LIFE CYCLE COSTS AND PUBLIC DECISIONS

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The authors present a well written paper that will probably cause Montgomery County to install a mass burn facility to produce electricity from some 437,000 tons of solid waste per year. The capital cost of the mass burn facility is projected at $96,377,000. Seventy-seven percent of this amount will be funded by debt, and 23 percent by equity. No profit is projected for the equity investors, so their "profit" will, presumably, be based on federal tax breaks — maybe they can take investment tax credit, energy tax credit and depreciation on the entire investment — even if they are really “at-risk” only as to their equity investment. If this understanding is correct, then, in effect, the Federal Government will have funded 23 percent of the plant.

Our rule of thumb [1], presented by Ed Sherwin in response to Velzy's paper, presented at the 1980 National Solid Waste Processing Conference, is that between 25 percent and 35 percent of invested capital is required in cash each year in order for a resource recovery project to break even, and we use 30 percent for planning purposes (the “30 percent rule”).

According to the authors, the mass burn plant that they recommend will cost about $46.10 per ton to own and operate, which cost includes residue disposal.

A corollary to the “30 percent rule” is that if one divides the capital cost, expressed in dollars per ton per day capacity (based on a 300 day year) by 1,000 the result will be the cost of owning and operating the plant in terms of dollars per ton.

Thus, in this case, the total plant cost is $96,377,000. It will process 437,000 t/year, or 1457 t/day, based on a 300 day year. The investment is therefore $66,000 t/day capacity. The corollary to the “30 percent rule” predicts that total costs will be about $66/t processed, provided that the plant actually performs to specification, and further provided that the solid waste is present in the quantities projected. This is about $20 per ton more than projected by the authors. A brief look at their projected plant economics reveals:

1. O&M costs that are only 4.3 percent of invested capital. We consider that actual O&M costs will be between 8.5 percent and 15 percent of invested capital. Thus, I believe that the authors have underestimated O&M costs by a factor of at least two.

2. There seems to be no allowance for replacement of very expensive items that are unlikely to last for the life of the project. Such items might include boiler tubes (particularly superheater tubes), furnace grates, refractory, electrostatic precipitators, mobile equipment and, perhaps, cranes.

3. There seems to be no allowance for general and administrative expenses (G&A), which we think will amount to between 1 percent and 4 percent of invested capital.

4. There is no analysis of the effects of decreasing energy prices. We are not expert in predicting
energy prices, but we note that only three cases are considered by the authors — 8 percent energy escalation, 9 percent energy escalation and 10 percent energy escalation. We have seen the price of #6 fuel oil drop from 89¢/gal one year ago to 64¢/gal today — or a drop of 28 percent. Would it not be prudent to project the effect of, say, 5 percent energy de-escalation?

5. No profit is shown for the equity investors.

We note that landfill costs begin at about $22/t, yet the residue disposal is projected to cost only $4.20/t. While we realize that the residue will have a much higher density than will the incoming material, still we wonder about this discrepancy. What will the cost of landfilling the 15 percent of the material which the authors wisely assume will bypass the plant? Will it begin at $22/t, and wind up at $123/t in the twentieth project year?

Up to this point, I have simply nitpicked the author’s project economics based on rules of thumb established by our company. Let us now compare this paper with one published by McGowin [2] in December, 1981.

<table>
<thead>
<tr>
<th>Capital Cost</th>
<th>Ingago, et al.</th>
<th>NC</th>
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<tbody>
<tr>
<td>Annual Tons</td>
<td>$96,377,000.00</td>
<td>19,820</td>
</tr>
<tr>
<td>$/ton per day capacity</td>
<td>437,000</td>
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<tr>
<td>O&amp;M Cost($)</td>
<td>$4,153,000.00</td>
<td>$22.70</td>
</tr>
<tr>
<td>G &amp; A ($)</td>
<td>$9.50</td>
<td>$22.70</td>
</tr>
<tr>
<td>Required Tipping Fee ($/ton) if electricity price is:</td>
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<tr>
<td>30 mills</td>
<td>$30.90</td>
<td>$51.00</td>
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<tr>
<td>40 mills</td>
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<tr>
<td>Btu/kW h</td>
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It will be noted that McGowin projections are very different from the author’s projections, and that McGowin’s projections are quite close to those used by our company.

I have been amazed over the past 12 years to observe well-meaning people project costs and income for resource recovery plants. The project costs really cannot be predicted closer than about 20 percent, and the income also cannot be projected closer than 20 percent. Planners often presume that costs will be at the low part of the band of cost uncertainty, and that income will be at the upper part of its band of uncertainty. Thus there are generated two very large numbers, which are very close together, neither of which can be predicted with certainty. It is easy to subtract these uncertain numbers and divide by the annual tonnage to predict a tipping fee. Then, in far too many cases, the costs and the income both go sour by 20 percent — resulting in an underestimate of the tipping fee of as much as 1,000 percent! The authors’ projections of tipping fee will not, I think, be off by 1,000 percent. Most likely I believe the required tipping fees will be merely 66 percent higher than projected.

I note that the authors assume that there would be very little additional income if a dedicated boiler were installed to burn an RDF. Yet, I believe that the efficiency of a dedicated boiler will be about 75 percent, whereas the efficiency of a mass burn boiler will be only about 65 percent. Perhaps the authors presumed (correctly I think) that a smaller percentage of the total waste stream can be processed into RDF than could be burned in a mass burn system.

There is no discussion of the condenser that is being considered for either the mass burn or the dedicated boiler system. If this is a water tower system, the boiler probably could not be operated on very cold days owing to the production of fog. If it is an air-cooled system, one would expect that perhaps 10 percent of the energy produced would be used to operate the fans associated with it.

McGowin’s paper concluded that the lowest breakeven tipping fee would be achieved by burning a high-quality RDF in an existing utility boiler, and I share this belief. If this is not possible in Montgomery County, then I wonder if it would not be wise to consider modifying the transfer station into a simple sorting system to produce a medium-quality RDF to be fired in a dedicated boiler located at the site of an existing utility boiler — and perhaps operated by the utility. The advantage of this concept would be that the existing condenser system (involving discharge of hot water into the Potomac River) could be used. The disadvantages of either a water tower or an air-cooled condenser would be eliminated, and, depending on what other equipment already exists, it might be possible to use existing turbines to produce the relatively small amount of electricity from the RDF system.

During the oral presentation, I believe that I heard one of the authors discuss the possibility of investing as much as $250,000,000 on this plant.
vs the $96,377,000 in the paper. If so, I would predict that the cost of owning and operating the plant would be about $75,000,000 per year — or about $170/t.

Except for Saugus, which was built years ago, and whose bondholders are being repaid with debased currency, we know of no large scale resource recovery plant that is breaking even — and even the technically-excellent Saugus plant was losing money until the price of oil increased by a factor of about ten. I continue to believe that it is possible for this country to enter into a period of currency stability — or even a period of currency deflation. If deflation should occur, perhaps accompanied by interest rates in the range of 3 percent to 4 percent, then plants that cost in the range of $100 million plus (financed at 10 percent interest) will become colossal white elephants — even if they fulfill their technical promise.

There is, happily, one element of conservatism in the author's economic projections; they predict only 454 kWh of electricity per ton of refuse burned vs perhaps 497 kWh that may be produced based on a station heat rate of 18,000 Btu of fuel per kWh.

In this connection, presuming that total capital is $96,377,000, and further presuming a 300 day year, then the generating capacity of the proposed plant will be about 27,500 Kw — which amounts to an investment of about $3,500 per Kw capacity. This should be compared with the investment in a coal-burning electric plant of about $1,000 per Kw capacity. This very large difference must be made up by the difference in cost of fuels used — adjusted to account for the greater expense of operating a solid waste boiler as compared with a coal-burning boiler. Is such enormous capital investment in marginal electric generating systems cost-effective for the nation?

Of course if inflation of energy prices and other prices continues, almost any project that is mostly funded by debt may be successful; its success will be based on repaying the lenders in greatly-debased currency. Is this any way to run an industry?

REFERENCES


AUTHORS’ REPLY

I would like to begin by thanking Mr. Nollet for his comments. In a relatively young industry, such as resource recovery, the exchange of ideas and opinions is a fruitful endeavor. In his comments, Mr. Nollet touched on many issues, some of which would require answers long enough to be considered papers in their own right. For example, his suggested use of RDF technology, while interesting, was precluded by Montgomery County’s requirement of adopting only proven technology for their system.

A lot of ground is covered in the comments, but I would like to restrict my response to his comments concerning costs, which was the topic of my presentation.

The thrust of Mr. Nollet’s comments concern the operating and maintenance costs presented for the proposed facility. Based on the “30 percent rule,” the O&M costs appear to be low. A description of the 30 percent rule is provided by Mr. Sherwin in the Discussion of Mr. Velzy’s article “Energy Recovery from Solid Wastes: Opportunity and Problems” presented to the 1980 National Waste Processing Conference, ASME [1]. The 30 percent rule “evolved” over the years and two applications of the rule are presented: the Ames, Iowa plant and the New Castle County, Delaware plant. I will refer to these as the “Thirty Percent Plants” or TPPs for short. As would be expected, the 30 percent rule applies well to the TPPs chosen as examples. The implicit assumption is: if the rule applies to these two plants, then it can be applied to all resource recovery facilities. This assumption ignores significant differences between the proposed facility for Montgomery County and the TPPs in the area of choice technology, size, and age.

Specifically, the combined cost of the TPPs, about $10 million, is roughly one-tenth of the estimated cost for the proposed facility. The Ames plant process only one-sixth the waste that the proposed facility will combust. The application of a rule of thumb to a facility the size of that proposed for Montgomery County based on the evidence that it is applicable to the very much smaller TPPs is, at best, tenuous.

The TPPs are early attempts at energy recovery and, as Mr. Sherwin points out, relatively unsophisticated. Automation and technology advances based on past experience can be expected to lower O&M costs. More importantly, both the TPPs mechanically process the waste. Mass-burn technology is designed to minimize mechanical processing
and handling of the waste. Again, the expected result is lower operating and maintenance costs. In summary, although the 30 percent rule may be applicable for small, older waste processing plants, there is no evidence presented that it applies to large, modern mass-burn facilities.

A mass-burn facility is Issy-les-Moulineaux of roughly similar size, 625,000 t/year, recorded operating costs of $14.70/t, in 1979, which is close to the O&M cost (approximately $10/t) projected for the Montgomery County Facility. It is expected the proposed facility will be more automated than the Issy plant, resulting in lower O&M costs.

By way of comparison, cost estimates for a 260,000 t/year facility are presented by Mr. Nollet. These estimates have now been published by EPRI [2]; however, I will continue to refer to them as “McGowen’s estimates.” During the Phase II work the O&M cost estimate for the proposed Montgomery County facility was revised upward to $4,850,000. This is still lower than McGowen’s estimate of $5,900,000 for the O&M cost associated with a hypothetical 260,000 t/year facility. The breakdown of the O&M costs into its components yields interesting results. McGowen’s labor cost estimate, $2,210,000 for about 75 employees, is higher than the $1,780,000 for about 55 employees needed for the proposed facility. To state the obvious, since fewer employees are needed to operate the facility, O&M costs are reduced.

Mr. Nollet questions the provision of moneys for replacement of capital equipment in the cost analysis. The Phase II estimate for maintenance costs is $2,184,000 annually. This estimate includes provisions for the replacement of capital equipment. It is greater by almost 50 percent than the maintenance entry by McGowen which is $1,422,000.

There is no significant difference between the two estimates for water and sewer. McGowen includes about $1.5 million for auxiliary power in the form of electricity. The estimates for the proposed facility are based on the assumption that the facility will generate electricity and sell all that is available only after the facility’s power needs have been met. The result is lower revenues rather than higher O&M cost and merely reflects differences in accounting methods.

To summarize, McGowen’s costs are higher, first, due to the need for more laborers, and second, due to the purchase of electricity for operation which is accounted for in the proposed facility’s economic analysis as lower energy revenues. This results in higher O&M costs estimated by McGowen in spite of the fact that significantly more money is included for maintenance in the economic analysis of the proposed facility.

Mr. Nollet also addresses the effect of inflation and real cost increases or decreases in energy prices. He correctly points out that the economics of capital intensive services are helped by assuming inflation will continue. Once the debt is raised, and the capital equipment is purchased, that portion of the annual cost is fixed. The investment in capital equipment then becomes a hedge against costs increasing with inflation, and allows local communities to better predict and budget for disposal costs.

Mr. Nollet suggests projecting the effect of decreasing energy prices, say 5 percent, rather than the increases in energy prices of 8 percent to 10 percent a year used in the analysis. The possibility of the real cost of energy decreasing is remote. To quote “Energy: The Next Twenty Years,” a report sponsored by the Ford Foundation [3]:

"The basic energy problem is that low cost energy such as oil is more scarce and abundant such as coal is more costly than was generally believed as little as ten years ago and will probably get more so over the next twenty years and beyond. In principle, technology could change this situation; there is no law of physics or economics that says that technology will never make solar energy or fusion power cheaper than oil energy was ten years ago, the way it made oil cheaper than coal and wood in the past. And there are some possible breakthroughs, particularly in solar energy, that could dramatically change the cost outlook. But on the whole, energy from futuristic sources such as fusion show little promise of reversing the trend toward higher energy costs. The abundant fossil, nuclear, and hydropower resources of the earth can be exploited now — it is just costly to do so safely and cleanly, and there is not much prospect that technology will change this fact dramatically. Technology will be able to help slow the rate of cost increase as lower quality energy sources are increasingly drawn upon, but it is not likely to solve the problem of higher energy costs.”

Combining an increase in the real cost of energy of 2 to 3 percent with an inflation rate of 6 to 7 percent, which is the rate over the last 15 years, results in a price increase of 8 to 10 percent. The 8 to 10 percent range is our best estimate and so was chosen for the analysis.

Another very important misunderstanding,
which may have been due to the method of presentation, should be cleared up. At the end of the presentation, I showed a newspaper clipping which contained in the headline the term "$250 million dollar incinerator." Mr. Nollet, and probably others, took the number and said that the facility should cost about $170/t for capital alone. This assumption entirely missed the discussion at the presentation. The facility capital cost estimate in 1980 dollars was $96.4 million.

All the work in the paper was based on that since the paper was submitted one year before the conference. If that number is escalated at 10 percent per year until 1984 when the plant was expected to be mid-way through construction, the base capital cost of the same plant is about $144 million. If financed with project revenue bonds, the additional financing costs at 12½ percent interest add about $100 million more to the original bond issue, not necessarily to the cost of the plant. Of that extra amount, about $85 million is in capitalized interest alone, with another $29 million going into a debt service reserve fund. From these and other costs must be subtracted (as credits) interest earned on the money during construction, as well as other investment earnings. The net result is an annual capital repayment of about $25 million, or about $50/ton for capital alone. The payment is not a simple application of a capital recovery factor to a single gross bond issue amount.

A final note on the cost analysis. The "discrepancy" of the difference in landfill costs portrayed by the author is easily cleared up. The landfill costs are provided on a basis of per ton of waste entering the facility. The combustion process reduces the volume (and mass) of waste entering the facility. The savings per ton reflect this reduction. Bypassed waste was included with the residue in the estimate of waste volume going to the landfill.

REFERENCES

