A SYSTEI EXAMINATION OF THE OPPORTUNITIES OF COAL FOR CALIFOk

W. H. Hathaway

Fluor Engineers and Constructors, Inc.
Irvine, California

ABSTRACT

Appreciable empirical evidence has been published which indicates a strong correlation between a society's economic wealth (its GNP) and its energy consumption. With a growing population and increasing individuals' aspirations, California's energy demands will also rise in the future.

Because of decreasing availability of petroleum fuels and natural gas, it is imperative that alternative means be developed for meeting these demands. In this paper we examine the options available for importing energy derived from coal.

These include: (1) electric power generated from coal, (2) coal gasification near the mine site for conversion to substitute natural gas or liquid products such as methanol or hydrocarbons, (3) converting the coal directly to liquid hydrocarbons similar to a synthetic crude oil.

Comment is made on the long lead times required between conception and completion of facilities of this type. Because of political and economic impediments, excessive delays have resulted in cancellation of projects such as Kaiparowits and WESCO.

The need for statesmen and citizens with vision and courage to act is emphasized.

Importation of Coal-Generated Energy; An Examination of Options

I. INTRODUCTION

The title of this session, referring to opportunities of coal for California, is one of the most encouraging signs I've seen to signify that more than just a few of us recognize two key facts:

(1) At some point in the future, we in California, along with all other Americans, will not be able to get as much petroleum products or natural gas as we'd like to get for the kind o price we'd be able or willing to pay.

(2) America's vast reserves of coal offer the hope of supplementing our energy needs at prices we can afford.

I've been asked this morning to examine just the options of importing coal-generated energy into California. The other two speakers of this session have addressed the problems associated with bringing in the coal itself for use here. Among us, we raise the kind of questions and issues which most people feel are important.

Since we've implicitly accepted the idea that an energy crunch is looming, there doesn't seem to me to be a need for documenting the why's and wherefore's of it. It does seem appropriate, however, to comment on the impact on our economic or material well-being that we should expect if our energy supplies do become inadequate.

Appreciable empirical evidence has been published which indicates a strong correlation between a society's energy consumption and its economic productivity, measured as GNP per capita. Among the leading industrial nations of the world, the U.S. compares favorably as an efficient user of energy as measured by $GNP/Unit of energy consumed. Some countries with outstanding energy consumption records usually have small populations and produce fine products; for example, Switzerland derives appreciable income from low energy content exports of fine clockworks.

There are fewer than 30 countries in the world with populations larger than California's 22 million; there are only 51 countries in the world with areas larger than her 160,000 square miles. If we were a separate country, our GNP of some $150 billion would be about the 7th or 8th largest in the world. This tells me that our state is big enough that the general data will apply to us. So I conclude that our economic well-being bears a strong relationship with our energy consumption. This has certainly been true in the past; our per-capita incomes have increased more or less in tandem with our per-capita usage of energy. Now, our population is growing, and so are individuals' aspirations.

Conservation, undoubtedly has an effect on this relationship and as the cost of energy increases, economic factors will tend to decrease energy consumed per $GNP. However, unless some heretofore unknown process can be made to act to further decouple material progress from increased energy usage, California's energy demands surely will rise.

I appreciate the opportunity to take a role in reviewing for those who lead our state some of the alternative means for meeting these demands. I hope that our policy makers are already aware of the probable consequences of failing to provide the amounts and kinds of energy the people will want, including the problem of who gets how much and why. So let's look at some of the ways in which we can import the energy de-

rived from coal processed beyond our state boundaries.

II. ELECTRIC POWER

In recent years, California's consumption of electricity has grown more rapidly than its use of any other form of energy. Unless sufficient nuclear capacity is built, coal must provide at least part of the growth that we must expect if this trend continues. Thus, electrical energy is a very attractive option for importation. All such systems, however, would require long distance, high voltage transmission, with attendant line losses that are proportional to the distance. At present, these losses limit the distance for economical transmission to approximately one thousand miles. Other parameters for any electric import system include water supply, coal transport costs, ash disposal costs, and environmental impact.

Let's not kid ourselves; we can't make an omelet without breaking some eggs. Any energy system that is to make a meaningful contribution to the needs of 22 million people will have some environmental impact. I see an analogy between saying, "I hate to see any environmental impact." and saying, "I hate the thought of growing old." You've got to consider the alternative!

Conventional Power Plant

As some of the following papers will elaborate, there are several options for making electricity from coal. First, because it is current technology, I think of conventional power plants. Under present laws, such plants probably would be required to employ stack gas scrubbers, which are somewhat controversial in regard to performance and which definitely add to the cost of the power. The 3000 megawatt system that was proposed for the Kaiparowits installation was an example of this technology. Most of you here today are surely familiar with the objections raised against that project, whether or not you happen to agree with the arguments. The major point was that the level of particulates produced would reduce long-range visibility and thus diminish the scenic value of the area.

Gasification - Power

Another approach would be to convert the coal to a clean fuel gas which could then be burned in the power plant. This would certainly ease the particulate problem, but it would be more costly. This would also be considered current technology. By adding advanced power cycle concepts that are now under development, increased efficiencies could help offset these costs. There will be further discussion on this later, but it does appear that this procedure is one of the brighter stars on our energy horizon. My own company, Fluor, is involved in test programs with Commonwealth Edison of Chicago and others, and Southern California Edison with Texaco are studying such a facility for Southern California.

In-Situ

In addition to converting coal to fuel gas with conventional gasification reactors, it is possible to gasify coal in-situ - without ever actually mining it. There is appreciable work being done now, mostly under DOE auspices, to develop this technology. The Russians have carried on such work on a semi-commercial scale for several decades, and one U.S. utility is proceeding with a program which considers the use of Soviet technology.

Just as with conventional gasifiers, such gas is readily cleaned of both sulfur and particulates. But it brings some new problems, too. Subsidence of the surface could occur, gas leakage at the surface is possible, and impact on underground water supplies is conceivable.

Fluidized Bed Combustion

Fluidized bed combustion is yet another way to use coal to make the steam needed for a power plant in a manner that promises to reduce sulfur emissions to acceptable levels under present laws.

MHD - Fuel Cells

Other modes of electrical generation, which are still in the developmental realm, are magnetohydrodynamics - MHD and fuel cell technology. Both have promise but our assessment is that these are still insufficiently developed to warrant serious consideration when we're examining options for the relatively near future. I mention it only because our DOE is providing substantial support in these areas.

III. GASIFICATION

I noted earlier that coal could be converted to a low or medium Btu fuel gas that could then be burned to produce electric power for import into our state. But a gaseous product itself could be an attractive import. There is proven technology for the conversion of coal to gas on a vast scale. Fluor is currently constructing such a plant that will process 40,000 tons of coal per day. This is for a client who has been operating a similar plant for about one-third that size for almost 25 years. It is most attractive to operate such plants near mine sites, thus avoiding the transport of useless ash or moisture.

A. SNG

California already imports appreciable natural gas, and coal can be processed to produce a substitute natural gas (SNG) that is indistinguishable from the natural

product. There is ample capacity in existing pipelines that transport large quantities of such gas. To convert the product fuel gas from such plants as I just mentioned to SNG is a relatively simple step. Several such plants were once scheduled to be built to supply such gas for California. One of them, WESCO, was a Fluor project. Various factors have combined to delay these - perhaps indefinitely. I presume that some of the reasons for the failure to move forward with these facilities is on the agenda of later speakers, but I wish to emphasize that the technology here is proven. The deterrents have politico-economic foundations.

B. Medium Btu Gas

If the gas from gasifiers is not processed to produce SNG, it will be of lower heating value. Such a gas cannot be mixed in pipelines with natural gas, but separate piping systems could be built to utilize it as an industrial or power plant fuel. The lower heating values, however, limit the distance over which the gas could be economically transported, to a few hundred miles. This may eliminate the importation to the California coast of coal energy in this form, but our border areas could conceivably be served by gasification plants located in adjacent states.

C. Synthesis of Liquids

The main constituents of such a medium-Btu gas as I've just been talking about are carbon monoxide and hydrogen. Mixtures containing these two gases are often called synthesis gas (or syngas) because a wide variety of other chemicals and hydocarbons can be synthesized from them by using suitable catalysts and process techniques. The one such material of greatest interest on our energy scene is methanol.

Methanol, formerly known as wood alcohol, has long been a material of commerce, and its value as a clean fuel, both for transport purposes and for power generation, is well known. Almost all methanol today is made from syngas derived from natural gas or other hydrocarbons. Thus, the only different technology involved in producing methanol from coal resides in producing the syngas. Although, as I have already noted, we know how to do this on commercial scales, the economics just aren't favorable compared to starting with hydrocarbons. A recent study for an ultra-large scale plant suggests that attractive costs are attainable, but those results are still not accepted by many of us in the technical community.

As the costs of hydrocarbons rise, however, methanol from coal will become more attractive. It is easily transported, and it thus is another potential method for importing coal-derived energy.

IV. HYDROLIQUEFACTION

Liquefaction of the coal by adding hydrogen is yet another option for importing coal's energy while leaving most of its problems elsewhere. (Again, let's not try to kid anybody. That is the main thrust of such options as I've been discussing.) Our conference program shows that Session IX on Thursday is devoted to this subject. Here, I shall only point out that, by appropriate processing, coal can be reacted chemically with hydrogen to produce hydrocarbons which are quite similar to those that are derived from petroleum. The ash and sulfur from the coal are removed at the processing plants, and the liquid products can be transported as in current practice. Depending upon the perceived needs of the market place, the coal could be upgraded to boiler fuel, petroleum-like feedstock, fuel oil, or distillates, including gasoline.

The technology for hydroliquefaction of coal is still under development in the U.S.; however, semi-commercial units are under construction and commercial sized demonstration modules are being proposed for construction today. While it's true that the Germans in World War II produced liquids in this fashion, it wasn't economics that provided the impetus.

V. SYSTEMS OVERVIEW

I've mentioned several technically feasible ways by which we can import into California energy which was derived from coal. It seems to be that, in the broadest sense, we must be concerned not just with California's energy problem but with a system that includes the overall political and socio-economic welfare of a major portion of the western United States. Just because the governing leaders of our previous generations saw fit to draw certain political sub-divisions doesn't mean that people who live on one side of the boundary lines are any different from those on the other. So the "solution set" to our energy problem must include not only satisfactory economic and environmental results for Californians, but also for the residents of our neighboring states and, perhaps, of some even more distant states who might supply us with coal or water.

I described at the outset of this talk some of the evidence that our economic well-being depends upon energy. We must recognize that the penalties for failing to develop energy supplies adequately appear to be potentially harmful to our economy and our society. Our state, and indeed our country, sorely need statesmen and citizens with vision and with the courage to act to meet the needs of the future.

I would leave this audience with one closing thought. -- Technology is available; either proven or under advanced

development, to provide us with the kinds of energy from coal that we require. The deterrents to developing this source of energy are political in the case of electric power and economic and political for the other forms.

REPRODUCIBILITY OF THE