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Selecting an energy source and conversion system

Many decisions are required as the design of a building thermal environmental system develops. This chapter addresses some suggested parameters to apply in the selection of energy sources and primary conversion systems.

Four energy forms available

The state of the art in available hardware has resulted in two forms of energy being needed to motivate and supply the HVAC needs of a space; these are thermal energy and electrical energy. The forms available for consideration for building systems as supplied are: electricity, fossil fuels; district heating and cooling, and solar energy.

Although there is some interrelationship between the use form and the supplied form, it is quite minimal. For example, available technology dictates that electricity is universally used to provide the energy for auxiliary system drives, such as fans and pumps for any number of uses, leaving the interrelationships between use and source to the primary motivating energy of the primary high-level (heat) and low-level (cooling) source systems. Thus, except for these two selections, the remainder of the subsystems are best designed irrespective of the source.

Energy source parameters

The selection of the building primary conversion system, however, cannot be separated from the source. The suggested parameters are:

- *Availability of source matter or energy*—It would be ridiculous to consider natural gas in an area where it is not available (a rather obvious parameter).
- *Unit cost of matter or energy*—Probably the most obvious parameter, and one which many times has been considered without regard for any other parameters.
- *Integrated efficiency of conversion to the required use form*—The term integrated is of paramount importance since the building energy system is a time-integrated entity; and over a given time span (such as a calendar year), it operates at less than design load the vast majority of the time. This realization coupled with the inherent reduction in efficiency at less than full load mandates consideration of the time-integrated efficiency.
- *Investment cost of storage, handling, and conversion apparatus*—Like the energy unit cost, this parameter appears obvious. However, in this context, it is emphasized that investment cost considerations of other subsystems, such as *distribution and terminal conversion or control, are to be considered separately*.
- *Environmental considerations of the space*—This is an indirect parameter in that it relates to a consideration of the basic need for energy. For example, in a warm climate, if thermal source energy is being considered for the purpose of dehumidification only, perhaps alternative methods of satisfying that need could be developed. Another example might be the reconsideration of utilizing high-level lighting heat when a fuel source might prove more energy resource effective.
- *Environmental considerations of the community*—Although it may seem a bit idealistic to suggest considerations beyond statutory requirements, such idealism has relevance both morally and potentially economically. From the moral side, all engineers are sworn

to consider the impact of their designs on the public welfare. Economically, future legislation could have significant financial impact on a building's primary conversion system (whether on- or off-site) if the system is considered detrimental to the environment.

- *Energy consumption and demands (power)*—This parameter, coupled with the unit cost schedule, is required to determine the ultimate annual comparative energy cost.
- *Cost and availability of maintenance and service for the conversion apparatus*—Although this may appear to be an obvious ingredient to those who support the concept of life-cycle cost analysis, it is the least easily quantifiable ingredient thereof. The hourly cost may be easily identifiable, but the hours required are most difficult to assemble or predict. The second consideration, availability, is the most overlooked parameter in energy conversion system selection. The availability of skilled maintenance and service personnel is highly regional in nature, particularly for sophisticated machinery and controls.
- *Cost and availability of replacement components*—Keeping in mind that most buildings are long-term investments, the conversion apparatus and its controls must be selected with the consideration that replacement components will be readily available for years to come.
- *Reliability of the source and conversion apparatus*—Reliability of the conversion apparatus, whether it be a boiler or a transformer/switchgear combination, is interrelated with cost; i.e., redundancy could achieve the needed reliability. Reliability of the source, however, is an often overlooked parameter. If there is any question of future availability or future stabilized cost, the system should provide for conversion to an alternate source.

Not included are sources dictated by code or legislation. This is not an oversight, but rather an expression of faith in a free economy. Hopefully, well-founded application of design parameters to energy source selection as well as other building conversion systems will result in the most effective use of energy resources; such that if and when federal or regional policies affecting energy use are adopted, the engineering profession will have arrived there first.