ECONOMIC POTENTIAL FOR CLEANED COAL WATER SLURRIES: A UTILITY PERSPECTIVE

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To help put into perspective the potential impact that cleaned coal water slurries could have on oil-burning electric utilities, I would like to breifly review with you some of the major problem areas facing such an electric utility in today's environment.

The oil-burning electric utility today is faced with some seemingly insurmountable problems which can be directly traced to the impact OPEC has had on not only our industry but all industries and economies in the free world. Since 1973, the price of oil, which is not only an energy source, but also a raw material for a multiplicity of other products, from synthetic fibers to plastics, has risen over 1500 percent. This increase in a vital material required by the industrialized free world has caused what economists call a "cost-push" inflation of an unprecedented magnitude. We all know this and are living through the effects of this. This cost-push inflation has been the primary cause for the "stag-flationary economy" of the 1970's. Within this economic context, electric utilities find it necessary to incur ever increasing costs to provide reliable electric service. However, their regulatory commissions are increasingly reluctant to allow electric utilities to pass these higher costs on to the rate payers who collectively are suffering from the combined effects of "stag-flation", that is unemployment and inflation. So, the condition of electric utilities, in general, is not good. The results can be seen by the higher interest rates on electric utilities' bond issues and decreases in common stock prices; the result can also be seen on their income statements in the form of fluctuating earnings.

My company, FPL, is coping with all of these problems. We are the nation's 5th largest investor owned electric utility and have a service area comprising 27,650 square miles, running down the East Coast of Florida from the Georgia border and including the southern one-third of the state. Within this service territory we serve a population of 5.3 million people. Unlike the situation faced by many other electric utilities, our population in Florida is growing so that we are projecting an average annual growth rate of 4% in the demand for electricity over the next decade. To meet our present demand we have an installed generation capacity of 12,758 megawatts of which 2,337 megawatts (18.3 percent) is nuclear, and the remainder is fueled by natural gas or fuel oil. FPL presently has no capability to burn straight coal. Ten years ago, in 1972, we used 35.1 million barrels of # 6 residual fuel oil at an average cost of $3.48 per barrel. At that time our annual fuel oil cost came to $122.2 million. This year we expect to burn about the same amount and have a total fuel oil bill of over one billion dollars.

What the future holds for oil prices is difficult to say. We are forecasting long-term increases, although perhaps not to the degree we have already experienced. What is fairly certain though is that no electric utility can afford to just "ride the tide" of oil prices for its primary fuel source. The price is too high and the security of this supply is in question. Any number of events, such as war, inflation, or shifting political balances can impact either alone or in tandem with each other the cost and availability of fuel oil. It is for this reason that FPL is seeking to reduce its dependence on fuel oil.

What options does a utility have in this regard? Not nuclear. The uncertainty surrounding the license process, the anti nuclear movement, the 10 year lead time in constructing such units, all combined with historically high cost of capital, make new commitments for nuclear generation unfeasible at this point in time. Not natural gas. With the legislation in place to deregulate natural gas prices, it is forecasted that the price of this fuel source will reach parity with fuel oil. In addition, one cannot count on continued governmental authority for increased use of gas as a boiler fuel. This leaves coal as the only realistic substitute for oil fired generation available today.

Like all business, electric utilities are faced with high cost of capital. Unlikely most other businesses, utilities cannot easily postpone needed capacity expansion due to their mandate of providing reliable electric service. This means that, hell or high water, utilities are in the capital market paying current interest rates to raise the vast sums of money required to merely meet this normal demand growth. When special circumstances such as the requirements to switch to alternative fuel types are added, the burden of raising the needed capital is even greater. Hence, it is imperative that we in the electric utility industry search for new generation technologies which result in lower capital cost requirements.

One of the ways FPL has avoided this additional capital cost burden, while "backing off" from a high degree of dependence on fuel oil is by purchasing large blocks of electric power from neighboring coal burning utilities. Just this year, FPL has entered into a 10 year purchase agreement for "coal by wire" from the Southern Company for up to 2000 MW's. This agreement will allow us some breathing room for evaluating and analyzing the various alternatives which may become available to FPL within this time frame. Therefore, we have already begun gathering the "facts" with regard to the costs associated with the various options available to us.

Based on preliminary engineering studies which we have had performed by an independent engineering firm, we now feel that we have some understanding of what it would cost us to convert each of our nine 400 MW and four 800 MW power plants to burn straight pulverized coal. It appears to be technically feasible, but would require huge expenditures. Additionally we have cost estimates for the increased operating and maintenance cost we would experience along with the reduced capacity factors related to burning coal vs. oil. But for FPL this does not represent nearly all of the incremental costs since we are geographically located far from the coal fields and have no readily available transportation system for delivering coal to our various plant sites. Therefore in addition to the actual capital cost of converting our power plants, the increased operation and maintenance cost, the lowering of our capacity factors (and in the case of our 800 MW units potentially derating the boiler itself), we must also pay for the development of a coal handling and distribution infrastructure in terms of the associated high transportation cost for coal. Naturally if there is any way to avoid the high cost of having to convert to straight coal, while still allowing us to <u>economically</u> reduce our dependence on oil, we would like to do it.

In 1980 FPL pioneered the concept of burning coal oil mixtures (COM) in a utility boiler by operating our Sanford 400 MW power station on COM for 12 months, on line, at up to full power. This test of COM was conducted in order to evaluate the impact that a coal based fuel would have on a utility boiler designed and constructed to burn primarily oil, as well as to determine the economies of using this new fuel type.

The results of that test which was completed in April of 1981, proved that this new fuel type was technically feasible. Based on economics, however, and long term fuel planning strategy, it was determined that COM should not comprise part of FPL's over all long term fuel mix.

Why? First, based on economics. Although the capital cost required to convert a unit to COM is moderate in comparison to the cost of full scale conversion to straight coal, the savings derived from substituting COM for heavy oil are also moderate. This is because on a 50/50 by weight percentage mix of coal/oil only 40% of the BTU's per ton of COM are derived from coal. This is due to the fact that coal has less heat energy value per unit of weight than does #6 oil. Therefore when our Sanford 400 MW power station was operating on a 50/50 mixture of COM at full capacity, 240 MW was still being produced by oil.

Second, from a long-term fuel planning strategy point of view, an electric utility must have diversified fuel sources to mitigate effects of a total supply interruption of any single fuel type. By utilizing COM we would still require oil in addition to coal at every plant so converted.

Our COM experience however, did allow us to develop engineering cost comparisons between using COM vs. straight coal. By examining these capital conversion and operating costs we have determined that it was COM's liquid form which made the cost of plant modifications relatively inexpensive for our use vs. straight coal.

As I mentioned previously, FPL has no coal fired generating capacity. This means that we do not own nor operate any bulk handling facilities nor are our power plant sites equipped to receive bulk product shipments. Therefore, major investment would be required in all the equipment for transporting and handling the coal as well as the ash by-product. The utilization of COM would not necessarily result in this same need since COM could be manufactured elsewhere, and transported and stored using FPL's existing but modified liquid fuel distribution system. So, where does this leave us? Conversion to straight coal appears to be an expensive undertaking for a utility which currently uses no coal and COM does not offer enough fuel cost savings nor strategic supply advantage.

Coal Water Slurries would appear to theoretically "solve" the electric utilities dilemma with respect to converting from oil to coal. Since CWS is a liquid, a utility would not require a completely new material handling system but instead could modify its existing oil distribution and storage system. Since CWS contains no oil, any plant converted would be completely independent from fuel oil requirements.

Theory, however, does not always work out in practice. Any number of factors can, and often do, come between a good idea and its practical application. From FPL's experience in using COM in a boiler designed to burn only oil, it was determined that the most serious obstacle to using coal was the build-up and accumulation of ash deposits. During our test of COM we were able to produce and burn a mixture comprised of 50 percent coal by weight. However, we could not sustain burning at this level of coal concentration due to our problems of ash slagging and fouling. In order to avoid this problem we were forced to reduce our COM mixture to 43% coal by weight. We do feel that with additional boiler modifications which were beyond this scope of the COM experiment, a 50/50 mixture could have been burned continuously.

With CWS, this problem would be difficult to overcome because 2 1/2 times as much ash would be fed into the plant as we fire with 100% of the BTU's coming from coal instead of just 40%. Therefore based on our experience with COM, we would predict that ash erosion and build-up will be a significant problem unless a substantial portion of the ash is removed from the coal prior to combustion.

It is for this reason that FPL is supporting research into coal cleaning technology. Coal cleaning, when combined with coal slurry technology, could offer the opportunity of manufacturing a truly innovative substitue for heavy fuel oil. Of course, the questions will be raised; "can you burn water?" We have given Bechtel Corporation, the architect/engineer for our Sanford COM experiment, a description of what we think a cleaned CWS would be like and it is their opinion as well as Foster Wheeler's, the manufacturer of our boiler, that, if the ash content can be reduced to 2-3%, and the product coal has a heating value of 14-15,000 BTU'S per lb., CWS can indeed be burned with relatively modest plant modifications. So, CWS may be technically feasible but is it economically feasible?

To date, most deep coal cleaning technologies have added significantly to the cost of the coal and it is therefore important to develop a technology in this regard which is affordable. At the present time, no CWS is commercially available and it is quite impossible to predict with any degree of certainty what cost it will add to coal. We do, however, have some fairly good order of magnitude estimates of what plant modifications would have to be made in order burn CWS. When we compare these to the costs of remaining on oil or converting the same plant to straight pulverized coal burning, we can then calculate an amount which could be added to the price of straight coal and still break even. This would be the maximum we could afford to pay for cleaning and slurrying the coal.

My first exhibit shows our current estimates of what the 1982 capital costs would be to convert one of our plant sites having two 400 MW power stations from burning heavy oil to burning straight pulverized coal and to burning a cleaned coal water slurry. It should be understood that the capital cost estimates for conversion to a cleaned coal water slurry are very preliminary in nature. They are based on a concept which addresses the basic modifications which might be required to burn CWS and includes many as yet unverified assumptions regarding the combustion characteristics of this new fuel type. Nevertheless, they do provide a good starting point for assessing the potential impact CWS could have on a utility. As can be seen, from this exhibit, the capital costs required for conversion to burning CWS are approximately one-fifth of the costs required to convert to straight coal. The main reasons for this startling difference is that by using a CWS there would be no need for any bulk coal handling and storage facilities and no major boiler modification. Additionally, other costs are lower due to a decrease in the volume of ash to be handled and disposed of thus resulting in a down-sizing of these related systems.

Exhibit No. 2 looks at what it would cost to operate a power plant consisting of two 400 MW units on straight pulverized coal and on a cleaned coal water slurry. All of the numbers shown on this exhibit are based on forecasted levelized annual costs over the first ten years' operation after a conversion. Additionally, the fuel costs both for No. 6 residual fuel oil and for raw coal are expressed in real, i.e., 1982 dollars, which exclude inflation but do recognize real price changes over the projected 10 year period. The coal cost estimates are expressed on a delivered basis, with mine month prices representing about two-thirds of the delivered cost.

The first number shown on Exhibit 2 is the cost for fueling this plant with No. 6 residual fuel oil, the fuel currently being used. As you can see it costs $225 million per year in 1982 dollars to fuel this plant. The second group of numbers you see are those associated with converting this plant to coal. Those numbers shown under the column entitled "Pulverized Coal" are for conversion to conventional straight pulverized coal firing while those shown under the column entitled "Cleaned Coal Water Slurry" are for that technology.

The first number shown under the caption "Conversion Costs" is the cost of raw coal delivered to the plant site. Since we do not know what premium will have to be paid for cleaning this coal and producing a slurry, we have shown here the same costs in both conversion scenarios. As you can see the equivalent fuel cost of operating this plant on raw coal would be $126 million per year or $99 million less than the fuel cost for No. 6 Fuel Oil. Burning coal in any form, however, results in larger expenditures in the areas of plant operations and maintenance. This is due to the additional personnel required to manage and operate the coal handling, pollution control, ash handling and disposal systems which are not required for oil. We have estimated this increase in O & M expenses to be approximately $8 million per year in the case of conventional coal firing and $7 million per year for cleaned CWS. The difference recognizes the fact that by using CWS there will be no bulk coal to handle and less ash to handle and dispose of.

The last number shown under "Conversion Costs" is the revenue requirements associated with the investment needed for plant modification to convert this plant to burn coal. By revenue requirements, we mean how much more the utility's customers must pay in order to cover the depreciation, taxes and capital carrying charges on this investment. Let's examine these costs for the conventional coal burning scenario first. As can be seen, by adding this amount, $149 million, to the costs for raw coal and the increased O & M expenses, the total levelized annual cost to our customers of operating this plant on straight pulverized coal is $283 million or $58 million more than the annual cost of continuing to operate on fuel oil. Obviously, this type of conversion would not make economic sense. As we have seen, while there are apparent savings to be had in fuel costs by substituting straight pulverized coal for No. 6 fuel oil, the additional capital costs required are too expensive to maintain this savings.

Now let's look at the cleaned CWS scenario. Here the revenue requirements associated with the plant modification needed to burn a cleaned CWS are only $28 million. Of course this is what we would expect since the estimated total costs for modifying a plant to burn a cleaned CWS are only about 20% of the costs needed for conventional coal firing. By adding this amount to the costs for raw coal and additional O & M expenses, we see that excluding the cost of cleaning and slurrying this coal, the annual levelized operating costs which must be paid by our customers is $161 million. As shown on the last line of Exhibit 2, this is $64 million less than the fuel cost of continuing to operate the plant on oil. What this also means is that in this example we could pay a $64 million or $1.43 per MMBTU premium for a cleaned coal water slurry and still not exceed the cost of continuing to operate the plant on oil.

It should be emphasized that these economic comparisons are quite dependent on the capital carrying charge rates used in calculating the revenue requirements. I have used a after-tax rate of 17% which represents FPL's current cost of raising money. If capital costs should become lower, than the economics of any coal conversion options will improve.

According to the information I have been able to get from potential CWS suppliers, approximately 10% of the weight (mostly ash) of feed coal is removed in the advanced cleaning process. Therefore, if we assume that we start with a coal quality 12,500 BTU/lb coal, and get .9 lbs of cleaned coal for each pound of feed coal, and each pound of cleaned coal is worth $1.43/mm BTU more than feed coal, then, the premium per ton would equal:

$$\$1.43 \times (12{,}500 \times 2000) \times .90 = \$32.18/\text{ton}$$

Of course it must be understood that these values are given as an approximation, and are highly dependent on the relative price of coal and oil over the period being considered, as well as the on the actual capital cost of conversions.

Now, the question is "Can a good cleaned cool water slurry be produced and delivered for this premium over the cost of straight pulverized coal?" This question can only be answered by the continuation of the development work currently being conducted by several companies.

Let me conclude by putting these capital conversion cost estimates into perspective. If FPL were to convert all of our 400 MW and 800 MW power stations to straight pulverized coal,the capital requirements would be approximately $4 billion, in 1982 dollars. This is equivalent to over 60% of our present total investment in utility plant. Assuming cleaned CWS can be used and that our conversion costs for this fuel are "in the ball park", a similar full scale conversion effort would have a capital cost of approximately $800 million, a savings in utility investment of over $3 billion. This magnitude of potential savings provides a clear incentive for continuing research and development on cleaned coal water slurries.

EXHIBIT 1

PRELIMINARY CAPITAL COST ESTIMATE OF CONVERTING TWO 400 MW OIL FIRED UNITS AT A POWER PLANT

1982 DOLLARS
$ MILLION

	STRAIGHT COAL	CLEANED COAL/WATER SLURRY
DIRECT COSTS:		
Coal Unloading & Handling Facilities	Large	None
Steam Generator Modifications	Large	Small
Control Systems for Generator	Small	Small
Ash Removal Systems	Moderate	Small
Electrostatic Precipitator	Large	Large
Ash/Sludge Disposal	Moderate	Small
Plant & Site Modifications	Small	Small
Electrical Systems – Additions & Modifications	Moderate	Small
Total Direct Costs	256	54
INDIRECT COSTS:		
Sales Tax	8	1
Construction Overhead	70	10
Contingency	51	14
AFUDC (Interest During Const.)	177	26
Total Indirect Costs	306	51
TOTAL COSTS	562	105

EXHIBIT 2
ECONOMIC COMPARISON OF CONVERTING A TWO 400 MW POWER PLANT SITE FROM NO. 6 FUEL OIL TO STRAIGHT PULVERIZED COAL VS. CLEANED COAL WATER SLURRY
ALL COSTS 1985 - 1994 LEVELIZED ANNUAL

1982 DOLLARS

	Pulverized Coal		Cleaned Coal Water Slurry	
	$Million	$/MMBTU	$Million	$/MMBTU
No. 6 Fuel Oil Costs	225	5.02	225	5.02
Conversion Costs:				
Raw Coal	126	2.81	126	2.81
Incremental O & M Costs	8	.18	7	.16
Revenue Requirements on Plant Modifications	149	3.32	28	.62
Total Costs Excluding CWS Processing Costs	283	6.31	161	3.59
Savings/(Cost) vs #6 Fuel Oil	(58)	(1.29)	64*	1.43*

* Premium which can be paid for cleaned CWS over price of raw coal and still break even with cost of using # 6 Fuel oil.