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PHILADELPHIA ENERGY CONSERVATION PLAN

Overcoming Institutional Barriers to Recovery of Energy from Municipal Solid Waste

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Introduction

This is a success story. It covers more than one and a half decades of an "on again, off again" struggle to bring into being a project which from the very beginning, seemed "so near, and yet so far:" so near, because it has always made so much sense; so far, because of bureaucratic inertia in both the public and the private sectors, a situation which now appears to have been overcome. To condense the story into a reasonable length, discussions of equipment and systems technology will be largely omitted. These are amply covered in available literature.

What will be emphasized, however, are the municipal requirements which had to be satisfied, and the utility constraints within which any refuse energy system has to operate. In short, therefore, this can also be considered as a statement on the general subject of refuse energy, from the viewpoint of one privately owned public utility company.

Historical Background

Our studies actually date back to 1959. At that time a new incinerator was being planned by the City of Philadelphia at a location roughly one mile from one of the Philadelphia Electric Company (P.E.Co.) steam transmission mains. At the same time, the steam business was in the midst of a rapid expansion phase. The dollar savings and fuel conservation possibilities were instantly recognized by both parties; but no one could agree as to who should benefit, the taxpayers or the ratepayers. Thus, institutional problem number one came clearly and instantly into focus.

Another troublesome institutional question involved definition of the interface. Where would ownership and operational responsibilities terminate for either party? The City could not visualize operating boilers under the utility company's direction; nor could P.E.Co. see itself in the refuse disposal business. Yet, if the energy output were to have value to the utility, it would have to meet the reliability criteria applicable to conventional generation methods. It would have to span the physical distance to our point of use; and, in addition, any system for refuse disposal had to be available all year, which might not be feasible during periods of low energy demand. In other words, as we in the utility business are well aware, the value of energy in any form is dependent not only on quantity, availability, and location, but also upon time of delivery.

So the stage was set for months of negotiations; but, with little understanding nor willingness by either side to compromise key requirements, and lacking any real commitment, no agreement was reached. By 1962, with both sides far apart as to contract price, talks were terminated; and the incinerator was built without heat recovery.

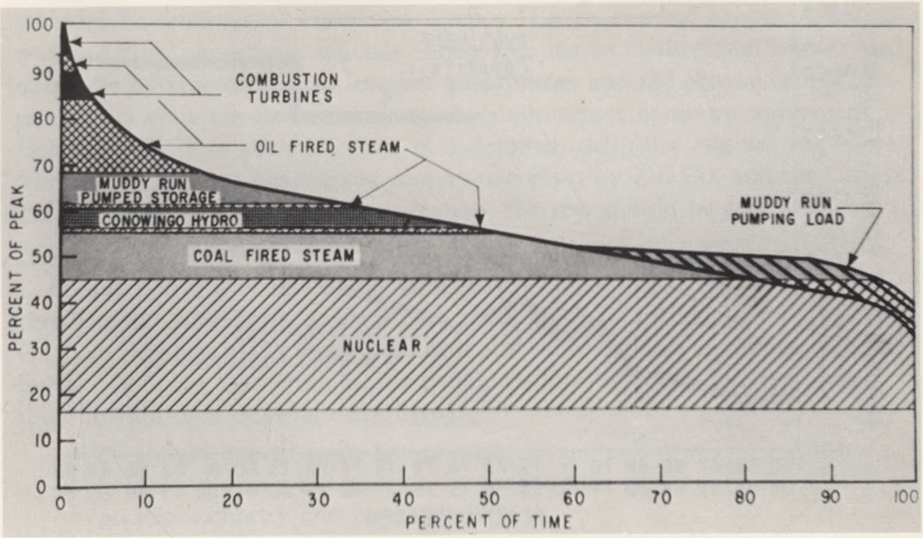

Fig. 1—Electric system load duration curve.

Almost a decade ensued, during which occasional exploratory talks occurred. Existing technologies were reviewed and ways explored to utilize this wasted heat resource. So we were, at least, keeping abreast of technological developments in the field; but it took some other compelling developments to create a desire for really serious studies. Those developments were, of course, the energy crisis and the rising public concern for the environment. At the same time, there was a noticeable decrease in public trust and esteem for governments and utilities, and it was recognized that much needed positive public relations might be realized from a workable trash-to-energy plan. By itself,

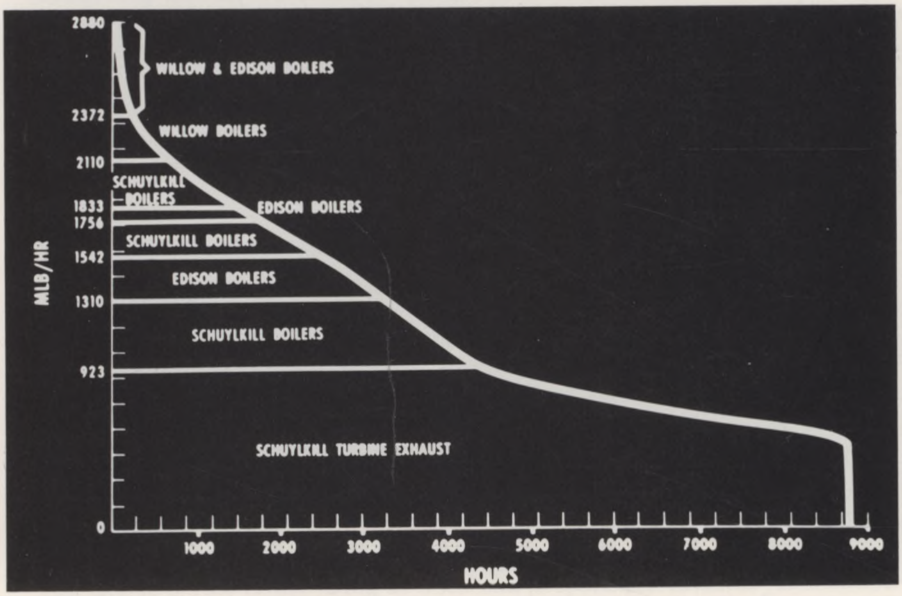

Fig. 2—Load duration curve without incinerator, 1979-80 winter.

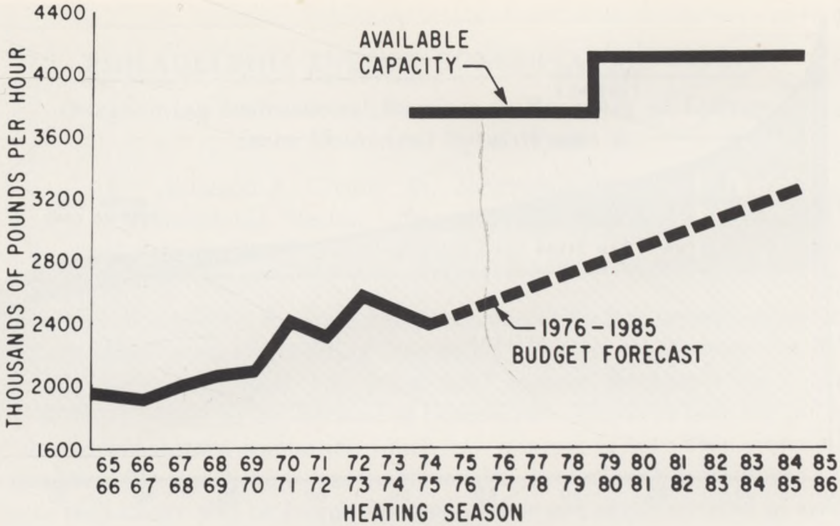

Fig. 3—Steam system load forecast.

such a reason might not sustain the project, but at least it was a potentially positive factor.

Commitment: A Key Ingredient

And so it was, that in the early 1970's, the talks and studies were resumed in earnest. Landfill sites were diminishing, and existing incinerators were falling short of meeting emission standards. Preliminary investigations showed, time and again, that in a new refuse disposal system, some form of energy recovery could pay off.

This time, though, a top level task force was formed with City, P.E.Co., and

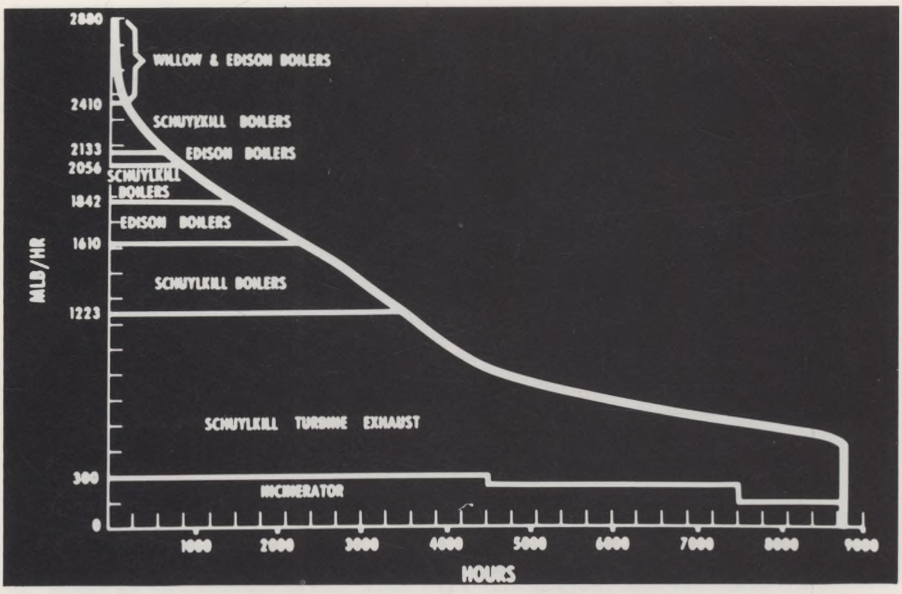

Fig. 4—Load duration curve with incinerator, 1979-80 winter.

regional Environmental Protection Agency (EPA), Federal Energy Administration (FEA), and State officials. Thus, one major institutional barrier was overcome by committing all levels of government and the private utility company to a common cause. From such commitment came an agreement in December 1975 to share the cost of a detailed, definitive engineering effort; from the agreement has come a cooperative effort by P.E.Co. and the City of Philadelphia; and with such cooperation, the rest should be relatively easy.

Defining the Task

At this point, a review of the problems seems appropriate. These can be classified into three broad categories: technological, financial, and institutional. Of these, the last is the most important and most difficult to resolve, because human, political, and often highly emotional questions are involved. Some of these institutional questions are listed:

—Who should benefit from any savings?
—Who should own what part of the operation?
—Who has authority and responsibility?
—How can public and private commitment be achieved?
—Who owns the trash and can guarantee its availability?
—How can (should) State and Federal agencies help?
—How should the plan be financed?

Admittedly, this is not an exhaustive list. But it does make clear the complexity of the situation. Each question leads to others, often seemingly insurmountable. Through the remainder of this report, it is hoped that the reader will see question after question resolved. To accomplish this, it is necessary to start with some basic utility considerations.

Evaluating Alternatives

Conceding that environmental, energy, and economic benefits are possible, what then are our options? As an energy company, our first task must be to identify and evaluate the available energy alternatives. For a multiple service company these can be broken down into electric, gas, and steam producing systems as follows:

1. Electric
   a. Refuse Derived Fuel (RDF)
      —mechanical reduction (shredded, pelletized)
      —chemical conversion (powdered briquettes, liquid, gas)
      —pyrolysis, fluid bed, hydro-pulping
   b. Partial (supplemental) firing with coal or oil
   c. Full firing in boiler or combustion turbine
2. Gas
   a. Methane extraction from landfills
   b. Low Btu
3. Steam
   a. Raw refuse in (conventional) incinerator/boiler
   b. RDF boiler (supplemental or 100%)

The choice of raw refuse firing or front end preparation involves justification of large additional expenditures on the basis not only of improved combustion, but also upon the risky secondary materials market. The technology is still in its early development, and its viability appears to be some years away.

There is also a tendency to over estimate the potential for energy recovery. If fully utilized, it is doubtful if municipal solid waste (MSW) would ever provide one per cent of our national energy needs. On a more localized plan, however, some significant fuel conservation is indeed possible; but it is important to keep in mind that the primary aim is now, and always will be, disposal of refuse, with energy recovery providing a means to reduce its cost.

Utility Constraints

A closer look at each of the alternatives reveals important utility related operational requirements.

For our electric service area which covers almost 2500 mi^2, comprising five counties extending as far as 50 or 60 miles from the city, it is impossible for any community to build a large enough system and provide it with sufficient trash, to realize the necessary economies of scale. A regional approach for electric energy extraction, therefore, seems vital.

By contrast, within the City of Philadelphia, a facility to handle only 40% of the City's trash can provide steam equal to one average sized boiler, or roughly 10% of the steam system peak load.

Aside from such geographical considerations, and far more important, is the system load duration curve, including the mix of generating facilities comprising the system. The electric system economic loading curve (Fig. 1) shows that a large nuclear and hydro base exists, and it is growing year by year. The fossil fuel units, in which RDF could be burned, and particularly the oil burners, are already very low in load factor and declining in use, making them very poor candidates for any kind of RDF operation. There are, of course, some solutions. One would be to run these units almost year round to accommodate the refuse disposal needs, but the cost penalty would be prohibitive. Another way would be to accept RDF only when the unit is run according to its economic scheduling. At all other times, then, an alternate disposal method would be needed. A third equally impractical solution would be the use of a gigantic storage facility, which would probably be as difficult to provide as ordinary landfilll

On the other hand, existence of a large, multi-station district heating system with a relatively good summer, or base, load (Fig. 2) is quite a different story. It is a fortunate circumstance that new steam generation capacity (Fig. 3) and new refuse disposal requirements coincide at this time. It also means that a combined refuse/steam producing system must be capable of immediate implementation, using proven existing technology that will not require a lengthy and uncertain development or trial period. Thus, RDF and other more exotic systems, as well as electric energy production, though certainly possessing potential long range usefulness, were ruled out for now by mutual agreement. We are therefore, concentrating on straight steam production from "conventional" raw refuse firing.

A closer look at the steam system load duration curve shows how the refuse produced steam fits in as a base load operation (Fig. 4). Obviously, if the MSW burning facility can be considered to be at least as reliable as conventional

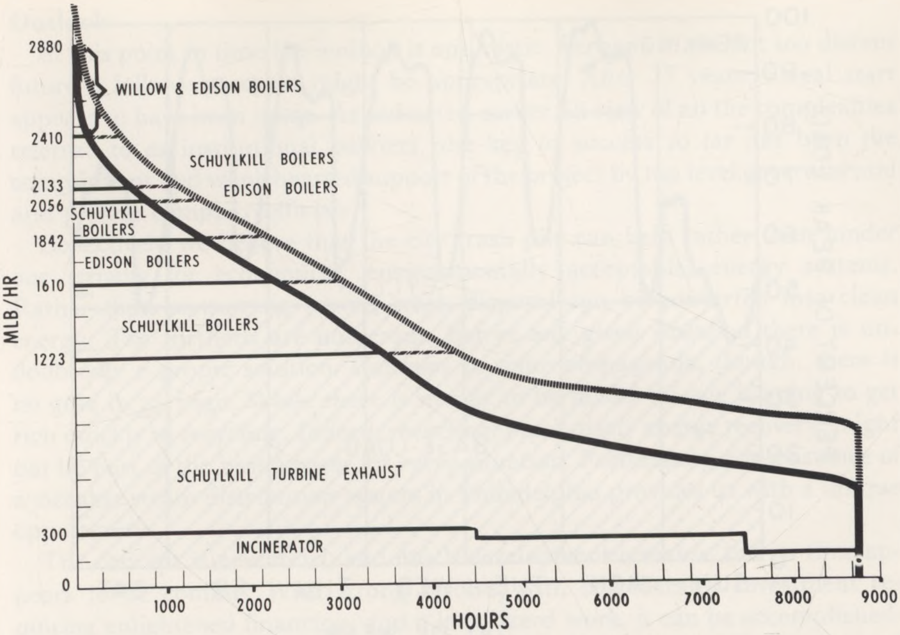

Fig. 5—Load duration curve with incinerator, 1979-80 winter, showing displaced steam.

oil burning equipment, and since there are many other boilers on the system for reserve or backup needs, the value of such steam can be greatly enhanced. This is particularly true without the nuclear and hydro penalty involved in electric generation. The actual value depends on the mix of steam displaced, or not sent out to the system by other plants (Fig. 5). This amount is represented by the area between the heavy solid line and the upper dotted line. On this chart the steam system duration curve with the incinerator (Fig. 4) has been superimposed on the one without the incinerator (Fig. 2), to illustrate the point.

A final, load related feature that must be recognized is the weekly and daily load cycle (Fig. 6). Here we see that system loads are lower overnight and on weekends. An hour-by-hour analysis for the entire year is necessary, therefore, to coordinate trash delivery five days a week with steam plant operations seven days a week.

Features of the Plan

Although many questions exist, many have also been answered. Electric power generation, with its costly apparatus and operating constraints, has been ruled out at this time. Ownership of the facility will be by the City or a specially organized agency. The utility will be strictly a purchaser of steam. A complex financing plan will be developed to result in lowest overall cost. The project cannot be financed out of the City's tax based operating budget; therefore, some form of public/private revenue bonds will be utilized to gain maximum benefit from both sectors. Materials recovery will be minimized, probably restricted to back end; any front end recovery will be limited to whatever is available from preparation needed for improved combustion.

The facility will process in the order of 1600 T/D of raw MSW all from within the City. No intercounty involvement is contemplated. No State or Federal

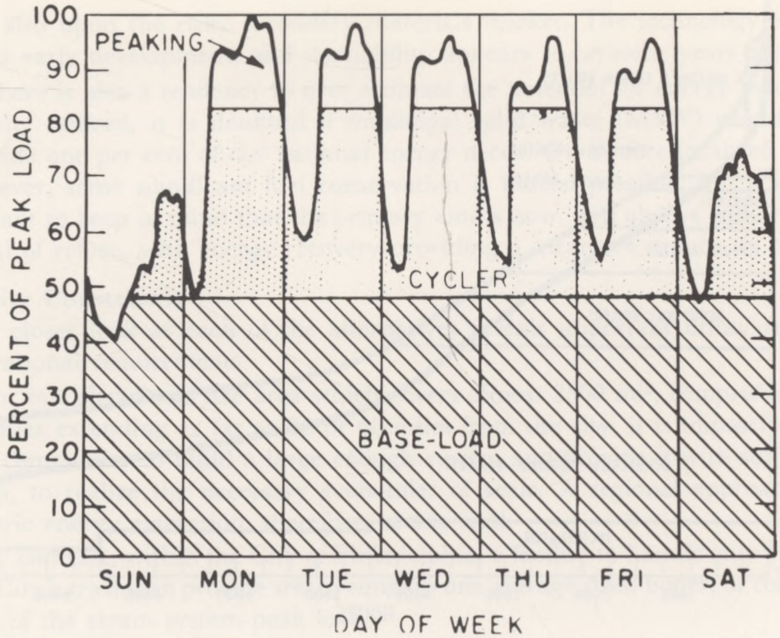

Fig. 6—Load cycle.

aid is anticipated, except for conceptual support through enforcement of reasonable laws pertaining to landfills, air quality, etc. About 300,000 lb/h of steam will be firmly committed, generated in three units plus one in reserve (a total of four). Thus, reliability requirements should be easily met.

Summarizing, some outstanding features of the plan are:

—Immediate implementation
—Conservation of fuel oil
—Environmental improvement
—Simplified materials recovery
—Lower cost of services
—Capable of aesthetic treatment

Unique Agreement

By far the most noteworthy feature of this ambitious plan is its unique City/Utility cooperative agreement, believed to be the first of its kind in the United States. Following an initial phase of recently completed preliminary studies, the agreement provides for 50-50 sharing of the cost (an estimated $500,000) of a second phase study. Included will be definitive plant design and firm capital investment, and operating cost estimates. During this six month study, the engineering firm of Day and Zimmerman is expected to also finalize other important matters such as site acquisition, permit requirements, community acceptance, and the financing plan. Assuming all the pieces still fit properly, and the concurrent third phase steam sales contract is successfully negotiated, then, upon completion of phases two and three, it is expected that phase four, final design and construction, will commence immediately. A 1980 service date is contemplated at present.

Outlook

At this point in time the outlook is optimistic. Perhaps in the not too distant future a follow-up report might be appropriate. After 17 years, a real start appears to have been made. As indicated earlier, in view of all the complexities referred to as institutional barriers, the key to success so far has been the commitment and wholehearted support of the project by top level governmental and private company officials.

Collectively we believe that the city trash pile can help rather than hinder our striving for economical, environmentally acceptable, energy systems. Rather than consuming power, trash disposal can be converted into clean energy. The methods are numerous, but in any given situation there is undoubtedly a proper solution. Contrary to some propaganda, though, there is no gold in garbage. While there is money to be made, no one is going to get rich quickly in recycling. Indeed, recycling, particularly energy recovery, might not be part of the best answer for every situation. Fortunately, the existence of a sizeable steam distribution system in Philadelphia provides us with a unique opportunity.

The concept is new to us, and much development remains, but its time appears to be coming. With strong resolve, with considerable investment requiring enlightened financing, and a lot of hard work, it can be accomplished.

As our nation begins its third century, we in Philadelphia, the Bicentennial City, are especially mindful of how the country has flourished on challenges such as this one to serve the common good! By replacing adversity with cooperation between the public and private sectors, we are convinced that our American system can create realistic and effective ways to convert trash into energy, with environmental improvement, some overall savings, and conservation of fuel.

DISTRICT HEATING ENERGY FROM SOLID WASTE: PUROX SYSTEM

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"District heating energy from solid waste" is a subject of high interest in Union Carbide Corporation which has developed a solid waste/resource recovery system called the PUROX System. A resource which is recovered from this system, and applicable to district heating needs, is a fuel gas suitable for direct firing into existing boilers of most any type.

The system is a result of more than six years of Company funded efforts, and converts municipal solid waste, refuse, into a medium Btu fuel gas and an inert slag. The system being marketed is based upon the successful opera-