

flame-retention-head oil burners in use increased from 100,000 in 1979 to more than 4,200,000 in 1989, saving approximately 71 trillion Btus annually. The flame-retention-head oil burner is projected to save 0.155 quad annually by 2000.

Radiant Barriers for Single-Family Housing

In single-family housing, 7% to 8% of winter heat loss and 17% to 20% of summer heat gain occur through attics. In a joint effort, DOE and the Tennessee Valley Authority performed field tests of a low-cost, easily installed aluminum foil product that promises significant reductions in attic heat transfer, and thus, savings in heating and cooling. The product's two reflective surfaces reduce the radiant component of heat transfer between the attic and the underside of the roof. Most homeowners can easily install this radiant barrier material over existing attic insulation.

Results of DOE tests of radiant barriers installed in three single-family homes in Tennessee indicate a reduction in cooling energy requirements by 17% and in heating energy requirements by 9%. Assuming homeowner installation, radiant barriers produce a payback in energy savings in two years. Cost-effective in hot climates, this product can save 0.17 quad per year in the South's 22 million homes. Its benefits are sufficient to make the radiant barrier also marketable in northern climates.

Measurement Device for Thermal Resistance of Insulation

The National Institute of Standards and Technology has conducted research on heat transfer through insulation for many years. Following the energy crises of the 1970s, thicker insulations (by several inches) were incorporated in many building designs. At that time, however, test methods to evaluate the properties of these thicker insulations did not exist.

In 1978–1979, the Federal Trade Commission proposed a plan to require manufacturers to label insulation material for thermal resistance and to base advertised thermal resistance values on product testing. Because precise measurement of the thermal resistance of thick, low-density insulation is difficult, DOE and the National Institute of Standards and Technology cosponsored the development of the one-meter line-source guarded hot plate to accurately measure insulation performance. This device is

capable of measuring heat transfer in insulation up to 15 inches thick. The insulation industry was given calibration transfer specimens with which to measure and label its products. Accurate heat-transfer measurement eliminates the need to install insulation of excess thickness, thus reducing costs. In 1984, the U.S. Department of Commerce estimated that the improved measurement capability developed through this project saves consumers \$90 million annually.

District Heating and Cooling Development

Once prevalent in almost every metropolitan area in the northern United States, district heating and cooling systems have been almost completely replaced in today's cities by individual space conditioning systems that operate using oil or natural gas. Yet, the district systems have inherent advantages in terms of energy conservation and fuel substitution. Consequently, DOE embarked on a program of research, project demonstrations, and feasibility assessments in more than 50 communities to redevelop this concept. As a result, cogeneration/district heating systems have been constructed and are operating successfully at three large universities and in Trenton, New Jersey. Together, these four systems have saved the equivalent of several thousand barrels of oil annually through combined heat and electric power production.

Furthermore, DOE's feasibility assessments have formed a basis for subsequent design and development using local government and private sector funding. Thirteen cities are proceeding with detailed designs for constructing district heating and cooling systems. Cities with new district systems include Baltimore, Maryland; St. Paul, Minnesota; Galax, Virginia; Provo, Utah; Piqua, Ohio; and Lawrence, Massachusetts. Construction of these systems on college campuses has increased more than fivefold since 1950.

DOE's district heating and cooling development program currently yields energy savings of more than 5 trillion Btus per year nationwide and has produced more than \$70 million worth of construction activity. Net energy savings in the year 2000 are predicted to be 163 trillion Btus, equivalent to 28.1 million barrels of oil with a current value of more than \$3 billion.