Financial Indicators for Energy Efficiency Investments

There are many methods for evaluating the cost-effectiveness of energy efficiency. Here several such methods are illustrated, using an example of a simple efficiency improvement: the addition of insulation to a roof. It is assumed that the insulation costs $1,000 (including labor and materials), and saves about 35 million Btus (MBtus) of natural gas per year, natural gas costs $5.61 /MBtu, the house and insulation last 20 years, fuel prices do not increase over time, and the appropriate discount rate is 5 percent,

Payback is the simplest method for measuring cost-effectiveness. It is simply the number of years required for the savings to equal the upfront costs. For the example here the payback is:

$$\frac{\text{Initial cost}}{\text{Annual savings}} = \frac{\$1,000}{35\ \text{MBtus/yr} \times \$5.61\ /\text{MBtu}} = 5.1\ \text{years}$$

Therefore it will take 5.1 years for the savings to equal the initial $1,000, and all savings after that will be profit. Payback is simple to understand and allows easy comparison to other measures, but ignores the time value of money, the value of the savings after the payback period, and the limited life of some measures.

Life-cycle cost is a general term for incorporating all costs associated with the measure over its entire lifetime. One way to measure life-cycle cost is with net present value (NPV), which translates all future costs and savings into their equivalent in today's dollars. For the example here, the savings occur over the next 20 years. If one ignores the time value of money, the total savings are:

20 years X 35 MBtus/yr X $5.61 /MBtu = *$3,900*

The net savings, or savings minus costs, are:

$3,900 (total savings) -$1,000 (initial costs) = $2,900

A more realistic calculation would recognize that a dollar received a year from now is less valuable than a dollar received today (because a dollar received today can be put in an interest-earning account, and will grow to $1.05 in 1 year in an account paying 5 percent interest). Future savings can be discounted to reflect the time value of money. The choice of a discount rate will strongly influence the financial attractiveness of an investment and is an area of significant controversy.[1] For this example, an illustrative discount rate of 5 percent is used. Discounting the total savings of $3,900 at 5 percent per year for 20 years yields a net present value equivalent of $2,450:

$2,450 (total savings with discounting) –
$1,000 (initial costs) = $1,450

Therefore this investment is equivalent to $1,450 received today,

A somewhat different but quite useful measure of cost-effectiveness is the cost of conserved energy (CCE), which measures how much one pays for each unit of energy saved. Its advantage is that it is independent of fuel price. The CCE can be compared to the cost of the supplied energy it displaces. The CCE is defined as the initial cost times the capital recovery factor (CRF, which converts an initial investment into an equivalent series of annual payments), divided by the annual energy savings (in energy units).[2] For the example here:

$$\text{CCE} = \frac{\text{Initial cost} \times \text{CRF}}{\text{Annual savings}} = \frac{\$1,000 \times 0.08024}{35\ \text{MBtus/yr}} = \$2.30/\text{MBtu}$$

Therefore the insulation can be said to supply energy at less than half the cost of natural gas ($5.61 /MBtu).

[1] See for example the discussion of discount rates for setting appliance standards in 56 *Federal Register 22261* (May 14, 1991).

[2] The equation for capital recovery factor (CRF) is $(i(1+i)^n)/((1+i)^n-1)$ where i is the discount rate and n is the number of years. For the example here, the CRF corresponding to a 5 percent discount rate and a 20-year lifetime is 0.08024.