

45

The status of total energy in 1980

Total energy systems (more recently reborn under the name of cogeneration) was a term coined to encompass energy conversion systems for building projects that basically provided, from a fossil fuel source, all of the end-use energy forms required for the project. The concept is philosophically and technically sound from the standpoint of increasing the effectiveness of the use of energy resources. Simply stated, the energy rejected from the power cycle is held at a high enough temperature level to enable its use to satisfy the thermal energy needs.

With properly balanced loads, if this conceptual efficiency is achieved, the cost of energy to the building owner is reduced. Furthermore, the fuel supplier has a beneficial customer, in that the annual load factor is usually much higher than for, say, a heating only or cooling only plant.

These mutual advantages for owner and fuel supplier converged, catalyzed by some inventive designers and state of the art availability of hardware in the early 1960s. For a period of years around 1965, many such plants were designed and installed in commercial and institutional buildings throughout the United States.

Ten to fifteen years later, many such plants are operating well, in the manner initially intended. Many others, however, have been or are being removed, to be replaced by other types of conversion systems or energy source forms. The question obviously might be asked in light of the failure of numerous plants, what went wrong? Was there something wrong with the concept? Has the aftermath of the so-called energy crisis unfavorably changed the economics of source energy?

The answer is not simple, but there is nothing wrong with the concept. Nor are source energy economics the culprit. There are several reasons for the failure of the plants, any one of which could be a fundamental cause for any specific plant, but in most cases there were combinations of causes prevalent.

High level of skill required

The first cause is failure of the building owning-managing team to recognize the management responsibility associated with having such a plant. To manage and operate an integrated conversion plant requires a relatively high level of technical and management skills. In many case histories, when this problem became apparent, the owners found themselves contracting out this responsibility to another agency. Two problems resulted. First, since the management requirements had not been identified initially, the costs associated therewith had not been provided for in the pro forma. Thus, the economics of the plant changed significantly. Second, the agencies contracting to undertake the management of the plants, in many cases, were themselves incapable of providing the technical expertise required. As a result of this, not only did the cost of operations increase, but the anticipated performance was not achieved.

Other causes of failures

The second cause of failure was that the designers of many such plants were embarking upon new technologies with which they were not familiar. These designers came from the ranks of thermal building systems experience. The integration of prime movers, heat recovery apparatus, electrical generation appara-

tus, and the like introduced elements of major hardware with which they were not familiar. In some cases, basic hardware was misapplied; in others, due to insufficient historical experience in the industry as a whole, the sizes of the conversion modules were improperly selected. Problems resulting from these deficiencies in design were premature failure of machinery, catastrophic interruptions in service, higher than necessary investment costs, and higher than anticipated fuel costs.

The third cause of failure touches a serious misunderstanding of the fundamental concept—that is, a failure to recognize both the static and the time-integrated nature of the loads as they relate to the conversion system. This lack of understanding led to the installation of many integrated plants that were doomed to failure. The building designer has a significant element of control over the magnitude of both the thermal and electrical design loads. He has the opportunity in the conceptual stage of design not only to minimize these loads but also to design to achieve a balance compatible with that provided by a given power-thermal cycle design. The error that often was made was that of trying to force this balance in design of the *plant*. Such forcing simply led to the creation of false loads that improved the thermal efficiency of the combined cycle machinery, while increasing the cost of fuel consumed when compared to

alternative methods of providing energy to serve the same real building loads.

As a result, many plants have achieved extremely high power-thermal cycle efficiencies while being economically disastrous.

Integrated energy systems

Now, at a time when most sectors of our society have matured in their recognition of the need to utilize our energy resources most effectively, we would benefit by considering the advantages of integrated energy conversion systems. We *must*, however, learn from our past experience regarding total energy. The U.S. Department of Energy is expending extensive efforts in the direction of integrated energy systems; we should hope they will address the historical experience. If they do not, these efforts will be destined for the same fate as the total energy boom of the sixties.

It is alarming to observe that there is one more reason for the abandonment of total energy plants. That is, allocation and curtailment of fuels. In case history examples, integrated plants that were both energy efficient and economically successful were abandoned because the fuel source was curtailed! This is one more example of the need for a technically mature national energy policy that acknowledges the efficient use of energy resources where they exist.