear them down.

At present, there is no way in which the cost of acquiring additional land to make provisions for the storage of coal can be computed. It will depend largely on local factors which vary so greatly from area to area, and even from facility to facility that it will likely never be known. What can be computed, however, is the capital utilities will require for the conversion of their equipment. Edison Electric Institute has estimated that the total cost of conversion will be in the range of $40 billion. This figure includes the cost of installing pollution control equipment.

MANPOWER

One of the major concerns regarding all aspects of increased coal utilization focuses on the question of whether or not adequate human resources exist to accomplish the stated objectives. Miners, boiler makers, engineers, and other skilled trades and technical specialties will be needed in increasing numbers. It is doubtful that they will be available to the extent necessary to complete the conversion within the stated time framework. One area which is especially doubtful is found in the area of mine expansion.

The National Coal Association has estimated that in order to increase production to the desired 1.25 billion tons annually by 1985, there will be a requirement for 214,000 additional miners. In this age of growing gravitation away from manual trades, it is somewhat questionable that sufficient numbers of individuals desirous of following such a trade can be recruited. Further, there are tremendous costs associated with such a large expansion of this segment of the labor force. On average, it costs approximately $32,000 to train and equip a coal miner.[36] This means that $6.848 billion of capital would have to be generated to provide enough personnel to get the coal out of the ground. This, however, is not the only cost for personnel. There will also be a requirement for 54,000 engineers, technicians and other salaried personnel. Assuming that half of these personnel are graduates of four-year colleges, and the remainder are only required to have two year degrees, the cost of their tuition alone, at present levels would approach $.5 billion. This would place the total costs of training personnel around $7.4 billion. Manpower availability in other coal related areas seems to be somewhat better than in the mining industry. According to the American Boiler Manufacturers Association, current capacity is adequate to produce approximately 1,000 boilers per year. As the industry has been somewhat depressed in recent years, it is believed that persons who have been furloughed from plants will provide a sufficient pool of manpower to meet any reasonable conversion program. A similar situation exists in the hopper car industry, where current capacity exists to produce in excess of 60,000 cars per year.[37] Since total car requirements are slightly less than 210,000 cars, there should be no problem in producing them as fast as they are needed.

In short, the only serious short-term manpower problem associated with coal conversion appears to be in the area of securing adequate personnel for expanded mining operations. Other areas either already have surplus personnel or do not envision problems in obtaining them.

CONCLUSION

It is worthwhile to stop and summarize the total requirements for expansion of coal utilization for the period between 1978 and 1985.

Depending on the level of production achieved, we can anticipate a demand for between $10.3 and $14.3 billion to upgrade our rail system and obtain additional hopper car and locomotive capacity. Mining operations will require between $18.7 and $27 billion to purchase equipment for expansion, and the impact of the surface mining law will amount to between $13.6 and $17.4 billion. Sludge removal will cost industry and utilities anywhere from $.84 to $3.6 billion. Converting utility boilers will cost $40 billion, and replacing the 1,452 industrial boilers of 250 million btu capacity and above will run between $12.2 and $19.2 billion. An additional 105,480 barrels of oil per day will be required to move the additional coal, at an aggregate cost of between $2.3 and $2.9 billion between 1978 and 1985. Unamortized capital from boiler conversion in the industrial sector will cost at least $1.6 billion and could cost as much as $2 billion. Finally, manpower training and recruitment costs for additional coal production will run between $6.5 billion and $8.3 billion, depending on the level of production achieved. The total costs for the three estimates, high, middle and low are as follows:

High	$134.7 Billion
Middle	117.4 Billion
Low	106.4 Billion

While there will be many factors affecting the ability of industry to generate the immense amounts of capital required for expanding coal production, perhaps the most important is the legislative environment. If producers fear the advent of unreasonable or contradictory laws, as evidenced by the conflict between the concept of mandatory conversion, and certain aspects of the Clean Air Act, it is likely that investment will be seriously curtailed. Conversely, in an environment which recognizes the fact that a balance between competing goals must be established so that economic growth can take place, investment should flourish. Ultimately, it will be the legislative environment which determines the success or failure of our attempts to convert to coal.

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FOOTNOTES

1. This figure, obtained from the Edison Electric Institute is generally accepted throughout industry as a standard rule of thumb.

2. See "Summary Report - Flue Gas Desulfurnization Systems, November-December 1976." This is a study of operating scrubbers conducted by PEDco-Environmental Inc. under contract with the Environmental Protection Agency. PEDco prepares biweekly reports on scrubber performance.

3. See "Proceedings of a Public Conference on Sulfur Oxides in N.E. Ohio" November 18-19, 1976 at John Carroll University in Cleveland Ohio. At this conference, R. E. Waller, of the Department of Health and Social Security in London stated "However...despite a vast amount of effort and expenditure's its (CHESS) execution and interpretation left so much to be desired that the results and conclusions are largely discounted outside the U.S.; and recently there has been much criticism of the interpretations of the results even there."

4. See February 1976 Environmental Protection Agency publication EPA-450/1-1-76-001.

5. Ibid.

6. See "Energy and Economic Impacts of HR 13950 - Surface Mining Control and Reclamation Act of 1976", prepared for the 94th Congress by ICF Inc. under contract number EQ-6A-0016, dated January 1, 1977. While this report deals with an earlier version of the law, the sections regarding reserves basically were the same. Further, as the new law is more stringent than HR 13950, the estimates are, if anything, conservative.

7. Ibid.

8. Ibid.

9. This estimate was made by the Tennessee Valley Authority of all costs associated with the new surface mining law. It includes such factors as increased permit costs, paperwork, etc. Other estimates are far higher.

10. This cost estimate was extrapolated using Bureau of Mines projections of surface mined coal and assuming that the TVA $4 per ton cost of the surface mining bill was accurate.

11. In this instance, Bureau of Mines projections were also used, with a higher per ton cost estimate of the surface mining law.

12. Library of Congress, Congressional Research Service publication number 95-15 titled "National Energy Transportation, Volume I -- Current Systems and Movement."

FOOTNOTES (Continued)

13. Ibid.

14. Ibid.

15. Ibid.

16. Peat, Marwick, Mitchell and Company - "Final Report, Railroad Freight Car Requirements for Transporting Energy, 1974-1985" prepared under contract to the Federal Energy Administration, Environmental Protection Agency and Department of Transportation.

17. This estimate is based on the assumption that 12.5% of the total volume of lime and limestone required for flue gas desulfurization will be carried by rail. Currently roughly 7% of all lime and limestone is carried by rail, however, problems with location of limestone quarries, and local siting restrictions will cause a slight increase in rail transport.

18. Library of Congress, "National Energy Transportation, Volume I," op. cit.

19. Ibid.

20. Peat, Marwick, Mitchell and Company, op. cit.

21. Ibid.

22. Library of Congress "National Energy Transportation, Volume I," op. cit.

23. This figure is based on an estimate made by the Tennessee Valley Authority.

24. This estimate is based on data from the Federal Energy Administration.

25. Ibid.

26. This estimate comes from a study which is currently being conducted by Aerospace Corporation under contract to the Federal Energy Administration.

27. The estimate used here comes from the National Association of Electric Companies. The association has received data from its members indicating that the cost of sludge removal runs from $10 per wet ton to $22.10 per wet ton. These estimates likely reflect local conditions which are likely to vary considerably in terms of transportation requirements and costs.

28. Ibid.

FOOTNOTES (Contined)

29. This estimate is based on Federal Energy Administration data concerning the amount of sludge which it anticipates will be generated by 1985. A disposal cost of $10.55 is assumed, reflecting the mean of reported costs and FEA estimates.

30. This is based on Federal Energy Administration Data.

31. Ibid.

32. This estimate is based on information supplied by the American Boiler Manufacturers Association.

33. Ibid.

34. Ibid.

35. Ibid.

36. Based on National Coal Association Data.

37. Peat, Marwick, Mitchell and Company, op cit.

TOTAL COSTS ASSOCIATED WITH EXPANDED COAL PRODUCTION

1978 - 1985

(In Billions of 1977 Dollars)

	LOW	MIDDLE	HIGH
Railroad Equipment & Improvement	$ 10.3	$ 11.5	$ 14.3
Surface Mining Legislation	13.6	15.5	17.4
Mine Expansion	18.7	21.2	27.0
Sludge Removal	.84	2.2	3.6
Utility Conversion	40.0	40.0	40.0
Industrial Boiler Conversion	12.2	15.2	19.2
Unamortized Capital	1.6	1.8	2.0
Manpower	6.5	7.4	8.3
Additional Petroleum	2.3	2.6	2.9
TOTAL	$106.04	$117.4	$134.7

COSTS ASSOCIATED WITH EXPANSION OF COAL PRODUCTION*

1978 - 1985

(In 1977 Dollars Per Household)

	LOW	MIDDLE	HIGH
Railroad Equipment & Improvement	$ 149.28	$ 166.66	$ 207.24
Surface Mining Legislation	197.10	224.63	252.17
Mine Expansion	271.01	307.24	391.30
Sludge Removal	12.17	31.88	52.17
Utility Conversion	597.71	597.71	597.71
Industrial Boiler Conversion	176.81	220.28	278.26
Unamortized Capital	23.18	26.09	28.98
Manpower	94.20	107.24	120.28
Additional Petroleum	33.33	37.68	42.02
TOTAL	$1,536.81	$1,701.44	$1,952.17

(*Note: Columns may not add due to Rounding)

NEW HOPPER CAR REQUIREMENT

(Absolute Number)

	LOW	MIDDLE	HIGH
Coal Carriers	35,100	39,900	51,600
Limestone Carriers	2,189	2,494	3,225
TOTAL	37,829	42,394	54,825

REPLACEMENT HOPPER CAR REQUIREMENT

(Absolute Number)

	LOW	MIDDLE	HIGH
Coal Carriers	139,900	157,038	205,653
Limestone Carriers	8,744	9,815	12,853
TOTAL	148,644	166,853	218,506

TOTAL CAR REQUIREMENTS

(Absolute Number)

	LOW	MIDDLE	HIGH
New Cars	37,829	42,394	54,825
Replacement Hopper Cars	148,644	166,853	218,506
TOTAL	186,473	209,247	273,034

COST OF NEW HOPPER CARS

(In Billions of 1977 Dollars)

	LOW	MIDDLE	HIGH
Coal Carriers	$ 1.0	$ 1.2	$ 1.6
Limestone Carriers	.1	.1	.1
TOTAL	1.1	1.3	1.7

COST OF REPLACEMENT HOPPER CARS

(In Billions of 1977 Dollars)

	LOW	MIDDLE	HIGH
Coal Carriers	$ 4.2	$ 4.7	$ 6.2
Limestone Carriers	.2	.3	.4
TOTAL	$ 4.5	$ 5.0	$ 6.6

TOTAL COST OF HOPPER CARS

	LOW	MIDDLE	HIGH
New Cars	$ 1.1	$ 1.3	$ 1.7
Replacement Hopper Cars	4.5	5.0	6.2
TOTAL	$ 5.6	$ 6.3	$ 7.9

ADDITIONAL LOCOMOTIVES REQUIRED

1978 - 1985

(Absolute Number)

	LOW	MIDDLE	HIGH
Base Coal	1,580	1,580	1,580
New Coal	1,500	2,650	4,170
Sub Total	3,080	4,230	5,750
Limestone	193	265	360
Total	3,273	4,495	6,110

COST OF ADDITIONAL LOCOMOTIVES

1978 - 1985

(In Billions of 1977 Dollars)

	LOW	MIDDLE	HIGH
Base Coal	$ .8	$ .8	$ .8
New Coal	.8	1.3	2.0
Limestone	.1	.1	.2
Total	$ 1.7	$ 2.2	$ 3.0

SUMMARY OF RAIL EQUIPMENT & IMPROVEMENT COSTS

(in billions of 1977 dollars)

	LOW	MIDDLE	HIGH
Track Repair	$ 3.0	$ 3.0	$ 3.0
Locomotives	1.7	2.2	3.0
New Hopper Cars	1.1	1.3	1.7
Replacement Hopper Cars	4.4	5.0	6.6
TOTAL	$10.3	$11.5	$14.3