Energy profile–the base

By **WILLIAM J. COAD**

Previous columns (July 1979 and September 1980) have made mention of the energy profile as both a diagnostic and a management tool. Regarding the diagnostic value, the September column stated: "The energy profile is to the energy analyst what an X ray is to an orthopedic surgeon." This column will address one of the telling characteristics of a profile—*the base*.

The base is the portion of the profile that does not vary with time of year. Remembering that the annual energy consumption is represented by the area under the curve, we can see that base energy is, in effect, defined by a rectangle. One aspect or significance of the base is that it can generally be assumed *not* to be weather related. The relationship of the area enclosed by the base rectangle to the total area under the curve leads the analyst directly to possible areas of energy waste.

Fig. 1 shows the fuel energy profile for a facility of approximately 1 million sq ft. It is a campus arrangement with a central steam plant and provides minimum standard housing for approximately 2000 persons, some light industry, a small hospital, and some office space. The majority of the buildings are relatively old with comparatively little air conditioning, about half of which is steam absorption. Referring to the profile, the left scale is fuel consumption (solid line), and the right scale is degree-days (broken line) for the same period. Note that the degree-day scale is offset, with the zero point coinciding closely with the lowest fuel consumption values. The line of zero degree-days as shown here is called *the base*. This technique is used to identify coincidence (or lack thereof) between the "variable" portion of the profile and the weather. In Fig. 1, we see that the two curves track quite well. Thus, the analyst can assume that the fuel above the *base* is that used to provide space heat to offset transmission and ventilation losses.

For this facility, the base rectangle represents 56 percent of the total area under the consumption profile curve. The assumption can then be made that this 56 percent of the total annual consumption went for something other than heat for space comfort! Essentially nonweather related useful loads were found to be domestic hot water, cooking, and industrial processes; also identified was a small weather related summer load, an absorption chiller. All of these loads were found to be quite small when time integrated monthly; thus, the difference between the identifiable use and the area defined by the base was approximately 80 percent of the base area. Continued investigation revealed that approximately 30 percent of the input energy in this facility was "lost" in the combustion process and another 30 percent disappeared via distribution system losses. The latter would have remained fixed in absolute value and increased as a percentage if the retrofit had been directed simply to reducing the heating load! This type of problem is rather common and readily identified by the high "base" line (in this specific case, the distribution system losses represented a fuel cost of approximately $216,000 a year). A similar phenomenon is often seen where a heating boiler is used year-round to serve a small thermal load such as domestic hot water. The boiler standby losses often far exceed the actual load served when time integrated.

Fig. 2 is an electrical energy profile for another facility, quite different from the one above. This project is about the same size (1 million sq ft) but is a modern curtain walled high rise, fully air conditioned. Approximately half is given over to residential occupancy and half to commercial space. The residential lighting, cooking, and convenience outlets are separately metered and therefore not included in this profile. As with the first example, the left scale and solid line represent the energy and the right scale and dashed line the cooling degree-days. Because of the similarity between the cooling degree-day curve and the "hump" in the energy profile, we can assume that the energy defined by the area under the hump and above the base line is related to the need for cooling. We can also assume that the energy represented by the area beneath the base line is *not* weather related. This base energy amounts to 62 percent of the total annual consumption. In this project, as in most commercial facilities, the nonweather related uses were found to be lighting and fans. A simple calculation showed that the lighting energy accounted for approximately 23 percent of the base energy, fans for approximately 68 percent, and nonseasonal pumps for the remaining 9 percent. This led to reducing fan energy as the first conservation consideration.

In this second example, as in the first, if successful conservation efforts had been directed at reducing the cooling load through reduced ventilation, dual glazing, reflective films, etc., and nothing done about the fan energy, the fan energy would simply have increased as a percentage of the whole.

The first and easiest characteristic to identify, then, in an energy profile analysis is the "base," and the most important aspect of the base is its magnitude compared to the total. The identification of the useful contributors to the base energy is generally quite easy since they are generally fixed loads that operate for identifiable time periods or relatively small, statistically determinable loads (such as domestic hot water). Whatever is left in the base after these have been identified is a loss that can be surprisingly large but readily understood once identified. If the base use is small compared to the total, then the first efforts at energy conservation are directed elsewhere.

Future columns will address other "characteristics" of the energy profile. Ω

On this page each month, the author shares his engineering philosophy by exploring a wide variety of topics, ranging from fundamentals to new frontiers, as they relate to building environmental systems. Mr. Coad is vice president of Charles J. R. McClure & Associates and affiliate professor of mechanical engineering at Washington University, St. Louis, Mo.