CUMBERLAND MANUFACTURING COMPANY

APPROPRIATE ENERGY TECHNOLOGY

SMALL GRANTS PROGRAM

DOE/R4/10151--T1

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FINAL REPORT

GRANT NO. DEFG4480R410151

COGENERATION OF ELECTRICITY USING WOOD WASTE AS A REPLACEMENT FOR FOSSIL FUELS

BACKGROUND AND SCOPE OF OUR PROJECT

Cogeneration is a term which has been applied to a broad range of practices which recapture waste heat or fuel for some productive uses, usually with more than one use being made of the same energy. The term cogeneration has also been applied to electric power generated at an industrial site which is then fed into the lines of a utility to supplement power generated at the utility's power plants or to power generated and consumed within a particular plant facility.

Cogeneration techniques have been in use for at least 100 years, and the use of waste energy for one or more secondary applications is not new. In the year 1900, over half of all industrial power was generated on the plant site, as were almost 20% of the U.S.A.'s total power needs in the late 1930's. As public utilities began providing more dependable and cheaper electricity, industries found it increasingly difficult to justify the additional equipment necessary to obtain that second or third use of energy expended. Operation and maintenance costs became high, and utility rate structures intentionally discouraged cogeneration. There were also concerns by industrial cogenerators about being classed as public utilities and becoming subject to a new level of regulation and taxation.

SUMMARY OF EVENTS

Our company makes hardwood dimension for the furniture and kitchen cabinet industries. In 1978, I contacted TVA and expressed an interest in utilizing steam from an existing wood waste boiler more profitably. One option discussed was to generate electricity using a steam engine - generator system which would be powered by the existing wood-waste burning boiler. An equipment search spanning six months was conducted, and it was determined that only one company is currently manufacturing steam engines in the United States. Arrangements were made with the salesman from the steam engine company to visit our plant, following which a quotation was issued.

The next step was to contact TVA to determine their interest in cogeneration. A meeting was held with representatives of the utility who were quite discouraging about cogeneration, and enumerated a number of reasons why it was not economically feasible. Chief among these reasons was that if the company isolated a section of its plant from their lines, the utility would still assess a standby charge which was essentially equal to current electricity cost to cover their costs should the company need to switch back to their utility's system in the event of a failure of the company's generating equipment. The representatives also stressed the

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additional liabilities the company would incur if power were fed into the utility's lines. The electric utility in effect did not wish to engage in a cogeneration agreement.

During the ensuing year, futher inquiries were made concerning cogeneration, and other possible uses for excess steam were considered including the possibility of piping the steam to a garment factory for building heat and heat for a permanent press curing tunnel. The garment factory displayed little interest in this option as it did not wish to make the required capital investment.

As a result of a new Federal legislation, and new directions by the board of directors, TVA's attitude about cogeneration changed at the upper echelon, and instructions were issued that any company wishing to cogenerate was to have the full cooperation of the utility staff. Further meetings were held, but it was learned that there was still a great deal of reluctance on the part of the lower echelons in the utility to promote cogeneration.

TVA's representatives stated emphatically that cogenerated power was not needed and that the company would still be required to safeguard the utility's personnel by positive automatic disconnects in the event of a utility power failure.

After another two month delay it was finally possible to obtain a cogeneration agreement from the utility. This agreement essentially stated that the utility would purchase any power generated during peak demand periods at 135% of normal rates and during off peak periods at 85% of normal rates. (note: Different electric utilities have varying policies concerning rates paid for cogeneration, however, utilities are legally bound to accept cogenerated power under PL 95-315.)

It was next decided to investigate sources of possible Federal funding, and a search of grant programs was conducted. Since this project appeared to be innovative, it was deemed desirable to write an application for an Appropriate Technology Grant under the U.S. Department of Energy.

The application pointed out that this project would utilize wood waste for a productive energy source which would displace the need for electricity being generated at the utility's fossil fueled power stations, and could tend to reduce systems expansion requirements. It was also stated that the proposed steam engine - generator system would not displace the current uses of steam including heat for the lumber drying kiln and the buildings, and that low pressure exhaust steam from the engine would be recaptured for current uses. Furthermore, excess wood waste consisting of sawdust and shavings currently being dumped in a landfill would be burned in an enviromentally acceptable manner using a newly installed bag house, and thereby prolong the life of the landfill for more essential uses.

The electrical energy generated would supply the equivalent of 60 homes, and could contribute to the avoidance of brownouts during periods of electricity shortages. The installation was also listed as a demonstration project which could serve as a model for other plants in the region which may have an interest in cogeneration. As a result of the grant application, the company was awarded $49,000 to assist it in implementing the cogeneration program.

As a result of further inquiries with the equipment dealer, it was possible to purchase a used steam engine-generator system which reduced by over 60% the cost of equipment to our company. TVA assisted us in designing the interface equipment which would control the

speed of the steam engine, and monitor the volts, kilowatts and cycles (Hz) being fed into the utility's electrical system. The control equipment also prevented electricity from feeding into the utility lines during a power failure. A series of meters which record kilowatts to be paid for by the utility to the company, and a more precise voltage monitor which regulates the engine speed more accurately have been installed.

The steam engine operates at 125 P.S.I. and the generator produces 115 kilowatts of electricity. The 30 P.S.I. engine exhaust steam is collected and run through a wood drying kiln, and is also used for heating the buildings during the winter. Previously, the steam was used only for heating the dry kiln and buildings, however, some excess capacity is now being utilized for the steam engine-generator, and the frequent releases of steam through the boiler pop valve have been reduced. To everyone's surprise, the engine increased the draw on the boiler only slightly, and there is still excess steam and fuel. The excess sawdust continues to be sold to a paper mill for fuel, with revenue equaling the trucking costs, and most sawdust is not being dumped in a landfill.

The steam engine is a very dependable piece of equipment, which requires less maintenance than a steam turbine. The components of the interface equipment are likewise standard and relatively dependable.

Installation of the equipment was supervised by the engine manufacturer's technical specialist with millwright, piping and electrical work being supplied by the company or hired locally.

ECONOMIC EVALUATION

The economics of this project were evaluated in a somewhat cursory manner. A chart was supplied by some guidance on the range of rates of return which might be expected from co-generation. Using this chart, I estimated some rough rate of return figures which indicated the project would yield about 24% on a 10 year project life.

Due to the low capital investment, the contribution of the Appropriate Technology Grant and the use of company and local labor for installation, the project costs were much lower than originally expected, and the revenue available was well above amounts needed to provide a payback on the initial investment which the company considered to be satisfactory. A summary of costs and revenues is as follows;

Costs:	Proposed New Equip. ($000's)	Actual Used Equip ($000's)
Steam Engine, Generator Synchronizer	145.0 (142 K.W.)	47.0 (115 K.W.)
Replacement parts, Lubricants	0.3	8.3
Building Modifications	3.7	3.7
Boiler Modification and Insulation	5.3	5.3
Installation	8.8	1.8
Piping	1.3	5.1
Electrical	2.0	2.9
SUBTOTALS		
Expense	14.4	15.4
Capital	152.0	58.7
Gross Project Costs	166.4	74.1
Less Federal Grant (Regarded to be a source of funds)	49.0	49.0
Net Project Cost	117.4	25.1

Revenues:	Proposed New Equip	Actual Used Equip
Electric Revenues (First Year)	35.7	28.9
Avoided Disposal Costs	10.4	8.4
TOTAL REVENUES	46.1	37.3

Return Estimates:		
Revenue/Cost Ratios (My estimate-undiscounted)	27.7% (3.6 Yrs.	50.3% (2 Yrs.)

	Proposed New Equip.	Actual Used Equip.
Computed Rate of Return	30%	35%
Computed Payback period (Using discounted cash flow, 10 year economic, 7 year tax life)	10 years	7 years

In addition to the revenue increase shown above, our company is obtaining qualitative benefits resulting from energy conservation tax breaks and the public relations benefit of a pioneering effort.

CONCLUSION

The purposes of this project have been to demonstrate that cogeneration is a feasible alternative for power generation and waste disposal at current electrical rates, and that the technology is currently available. Although, cogeneration has been branded the power of the future, my feeling is that cogeneration is here today, and is a viable source of power and revenue for small or mid-size companies as well as large companies.

Cogeneration is also compatible with new and developing energy forms such as geothermal, solar photovoltaic and nuclear fusion. Creative applications of cogeneration using existing technology or in combination with new energy technologies could make a substantial impact on the energy crisis which continues to plaque the developed countries of the world.

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