Official Proceedings

SIXTY-FOURTH ANNUAL MEETING

OF THE

INTERNATIONAL DISTRICT HEATING ASSOCIATION

HELD AT

THE FRENCH LICK-SHERATON HOTEL

FRENCH LICK, INDIANA

JUNE 18, 19, 20, 1973

VOLUME LXIV

PUBLISHED BY THE
INTERNATIONAL DISTRICT HEATING ASSOCIATION
5940 BAUM SQUARE, PITTSBURGH, PENNSYLVANIA

CENTRAL HEATING AND COOLING SERVICES PROJECT WITH SOLID WASTE FUELED PLANT

Carl E. Avers, *General Manager*
Nashville Thermal Transfer Corp., Nashville, Tenn.

Introduction

The Nashville Thermal Transfer Corporation Central Heating and Cooling Service Project, which includes a solid waste fueled plant, can be characterized as a tale of two marriages: one the marriage of private enterprise and government, the other a marriage between two well-proven technologies. These marriages will become evident as the salient features of the project are presented. This presentation includes:

1. The project's objectives.
2. A general description of the concept and services.
3. A description of the plant and distribution system facilities.
4. A description of the organization and financing of the corporation.
5. The general application of solid waste as a source of energy for central energy plants.

Objectives of the Project

The primary objectives of the $16,500,000 Central Incineration, Heating and Cooling Service Project, which will serve the Center City area of Nashville, are:

1. Provide low cost district heating and cooling to Nashville's Center City area buildings.
2. Recover energy in all combustible solid waste not recycled for other purposes.
3. Virtually eliminate the need for sanitary landfill in Nashville.
4. Reduce substantially and almost eliminate the solid waste disposal cost for Nashville.
5. Improve water and air quality in urban Nashville by meeting solid waste disposal, water and air emission standards with a central plant which incorporates effective environmental control equipment.
6. Provide for major ferrous material recycling from incinerator residue.
7. Create and operate a solid waste fueled central heating and cooling plant project that has a favorable economic and environmental impact on the community.

Background and Description of the Concept and Services

To achieve these objectives, the Nashville Thermal Transfer Corporation was established in 1970. Under construction is the $16,500,000 facility which will carry out the above objectives. Construction began in June 1972, and it will go into preliminary operation in late 1973 or early 1974.

The project is called "Cash for Trash" in Nashville. In the trade magazines it is referred to as "one of the most exciting things in the business of running cities and living ecologically."

The project will heat and cool Nashville's downtown high-rise buildings with energy recovered by combusting the city's garbage and trash. The design engineers, I. C. Thomasson & Associates of Nashville predict that within a year, more than three-fourths of the air pollution which is currently emitted by the buildings to be served will be eliminated. At the same time, the building owners will enjoy saving between 15 and 50 per cent on their normal building heating and cooling costs.

The new convention hotel, expected to be completed soon after the project is ready for services, will save an estimated $400,000 in capital costs by not having to install its own in-building heating and cooling plant. The average price for chilled water will be $4.14 per ton-hr, and the price for steam about $1.50 per M lb. The Metropolitan Government of Nashville and Davidson County will save about $1.25 million yearly by avoiding operation of expensive, and hauling to, remotely located sanitary landfills.

Building owners will not have to worry about shortages of gas, oil, and coal, because the project's fuel will essentially be 100 per cent solid waste, which is in constant and increasing supply. By helping to save on the demand on the nation's fossil fuels, the Nashville project is energy conservation at its best. The thermal energy value in a pound of solid waste is roughly one-third to one-half the value of a pound of coal, and it is a very good fuel.

Today this fuel is being discarded by cities across the country, and it amounts to 543,000 tons per day. If the country's solid waste were all converted into cooling capacity, it would amount electrically to about 16 million kw, which is twice the peak electricity demand of New York City.

Throwing solid waste away eliminates the opportunity to utilize this free fuel, and it also costs a lot just to bury it properly. The normal landfill cost exceeds $5 per ton. Disposal costs in the nation for sanitary landfill operations are estimated at $500 million per year, and landfills consume about 60,000 acres of valuable land annually.

This concept sounds so reasonable and attractive that one wonders what the catch to a "cash for trash" system is. There doesn't seem to be any at all. However, some obvious questions are: Will this project create a nuisance in the downtown area by causing traffic problems, pollution and odors? Will it concentrate all the pollution into one smokestack? Does garbage actually burn well? Who pays for this process? Is the project subsidized? Are the economics proven? Is this an experimental plant? Why hasn't it happened before now? Why aren't all large cities installing a similar project now?

These questions will be answered specifically in this presentation when the operation and design of the plant are described in detail. However, the answers in general, to some of the more serious potential problems follow:

1. How will the odor problem be handled? The waste will be hauled in covered trucks to a pit that is within a heating building. Fresh air will be circulated from outdoors over the pit, picking up the odiferous air, and it will be incinerated in the process plant.

2. How about pollution? The 27 buildings that will initially be served by the system are currently emitting particulate matter. The thermal plant will reduce this by over 75 per cent. Also, because of the 27 individual heating and cooling plants utilizing sulfur-laden coal and oil for energy, the sulfur dioxide created to produce the energy in the individual plants is substantial. The Thermal plant will reduce current sulfur dioxide emissions from this source by 90 per cent. Nitrogen oxides will not be generated by the plant, because the furnace temperature will be less than 1800 F. Additionally, the individual buildings concentrate their pollution into the five winter heating months, while Thermal's plant will not.

3. Does garbage and trash burn? Yes, surprisingly well, without any additional fuel, so long as the solid waste is relatively dry. Ignition is not a very exotic process; it can be started simply by tossing in a match.

4. Is this a well-proven idea? This plant is similar to many existing plants. There are hundreds of central steam and cooling plants throughout the United States; and plants in Europe have been, for a number of years, combusting solid waste in heat recovery systems. Therefore, the Nashville project really isn't anything new. However, it will be the world's first large-scale plant to produce both steam and chilled water from solid waste. The project is a combination of proven ideas, a marriage of proven technologies.

This is in the era of increasing fuel costs and limited fuel, and the environment needs to be improved. Central heating and cooling plants have proven to be a way of conserving energy, reducing pollution, and reducing capital and operating costs for building heating and air conditioning plant facilities. At this point, this Nashville enterprise appears to prove the old adage that problems are merely unexploited opportunities. The Nashville-type system is beginning to be utilized as a model for other cities with high solid waste disposal costs, and a genuine interest in keeping their downtown areas vital by providing modern heating and cooling services.

Every community seems to be in the same boat on solid waste. It makes sense to make garbage pay its own way, rather than it being a burden on the community taxpayer.

Thermal Transfer — How Does It Work?

Thermal's dual-purpose central energy plant will produce steam and chilled water, with its primary fuel being energy recycled from solid waste loosely compacted and delivered by the Nashville solid waste collection process. Fig. 1 is a simplified flow diagram which describes the various systems in the process.

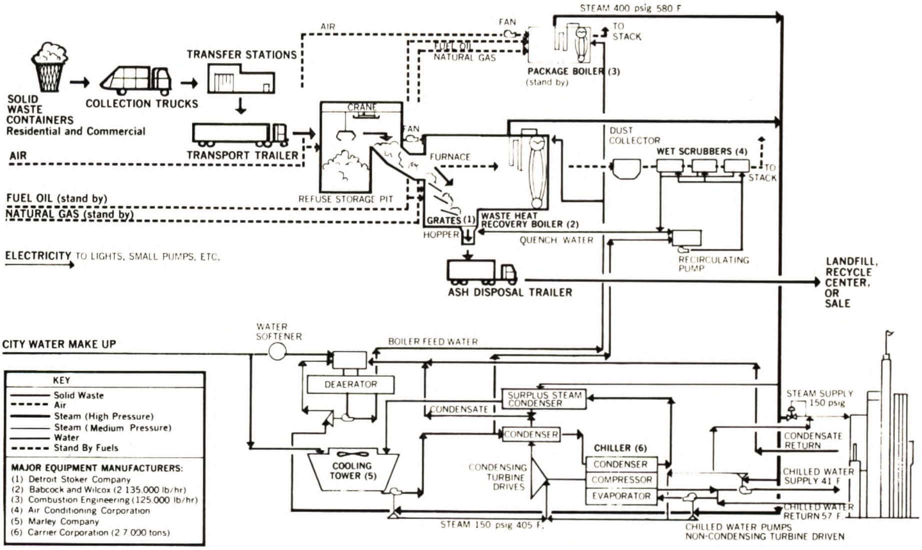

Fig. 1 — Simplified flow diagram of the solid waste fueled plant.

Local garbage and trash route trucks operating throughout the county deliver their solid waste to three strategically located transfer stations. At these stations, solid waste from many local, relatively small trucks is placed in large 65 and 75 cu yd trailer trucks. The solid waste is then delivered to the plant in these large, fully enclosed semi-trailer trucks, and dumped into a refuse pit large enough to permit weekday and weekend operation on weekday deliveries. One or two deliveries per hour will be made to the central plant. The transfer station process significantly reduces annual travel, and keeps local trucks off the main roads and permits them to return to their routes more quickly, thus saving fuel and labor costs.

A crane will pick up the solid waste in one-ton bites, and feed it into the multi-level steam generating incinerator-boilers. The plant will include two 360-ton per day steam generators manufactured by Babcock and Wilcox Co., and eventually will be expanded to include about three additional 360-ton units. These boilers can also operate on 100 per cent natural gas or oil fuel. The solid waste is continuously fed into the steam generator by agitating grates, manufactured by the Detroit Stoker Co.

Ash from the incinerator is dropped into an ash hopper and sprayed with water from the scrubber tank. Spraying cools the ash and eliminates dust problems during the removal and disposal process. This is also the method of disposing of the particulate matter that is scrubbed out of the stack gases. Trucks haul ash from the plant, and the sterile residue will provide a dense road bed fill or building block material, where desirable. If trucked to landfills, it will not require earth cover. It is planned to add a ferrous recovery system, which will allow recycling of all ferrous material in the incinerator residue, when a market can be established for the ferrous material.

Combustion air, drawn into the plant through the solid waste storage room, allows incineration of odors in the steam generator, thus eliminating any potential odor problem in the plant area. The furnace is sealed and operated under a slight negative pressure to prevent escape of dust and odors. The 1800 F heat in the furnace explodes most of the glass into tiny fragments much like sand. The odorous gases are removed when exposed to temperatures above about 1500 F.

For maximum heat recovery, the flue glass will exit from the boiler sections through an economizer bank, wherein the temperature of the gases is reduced to approximately 500 F. These gases then go through sophisticated particulate and gas collection devices, in order to meet emission criteria. The gases first are subjected to a dry "cyclone" for removal of large particulate matter, and then to "wet scrubbers" to remove the remaining particulates and water soluble gaseous constituents. The cleaned gases leave the scrubbers at about 140 F, and then discharge via stack heaters into the atmosphere through low profile stacks. These scrubbers include three sets of water sprays and two sets of wetter baffles, all in series.

Pollution control is a very important part of the project. Very low particulate matter and sulfur dioxide emission rates are accomplished with the combination of dust collectors and the series of wet scrubbers built by the Air Conditioning Corp. of Greensboro, N. C. The level of particulate and sulfur dioxide emissions is reduced by 75 and 90 per cent respectively, over the pre-existing in-building systems replaced by the Thermal plant, as previously presented.

For heating purposes, steam at 400 lb pressure and 600 F goes directly from the boilers into noncondensing steam turbines, and then into the distribution network. For cooling, steam generated in the boilers is piped to non-condensing turbines, whose exhaust steam drives two condensing steam turbine driven Carrier Corp. chillers rated at 14,000 tons of cooling capacity.

Two cooling towers reject heat from the refrigeration cycle. Each Marley Co. tower has a water capacity of 90,000 gal, and a recirculating water rate of 17,000 gal per minute. At full load, when both chillers and boilers are operating at capacity, the plant has a make-up water requirement of approximately 1,500,000 gal per day, which will be supplied by the Nashville city water system. This exceptionally high water requirement, however, is less than the demand by plants replaced by the Thermal operation. Less than two per cent of the total water used by the plant is fed back into the Nashville sewer system. Initially, no water will be used directly from the Cumberland River, and no water will be returned directly to the river.

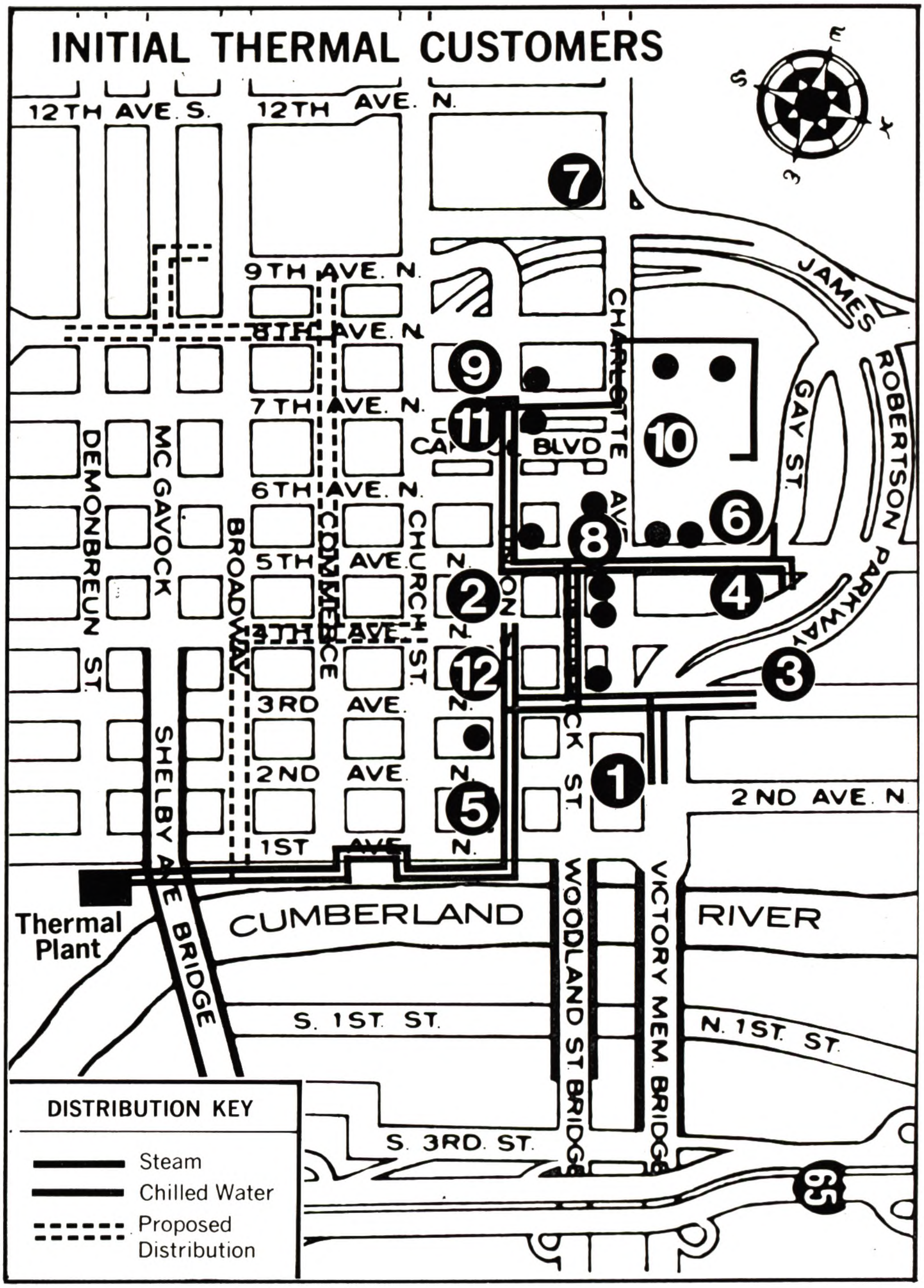

Fig. 2

Steam and 41 F chilled water is piped under city streets through a four-pipe distribution system 15,000 trench ft in length. Fig. 2 shows the layout of the distribution system superimposed on a Nashville street map. The condensed steam and 57 F chilled water is returned to the district plant in closed recirculatory systems. Each customer is billed according to the quantity of cooling and heating utilized.

This four-pipe distribution system consists of a chilled water supply line, a chilled water return line, a steam feed line, and a condensate return line. Fig. 3 shows a typical pipeline cross section. The normal operating pressure of the steam lines will be about 150 lb. Both chilled water and steam service supply lines will terminate at meters installed on the customer's premises.

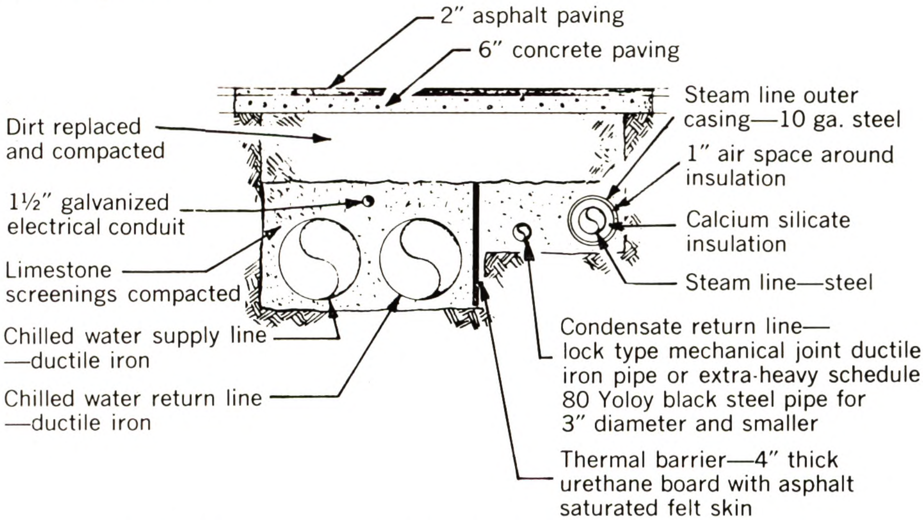

Fig. 3 — Typical pipeline cross section for the four-pipe distribution system.

Although solid waste is the principle fuel for steam production, each incinerator is equipped with gas and oil burners. The auxiliary fuels are deemed necessary by systems engineers for the maintenance of consistent steam pressure, in the event of an unusually high moisture content of the solid waste. In addition, a 125,000 lb per hr stand-by and supplemental package boiler, fired by gas or oil, is also available to increase the overall plant reliability and operational flexibility during maintenance periods. This unit will be supplied by Combustion Engineering. Natural gas and waste oil will be the principle stand-by fuels. The engineers estimate average auxiliary fuel usage at less than ten per cent of the energy required.

That generally is how Thermal Transfer will work — that is, work in an engineering sense. But Thermal, like any other organization must also work in a political and economic sense, and the corporation is also rather unique in these respects.

Nashville Thermal Transfer Corporation

Originally, Thermal was not conceived as a means of solving Nashville's solid waste disposal problem. The project began in mid-1969, when Nashville Mayor Beverly Briley commissioned a study of the feasibility of constructing a central energy service facility for heating and cooling municipal buildings. The study by I. C. Thomasson & Associates established conclusively that the project was economically and technically feasible and would benefit the community, particularly if broadened to provide service to the entire downtown area.

Original plant specifications called for the use of conventional fossil fuels (gas and oil) to produce the necessary steam and chilled water. It was determined by Charles Griffith, then Director of Law for the City, that the Nashville Electric Service and the Nashville Gas Co. lacked the requisite authority to undertake the project without a public referendum. Best estimates for coordinating plant construction and customer demand, indicated that all plans had to be completed and bids ready for letting no later than the summer of 1971. Thus, timing ruled out the lengthy referendum process.

With this timing factor, the most practical means of organizing and financing the project appeared to be through establishment of a separate corporation. On May 14, 1970, the Nashville Thermal Transfer Corporation was chartered under the laws of Tennessee to construct, own and operate the central plant facilities, and to provide low-cost district heating and cooling services. The Executive Director of the Metropolitan Planning Commission, Farris Deep, was named as President of the new, not-for-profit corporation.

Shortly after initial contracts were made with potential customers, it was suggested that solid waste be substituted for conventional fossil fuels to produce steam for heating, and to drive coolant compressors. After intensive study and modification of the original plans, the consulting and design engineers concluded that the idea was feasible, and Thermal entered into the incineration business, along with heating and cooling. Nashville agreed to provide to Thermal, at no cost for the next 30 years, its current solid waste, which is now about 1400 tons a day.

Engineering and design of the facility were started early in 1971 by I. C. Thomasson's firm. The eight-acre site for the plant was selected and approved early in 1972. The project was financially sound based on firm 30-yr heating and cooling contracts with the State of Tennessee and private users, and firm 30-yr heating, cooling, and solid waste contracts with the Metropolitan Government of Nashville. Nashville's prime contractor, Foster & Creighton Co. of Nashville, began construction of the central heating and cooling plant in June, 1972, based on its low base bid of $8,358,026. Hardaway Construction Co., Nashville, is proceeding with the distribution system construction on a low bid of $3,996,371.

Thermal is directed by a nine-member Board of Directors. The State Attorney General, State Commissioner of Finance, Nashville's Executive Director of Planning, Director of Law, Director of Finance and Director of Public Works are among the Board Directors.

The General Manager reports directly to the Policy-Setting Board. Thermal will have about 20 full-time employees by late 1973. Thermal contracts with Chicago-based Duff & Phelps for management services, and with I. C. Thomasson for engineering services. Legal services are provided by a Nashville public and environmental law firm, Griffith & Stokes. Public auditing is done by the nation's largest public utility accounting firm, Arthur Andersen & Co.

The Corporation is specifically exempted from public utility commission jurisdiction. Rates are set under terms of a comprehensive bond indenture.

Thermal is financed by revenue bonds. The users of the system, through their 30-yr term agreements, provide the necessary revenues for operating at fixed costs.

The situation leading up to the formation of Thermal was influenced by the circumstances and local government of Nashville; and this, of course, brings us to the question of general applicability of our corporation type and system to other communities.

Application to Other Communities

There are several reasons why this type of project should be considered as an alternative to existing processes for solid waste disposal and district heating and cooling in all large communities.

1. Once cheap fossil fuels cost more today than just a few years ago, and these costs are projected to increase over the next few years by up to 250 per cent.
2. Industrial, commercial, and perhaps residential areas must concern themselves with the availability of fossil fuels for heating and cooling. Articles in *Newsweek* and other publications state that communities will experience so-called fuel and power "brown outs," like the ones that have occurred on the East Coast, Denver, and other areas this past heating season. There isn't enough fuel to go around.
3. Most cities are running out of sanitary landfill sites, and the Environmental Protection Agency will no longer allow cities to continue operating open dumps. EPA insists on sanitary landfill operations. This, of course, causes problems and higher costs, because sanitary landfill operations are perhaps double or triple the cost of open dump operations; and in areas like Nashville, there is another problem due to the lack of top soil. It is almost impossible to operate a sanitary landfill to meet the state standards in Tennessee.

Thermal Transfer Serving Nashville

In 1974, the first full year of operation for Thermal, heating and cooling customers will include at least 12 state office buildings, four municipal buildings, and 11 private buildings. These original contracts have been executed for 30-year terms, commencing with the initial delivery of service. Contracts with additional customers are being negotiated. It appears that the central plant will be expanded in 1974, with the installation of a third solid waste fueled boiler and an additional 7000-ton chiller. Also, major distribution system extensions will be installed to service new customers. Now that the project is essentially a reality, more customers in the downtown area are signing up for heating and cooling services.

Summary

Today on the Cumberland River bank, a few hundred yards south of Nashville's frontier beginning as Fort Nashborough, modern pioneers in the spirit of Nashville's founder, Colonel John Donelson, are setting a precedent with international potential. The Nashville project will be utilizing a new, free and expanding energy source to meet one of the critical challenges of the developing urban area. Solid waste, garbage and trash, historically disposed of in dumps and landfills, will be utilized as primary fuel in an efficient, modern, and economical central energy plant to heat and cool downtown community buildings.

Pioneering in thermal transfer, the Nashville Thermal Transfer Corporation hopes to demonstrate and help set a positive trend, which can benefit all communities as they strive to meet the challenges of supplying energy to fill the unique needs of modern communities, while preserving and improving the urban environment, and therefore, the quality of urban life.

WEDNESDAY, JUNE 20

2:00 P.M.

SECOND GENERAL SESSION

ALVIN B. SPETZ, *First Vice-President, Presiding*
Rochester Gas and Electric Corp., Rochester, N. Y.

ENERGY AND THE ENVIRONMENT

L. R. LOVE, *Vice-President and General Manager*
NUS Corp., Cyrus Wm. Rice Division, Pittsburgh, Pa.

Environmental degradation has become a major concern in the minds of many segments of the American public in recent years. Many view it as a direct result of energy usage; therefore, contend that the problem can be alleviated only by drastic energy cutbacks. Although energy production and usage must shoulder the blame for a large portion of man-made pollution, the importance of energy to our environment requires that careful consideration be given before limiting its availability.

The story of civilization parallels the increased availability of energy to man. Primitive man had available to him only the heat of the sun and the energy generated by his body from the food he consumed. As a result, his