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DEFINITIONAL MISSION

CALCUTTA WASTE-TO-ENERGY PROJECT

Final Report

November 13, 1986

Submitted To:

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U. S. Trade and Development Program
Washington, D. C. 20523

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DEFINITIONAL MISSION: CALCUTTA WASTE-TO-ENERGY PROJECT

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1. EXECUTIVE SUMMARY

The team was introduced to many government officials and private citizens who advised that ten or twenty years of useful dump life remained before Calcutta would have to find alternatives to land filling. It was argued, however, from environmental and public health viewpoints, that the current system of solid waste management was inadequate and needed considerable upgrading. A sense of urgency was communicated and the team began to examine the technical and financial parameters of a resource recovery center based on energy production in the form of electricity. Due to the fact that there is a shortage of power and little reserve capacity, there is an assured market for electricity. This position was strongly supported by the manager of a large regional electric utility company.

The first consideration in defining landfill alternatives is to establish the opportunity for energy recovery from Calcutta's solid waste. An initial concern that municipal wastes would not contain an economically recoverable heat value was examined. Data from sampling at ten collection sites in 1970 indicated an average heat content of 2700 BTU per pound, well below the threshold of practical energy recovery. Additionally, much energy would have to be used to drive off the 41% moisture content of the wastes before useful heat could be recovered. These data are now quite old and may be too outdated for estimation purposes but, nonetheless, they provide a guide to an available resource. More recent unconfirmed reports indicate similar heat and moisture values. It is, thus, recommended that new samples be taken before the final determination of technical feasibility is made for the approximately 1500 tonnes per day of solid waste from Calcutta.

In the following calculations, the team assumed and then verified with subsequent meetings that there is a higher heat content in selected, more affluent, commercial and residential areas. It was also assumed that new collection modes and containers would become more widespread and thus reduce the amount of local scavenging before entry to a recovery center. These favorable assumptions could result in the generation of 400 tons per day of a selective waste stream averaging 3500 BTU per pound with a lower moisture content, except in the rainy season. For this amount of waste, collected as suggested, there is little doubt that the program of energy recovery is technically feasible.

For the remaining wastes, it would be unlikely to find an economical level of heat content without some means of waste separation and/or augmentation of the municipal sources with supplementary conventional fuels, industrial refuse, or methane from the landfill itself. It was not possible to document the existence of more potential fuel sources from other wastes. The attempt to find industrial sources was discouraged by the existence of an extraordinarily thorough scavenger effort throughout the society that already recycles materials for more valued purposes than energy recovery. The existence of economic levels of methane in the shallow landfills can not be known by inference and steps to acquire more information are called for in the following proposed scope of work for the Feasibility Study.

The next factor for consideration that would develop interest in an energy recovery center is the benefit of volume reduction. Considering the assertion that there will be a lack of local space for further environmentally suitable dumping after ten years, this argument merits considerable attention. Many cities of the world are forced to send wastes farther and farther from initial disposal sites. It is believed locally that distant land available to Calcutta has higher and better uses than waste disposal. While the team could not verify this complex statement of fact and value, it did investigate two features of the assertion, volume reduction through combustion and projected life of current dumps.

The volume reduction benefits of combustion are limited to about 50% because much of the current municipal waste stream in its unseparated form contains silt and other non-combustibles. Space for landfilling of about one half of the existing waste stream would, thus, still be necessary, even if all wastes were processed in an energy recovery center. Nonetheless, even an approximate 50 % reduction is significant, when there is pressure on the land to be converted to higher and better uses.

The issue of a ten year limit for existing nearby sites was investigated. If it is indeed true that space will be gone and that distant sites create unacceptable conflicts with preferred land uses, the time to start work on a resource recovery center is now. No documented source for the ten year estimate could be found. A recent report, however, published in 1986, "Calcutta: City of Joy", indicates that by filling beyond a two meter depth for a few years, the existing dump sites could accommodate Calcutta's needs until the year 2008. Other cities of the world are mounding their wastes far higher, creating hills where none existed. The ten year life projection for existing facilities in Calcutta assumes a rejection of poor environmental dumping and mounding practices.

If it is recognized that at least part of the waste is combustible and that the dumps can no longer be operated the way they have been; then, the initial motivation to consider energy recovery should be sustained over the process of implementation. The years of delaying a decision to substantially modify solid waste practices, begun with serious studies in 1970, may have come to an end. There is now an apparent confluence of policy and a corresponding proven technology to implement that policy.

It is precisely within the context of satisfying public health and environmental values that the determination must be made to invest in an energy recovery facility. As the team indicates in this report, there is no financial attractiveness to a recovery center operation without increasing present disposal costs. The alternatives of open dumping in the wetlands and efficient scavenging of the wastes are far less costly in financial terms. The municipal authorities must determine if they are willing to sustain the capital costs to change this situation, at least partially, and preferably in an evolutionary fashion, giving time for social adjustments to be made. The tradeoffs and conclusions they make will be reflected in the willingness to pay for the additional quality of service which energy recovery affords.

The team believes that Trade and Development Program internal criteria

for funding a full feasibility study in the near future are satisfied and thus recommends a continuation of funding. The preliminary design of the project in two steps responds to the question of resolving remaining technical uncertainties and demonstrating organizational and economic committment. Scopes of work for these two studies are included.

The team also believes that further testing of the waste's characteristics and the use of selective collection will prove that energy recovery is technically feasible for a significant quantity of Calcutta's waste. The financial feasibility is conditional, depending on the levels of costs public bodies are willing to pay for the additional services. Recovered costs from energy generation will at least pay for some of the benefits of environmental and public health improvements. The decision to recover energy from municipal wastes will, therefore, make economic sense as well.

Mr. Morton Gorden, Ph.D.
Mr. Abraham Michaels, P. E.

2. TECHNICAL, ECONOMIC, and FINANCIAL ASSESSMENT

The primary technical considerations for this project are the heat value of the solid waste, the cost of converting the waste to energy, and the value of the energy. Another important consideration is the ability of the region to properly dispose of waste for a reasonable period of time without the benefit of a reduction in waste volume.

A comprehensive study of the characteristics of the waste generated in Calcutta in 1970 revealed an average heat value of the solid waste to be 2700 BTU per pound with a moisture content of 41%. Discussions with management and employees of the Calcutta Municipal Corporation, the agency responsible for solid waste management, and examination of the solid waste delivered to several landfills lead us to conclude that the characteristics described in 1970 are reasonably close to the solid waste we examined.

Based on applying these averaged data, there is no encouragement for energy recovery. However, a review of solid waste collection records from different parts of the city reveal that different waste densities are generated in different parts of the city. Records kept at the Calcutta Municipal Corporation shown by Mr. Nundi, Department Director, and orally confirmed by Mr. Oshaka, Landfill Engineer, indicated significant deviation from average densities. These less dense wastes could mean that some areas of the city generate waste with more combustible matter than others. It is, thus, quite likely that some of the waste in the city would have a higher heat value than the average waste.

Experience with the combustion of municipal solid waste reveals that the average Calcutta waste, i.e. material of 2700 BTU/Pound and 41% moisture, cannot support combustion. It is concluded, consequently, that the waste currently disposed of in the city's landfills cannot be used to generate energy without the use of an auxiliary source of heat or a waste sorting process. Recognizing that waste of a higher heating value than the average for the city may exist in parts of the city, and recognizing that waste with a heat value of 3500 BTU and 40% moisture could support combustion, it is suggested that a waste-to-energy facility may be capable of producing energy if a selected quantity of the high BTU value waste generated in the city is to be used.

The waste now disposed of by the City of Howrah was also examined at that city's landfill. An examination of the contents of a number of trucks revealed a high dirt and silt content and significant quantity of fresh vegetation such as leaves, stalks, etc. It is the opinion of this team that the Howrah waste is no more likely to support combustion than the average Calcutta waste.

The team investigated the present disposal practices and the available capacity of the present and planned future landfill space to accomodate a continuation of present waste production. At the present time, Calcutta householders practice recycling extensively by retaining and selling old newspapers to recyclers who pick up the newspapers at the residences. Recycling is also practiced extensively at the public refuse storage bins and all dumping sites. It is estimated that 40,000 people are involved in

the scavenging/recycling efforts throughout the city. In addition to scavenging by local people, farm animals root through the dumped waste for food. A significant percentage of the City's waste is composted, both mechanically and manually. And although the City is unable to sell the mechanically produced compost, the manually produced compost is used completely by farmers who pick up the compost and spread it on their land.

It is reported that Calcutta has been dumping solid waste in wetlands for 100 years and that the completed filled areas comprise farmlands which grow produce to feed a large portion of the population. Although initially, we were advised that there was only 10 years of landfilling space available in areas currently available to the city; subsequently, it was learned that the last evaluation, as reported in the City Plan, "Calcutta, City of Joy", prepared this year, reveals adequate space is available to the year 2008, providing mounding of wastes is permitted.

The review of landfill space availability in Howrah indicates over 10 years of space using present methods of filling, and a likelihood that this could be increased to 20 years with mounding. It is concluded, therefore, that by using present disposal practices, there is no shortage of space for the disposal of solid waste in Howrah for the next 20 years.

The team was advised that the present cost of the entire solid waste collection and disposal services for Calcutta is approximately Rs. 25 ($2.00) /person/year, and that the average quantity of waste disposed of in Calcutta is approximately 1,500 tons/day which is 0.33 Kg./day/capita or 127 Kg./capita/year.

We learned from meetings with municipal, business, and utility officials that there are differences of opinion as to the environmental and public health acceptability of present disposal practices. It is apparent that if present practices are acceptable, the 20 year life of landfill space should apply. If these practices are not acceptable, there is an immediate need for a change to other disposal methods which could include, incineration, with or without energy recovery; sanitary landfills in suitable distance locations; composting; and recycling under controlled, sanitary conditions.

It is conceivable that a portion of the waste product collected in Calcutta can be isolated from extensive recycling and from street sweepings by using a container storage system, and that this waste will contain enough of the combustible fraction of recyclables to raise the heat value to 3500 BTU/pound or higher. At that heat value, the waste would be able to support combustion and generate heat which can be converted to energy. We are advised by municipal officials that 400 tons per day of solid waste can, probably, be made available in this condition; and for purposes of this study, it is assumed that 400 tons per day of 3500 BTU solid waste with a moisture content of up to 40% will be available for the waste-to-energy process.

Several technologies are available which may be used for converting this type of waste to energy; and, based upon the most recent worldwide experience, the most reliable of these technologies is referred to as Mass Burn. Mass Burn is a technology in which waste, as delivered, is charged into the furnace without preprocessing. There are a variety of mass burn

furnace designs and boiler configurations. The least expensive to construct of the mass burn designs is the modular furnace; and this design, when utilizing the "starved air" concept, generates the least air pollution of all furnace designs. Modular furnace equipment with waste heat boilers and steam generators would be suitable for a small to medium sized 400 TPD facility, and this size and design will be assumed for purposes of estimating the economics of the project.

A 400 TPD, 3 or 4 furnace, modular waste-to-energy facility with air pollution controls suitable for Calcutta should cost approximately $12 million in the U.S. We are advised that construction costs in Calcutta should be approximately 1/3 to 1/2 of construction costs in the U.S. Recognizing that the equipment for this facility will cost from $6 to $8 million, it is assumed that the plant in Calcutta should cost approximately $9 million.

The operation and maintenance (O & M) costs for the proposed facility in the U. S. should approximate $15/ton of capacity. We are advised that Calcutta salaries, with fringe benefits, should be approximately 1/10 U.S. costs. It can be assumed, however, that greater productivity by U. S. labor would result in an increased labor force for Calcutta employees of approximately 100 %. Recognizing that labor represents 1/2 to 2/3 of O & M cost, it is estimated that O & M costs for this facility would approximate $8/ton. Advice from public officials and others concerned with this project is that the operation and maintenance experience of public employees is extremely poor. We were advised that the facility would be operated by the electric utility company serving Calcutta or by a private company. We believe that adequate operations and maintenance capability would be available from these sources to assure proper operation of the facility under consideration.

The economic and financial prospects of this waste-to-energy project follow a rather well known pattern. If the project is evaluated on its ability to be self financing, that is the energy output is expected to pay for the conversion plant and its operations; it will not recover its costs. As has become established through practice, however, such waste-to-energy plants provide public benefits beyond energy generation; and the public is willing to pay for these benefits through different means. Frequently, the risks and gains are shared by means of tipping fees for the disposal service, prices for electricity which support the generation costs, and contractual mechanisms which deal with liabilities in an equitable fashion. Through careful negotiations, each of the parties to an agreement can discover mutual interests.

The project in Calcutta has potential to be made economically attractive for public investment; and if certain skills from the private sector are desired for operations, it can be made financially attractive through contracting for services. In this context, separating investment from operations, it has potential for a joint sector approach.

While there are a number of economic scenarios possible, each one suited to particular institutional arrangements, one basic project was structured to examine general feasibility. For testing purposes, the following assumptions were used for a publicly owned facility. The assumptions regarding payments for power and management arrangements were

suggested by Dr. B.P. Banerjee, Chairman, West Bengal State Electricity Board. They were examined further in discussions with the Minister for Power, the Honorable Prabir Sengupta and Mr. Ajoy Sinha, Secretary, Department of Power.

The capital cost of 9 million dollars was allocated between debt and equity such that one third equity was required. The loan was assumed to come from the International Development Agency (IDA) at a concessionary 4%. A grace period on principal payments was extended until completion of construction and plant shake down, but a relatively short payback of the loan was anticipated within 9 years. Plant life should extend well beyond the loan payout period of 9 years, after which there is positive cash flow.

Longer term financing is likely to be available, but then a sinking fund might be started earlier. An extended period of financing was desired by the Chairman of the Electricity Board in order to lessen the annual payments. The longer period was not used in analysis because the maintenance costs and a sinking fund would absorb much of surplus after a decade of operations.

The revenue stream was analyzed at 7 cents per KWH suggested as a possible level of payment by the Utility. The years of negative cash flow prior to payoff of the loan were analyzed to provide a sense of the necessary fee for disposal that would make the plant financially feasible.

Under these assumptions, the basic economic profile appears to be quite reasonable. Cash flow is positive within ten years. Revenues, thereafter are at a level of $300,000 per year, using 7 cents per KWH income for the electricity generated. This income provides an opportunity for a sinking fund to build before major replacement and reconditioning will be required.

The annual disposal costs to be paid to the plant operators for the service of processing 400 tons of waste each day for 310 days a year would have to average about $685,000 for 7 cent electricity generating fees. It is a political matter beyond the jurisdiction of the study team to recommend which agencies, either the Municipal Corporation, or the Utility should support the costs. The numbers are provided to indicate the general parameters needed to support the project.

Another way to consider the allocation of costs is that a 7 cent charge for electricity generation requires a disposal fee of $5.52 per ton to provide a healthy financial basis to a publically financed project. These payments would decline with longer term financing.

The acceptability of these charges is a matter for local evaluation, although informal discussions have indicated the general levels are not likely to be prohibitive. The balance between payments for disposal or electricity, likewise, is a local matter. Furthermore, no provision has been made in these assumptions for private sector incentives which would be necessary in a joint sector approach. Potential private operators from the Calcutta Management Association indicated there is considerable precedence for negotiating a workable package, and the ranges of costs described would not provide a barrier to implementation.

3. SCOPES OF WORK

Two activities are proposed for the continuation of this project. The first activity is a Prefeasibility Study which includes identification of a region(s) within Calcutta which can supply 400 tons per day of a waste with a higher heat value and a lower moisture content than the waste traditionally found in Calcutta. A characterization of this higher heat value waste will be performed in this study. Its successful completion should lead to a Feasibility Study. Scopes of work for each are presented.

A. Scope of Work for Prefeasibility Study

Objective: Perform waste characterization study on pre-selected waste which includes four sets of samples collected over a one year period illustrating the maximum variations associated with wet and dry seasons.

1. Survey Calcutta to determine area or areas in which waste may be assumed to have higher heat value.

2. Evaluate waste characteristics from this area or areas including moisture and heat value from three sources of wastes:

- Waste as now collected from households
- Waste from outdoor storage bins with and without street sweepings, and
- Waste from containerized systems now being introduced.

The test procedures for the representative samples should include the following:

- Determination of moisture content
- Bomb calorimeter evaluation of heat value, and
- Physical separation into recognizable fractions.

The results of the calorimeter tests should be compared with the theoretical heat value as determined by calculating heat values of the reported fractions adjusted for moisture content. Data should be collected following traditional physical/chemical procedures and be recorded in a manner convenient for interpretation.

3. Survey selected areas of Calcutta to determine the presence and physical/chemical descriptions of industrial wastes which regularly appear in the municipal waste and would supplement the average heat content.

4. Prepare Interim Prefeasibility Study Report which includes test results from period of maximum precipitation. This report could facilitate an early project decision and lead directly to the Feasibility Study.

5. Prepare Final Prefeasibility Study Report including all findings over the one year period.

This work should be performed by a team consisting of utility company employees, municipal employees, and the TDP-selected consulting engineers.

B. Scope of Work for Feasibility Study

Objective. Determination of technical and economic viability of proposed waste to energy project.

1. Review and expansion, as required, of the waste characteristics from the Prefeasibility Study including

- Waste as now collected from households
- Waste from outdoor storage bins with and without street sweepings, and
- Waste from containerized systems now being introduced.

The Prefeasibility Study has determined the moisture and heat value of scientifically selected representative samples of each type of waste recognizing seasonal variations. These and additional data provide the basis of determining the areas of the city from which waste will be collected for energy recovery.

2. Determination of collection areas and/or industrial waste supplements required to provide 3500 BTU quality solid waste to a 400 TPD facility. This should be based upon a review of municipal collection records; a study of the availability of combustible agricultural and industrial waste, i.e. rice hulls; advice from municipal sanitation personnel; and the findings of Prefeasibility Study.

3. Determination of energy output, residue quantity and characteristics, and gas emission characteristics for modular 400 TPD plants using waste containing the characteristics of the waste as determined in the Prefeasibility Study. Use operating experience to the extent available of existing mass burn waste-to-energy facilities, manufacturer's design data, and theoretical combustion analysis. Determine air pollution control methods required to meet local emission standards.

4. Selection of at least two suitable sites for the location of a 400 TPD facility with the assistance of municipal and electric utility personnel. One site should be on or adjacent to an operating landfill, the second site should be near the collection centroid of the area served. Determine the location of a suitable connection to the public utility power grid for each site studies. Determine the value of energy for sale to the public utility.

5. Estimation of the construction and operating cost of the design studied. Estimate the energy income from the sale of electricity to the public utility. Determine the site development costs, electric transmission costs, and the cost of transporting the waste from collection routes to the plant site for each selected site.

6. Determination of transport and disposal costs of present practices for the area to be serviced by the new facility.

7. Evaluation of life cycle costs for a 10 year operating period for each plant studied for each of the sites studied. Include the transport cost for the delivery of collected waste to each facility in the evaluation.

8. Determination of economic feasibility of the project, the scheduling, and cost of implementation. Discuss institutional and financial arrangements. Prepare report of data and findings in a form suitable as guide to investors.

9. Identification of quantity and quality of landfill gases generated. Drill minimum of 12 test wells in existing landfills.

10. Determination of potential gas quantity, cost of extraction, and energy value of gases in the two major landfills, if gas generation is significant.

4. COST ESTIMATES

A. Cost Estimate for Prefeasibility Study

This study cost is estimated as follows.

Consultants' Time includes 23 mandays.

23 mandays @ $700 (Incl. per diem)	$16,100
Travel (Including 3 trips)	9,900
TOTAL	$26,000

Cooperation has been pledged by the municipality and the utility to support this effort with significant levels of manpower and facilities as requested by the definitional mission contractor.

B. Cost Estimate for Feasibility Study

The following table presents task time estimates for all participants in mandays. The cost estimates do not include the in-kind services of the Municipality and Utility which have been offered by these groups. These groups are interested in participating and have indicated a willingness to sign performance contracts because the desire for technology transfer motivates their cooperation. This offer should be accepted both to maintain a favorable cost to benefit ratio for TDP and also because the intimate knowledge of the city by local participants will be necessary to identify the neighborhoods where suitable wastes will be found.

Time Estimates in Mandays for All Participants in Feasibility Study

Task	Consultant	Municipality	Utility
1	10	10	20
2	10	20	40
3	30	-	5
4	10	10	5
5	30	20	5
6	5	5	-
7	5	5	-
8	30	-	-
9	5	5	10
10	10	5	10
Total	145	80	95

The project cost estimate, excluding in-kind services, is as follows.

Consultants' Time includes 145 mandays	
115 mandays @ $700 (Incl. per diem)	$ 80,500
30 mandays @ 600	18,000
Travel	12,500
Total	$111,000

An alternative arrangement which does not rely on local in-kind support would cost an additional $96,000 for labor and expenses and $15,000 for travel. This supplemental cost brings the total to $222,000. This estimate assumes that the 175 mandays of local support would be replaced by 155 mandays of consultant time at $600 per day. Under this assumption, the local participants would only be obliged to perform for about one man month and additional time would be at their discretion. The distribution of work by tasks would approximate the time estimates given above.

5. FINANCING SOURCES

Based on conversations with high level decision makers, the Municipal Corporation of Calcutta would be the most likely organization to pay disposal fees, the West Bengal Electricity Board the most likely to pay for the electricity generated, and a coordinated State and National group the most likely to deal with the International Development Agency for capital requirements. Based on discussions with the IDA, concessionary funds are available to India, but negotiations regarding priority application of those funds will have to be accomplished. It would be worthwhile for the Indian government to conduct those negotiations in principle before committing funds to a feasibility effort.

Financing discussions have been tentative in nature and the opportunity to look beyond these sources remains open. There are also government funds available for joint sector projects. This particular project is suited to such an approach, but the financing cost then would be 11% , rather than the public concessionary funding of 4%. One appropriate package that appears quite feasible at the moment is public ownership of the facility, probably by the Municipal Corporation, with an operators contract for a separate agency. The West Bengal State Electricity Board has expressed an interest in being the operator, as have some private individuals from the Calcutta Management Association. It is too early for sorting out the choices. The important feature is that groups have already come forward to express an interest in participating.

6. COST ESTIMATE FOR IMPLEMENTATION

The team estimates that 9 million dollars will be required for the waste-to-energy facility assuming contract management by the Utility Company.

7. COST ESTIMATE FOR IMPORTATION

The team estimates that 7 million dollars will be required for importation. Note: we are advised that this equipment would be duty free.

8. COST ESTIMATE FOR IMPORTS BY CATEGORIES

The contractor must be a full service contractor who will provide design, construction, start-up, and training for the complete facility. The cost of these services is integrated into the total project cost. Construction of the facility is expected to be performed by local contractors under the direction of the prime contractor.

General Categories for Cost Estimate:

Furnace, boiler, ancillary equipment	$6,000,000
Air pollution and materials handling	550,000
Generator	450,000
TOTAL	$7,000,000

9. FEASIBILITY STUDY FUNDING RECOMMENDATION

The team recommends that TDP fund a feasibility study, assuming a successful prefeasibility study. As indicated in the proposed scope of work, there should be an early effort to verify technical feasibility through updated waste characterization in selected geographic areas of the city. TDP should lessen its risk by funding the study in two steps. The prefeasibility costs would provide verification of the waste characterization assumptions used in this Definitional Mission, and the remaining portion of funds would be released pending satisfactory results. For the prefeasibility study certain manpower has been requested from local authorities to assist with waste characterization information. These obligations have been discussed and it is recommended they be written into a grant agreement.

The justification for the project is found in the apparent motivation by officials to implement an alternative to existing dumping practices. A positive study result is thus likely to find strong internal support for action. This is not to say that there will be no opposition. There are those who believe a twenty year dump life remains using current practices and there has been a solid waste committee report recommending distant sanitary land filling. A good feasibility study could change this debate in favor of energy recovery.

TDP export incentives are also present. Approximately $7 million of goods and services are involved for the first unit only. Further expansion in Calcutta is likely as well as in other cities in India. See Appendix B. There is currently one center under construction in Delhi by an Indian/Danish venture that has created a great deal of interest. While there has been only one sale, the market is beginning to open.

The cost of the feasibility study, lessened by local in-kind participation, has a very respectable ratio with reference to potential 5 year export sales. The type of unit suited to Calcutta, a modular mass burn design of 400 tons, is one where the US technology has an edge. While there is no present knowledge of the competing bid in circulation, the costs in this study would be highly competitive with its reputed costs.

While the ultimate export content of any single project may be lessened by joint venturing with an Indian firm, the cost advantages of doing so are evident. A licensing agreement would both help insure a sale and bring local interest to the project for expanded Indian markets.

In sum, the TDP criteria are generally satisfied. The risk of failure in the prefeasibility study is small and the team is confident that the strategy of selective collection will overcome the traditional problem of the low heat value of wastes in developing countries. Energy recovery in Calcutta is recommended for inclusion in the TDP portfolio pending the outcome of the prefeasibility study.

10. DRAFT NOTICE FOR PLACEMENT IN COMMERCE BUSINESS DAILY

Feasibility study for municipal waste to electricity project in Calcutta, India. Firm sought for study to work with Indian counterparts to prepare technical, economic, and financial feasibility data for study on selected municipal waste stream. Public or joint private sector approach to own/operate facility of 400 tons is anticipated. Summary of scope of work follows by task: 1. Waste characterization for selected areas of Calcutta; 2. Determination of collection areas; 3. Determination of energy outputs, residue, and emissions; 4. Site selection; 5. Cost estimates for construction and O&M; 6. Determination of transport and disposal costs; 7. Evaluation of 10 year life cycle costs; 8. Determination of economic feasibility and related institutional arrangements; 9. Identification of landfill gas generation; and 10. Determination of potential for gas utilization.

Specific selection criteria include: previous professional experience and quality of professional skills in performance of feasibility studies on municipal waste to energy projects for both the company as well as selected professionals, experience of company and individuals in completing similar projects for developing countries, and history of previous projects indicating quality and timely performance.

Additional information and copy of RFP available from Daniel D. Stein, Regional Director, U. S. Trade and Development Program, Washington DC 20523, (703) 235-3660.

(Additional note: A final version of this notice including identification and address of the grantee can be prepared upon completion of the prefeasibility study.)

11. POTENTIAL FOREIGN COMPETITION

Foreign competition is not significant for modular units. For non-modular designs the market is estimated at 1/3 US and 2/3 foreign companies. Most foreign companies have US company franchises. There are several outstanding proposals for Indian cities at this time from non-US companies for non-modular units. They include one from the Volund Co. of Denmark to Calcutta discussed in Appendix B.

APPENDIX A. LIST OF INTERVIEWS

The following people graciously gave of their time to inform the study team of the many facets of wste disposal practices in Calcutta. Thanks are given to S. Gupta and J. Cole for their assistance in arranging interviews. The team is also grateful to Consul General Walker A. Diamanti for putting the resources of the Consulate at our disposal to facilitate interaction with the following interviewees.

CALCUTTA METROPOLITAN DEVELOPMENT AUTHORITY (CMDA)

Honorable Prasanta Sur, Minister of Urban Development & Municipal Affairs, Government of West Bengal, and Vice Chairman, CDMA

Mrs. Leena Chakrabarti, Chief Executive Officer

Mr. P. Mandal, Director General

Mr. S. R. Mukherjee, Director

CALCUTTA MUNICIPAL CORPORATION

Mr. Prasanan, Commissioner

Mr. D. Nundi, Department Director

Mr. Ashoka, Landfill Engineer

CALCUTTA MANAGEMENT ASSOCIATION

Mr. J. P. Chowdhary, President

Mr. B. Misra, Member, Solid Waste Committee

HOWRAH MUNICIPAL CORPORATION

Mr. S. Chakravarty, Member, Mayor's Council

WEST BENGAL STATE ELECTRICITY BOARD

Dr. B. P. Banerjee, Chairman

GOVERNMENT OF WEST BENGAL

Honorable Prabir Sengupta, Minister for Power

Mr. Ajoy Sinha, Secretary, Department of Power

INSTITUTE OF WETLAND MANAGEMENT

Dr. D. Ghosh, Director

Report of A. Michaels' meetings in New Delhi with AID personnel and affiliates working on waste-to-energy projects - August 27, 1986.

I met with S. Padmanabhan, Energy Specialist of US AID and A. Bhattacharya of J. K. Synthetics, Ltd., (J.K.) the licensor of the Volund Company in Delhi to discuss the Delhi 300 TPD facility. Bhattacharya advised that the 300 TPD plant which should start operating before the end of this year is a "gift" from the Danish government.

The waste tested to 1465 kcal/kg, and the plant is designed accordingly. The manufacturer recognizes that this is marginal for energy generation. No auxiliary heat is used other than for startup. A low arch over the long feeding grate is used for dryout and ignition of the waste prior to placement into a rotary kiln for complete combustion. Energy payment will be 65 p/kw or $.04/kw. The plant will be run jointly by the municipality and the public electric utility. Volund, (J.K.) has 2 years of operating responsibility including training of Indian personnel. After the two year operations period, Volund (J.K.) is free of any responsibility.

The O & M costs as well as a replacement reserve fund are to be paid for from energy sales income. The site is provided by the municipality, residue disposal is the municipality's responsibility, and engineering and construction were provided by J. K. and Volund. J. K. investigated the availability of industrial waste as an additive for heat value but was unable to find any. J. K. has six additional proposals in other cities in India, including an informal Calcutta proposal, and two outside of India.

Padmanabhan advised of AID work with alternate energy projects and of work that Jack Stafurik of Hagler, Bailly & Company, Inc. is doing in a study of alternate fuels including solid wastes. AID has solid waste surveys of some India cities. We discussed the institutional problems of getting public and private sectors together to work jointly in areas such as alternate energy sources. Apparently, it is illegal for the private sector to produce energy for other than an industry's own needs. AID is trying to change this and Padmanabhan was interested in the University Science Center approach used in the U. S. to get universities involved in commercial enterprises.

At Padmanabhan's suggestion, I met John Stafurik who was engaged by AID to study energy alternatives for several Indian cities. Study includes all alternate energies including biomass, solar, waste-to-energy etc. I received copy of Bombay City Refuse report and discussed our TDP Calcutta work with him.