Payback Periods

The following formulas and examples have been provided courtesy of Paul Scheckel, author of the Home Energy Diet (New Society Publisher 2005). Paul has chosen to focus on replacing a refrigerator, however these concepts and formulas apply to any appliance that uses energy.

Simple Payback

My old refrigerator use 1,500 kilowatt-hours per year and probably has a few years left in it before it completely fails. If it breaks down, I won't want to put any money into repairing it. I want to be ready and know exactly what to buy and where to buy it. I really don't like emergencies.

- Fridge #1 costs $550 to buy, and according to the Energy guide tag consumes 850 kWh per year in electricity.
- Fridge #2 costs $750 to buy, and according to the Energy Guide tag consumes 450 kWh per year in electricity. It has the Energy Star ® label.

To determine what each unit costs to operate, multiply the price you pay for electricity by the refrigerator's power consumption:

- I pay 8.2 cents per kWh for electricity. My old fridge is costing me:

$0.082 per kWh x 1,500 kWh per year = $123 per year in power.

- Fridge #1 would cost $69.70 per year in power (0.082 x 850), and Fridge #2 would cost only $36.90 per year to operate
- Fridge #1 then *saves* me $53.30 per year in power ($123 - $69.70), while Fridge #2 would save $86.10 per year.

Purchase price and energy cost are all we need to know to determine Simple Payback.

Here is the formula:

Purchase Price divided by Annual Energy Cost Savings
= Simple Payback (in years)

The payback for replacing my old refrigerator with fridge #1 then is:
$550 divided by $53.30 = 10.3 years.
The payback for replacing my old refrigerator with the more efficient fridge #2 is:
$750 divided by $86.10 = 8.7 years.

Even though fridge #2 costs more to buy, it has a shorter payback period due to its superior efficiency.

Return on Investment (ROI)

ROI is telling you what percentage of the purchase price you get back every year as a function of energy saving. Here's the formula:

Annual Cost Savings divided by Installed Cost of the Appliance x 100 = ROI

The reason you multiply by 100 is because the answer is expressed in percent. If I choose the Energy Star ® refrigerator, I will need to spend $750 to reap an $86.10 annual savings. My annual ROI then is:

$86.10 divided by $750 x 100 = 11.5% annual return on investment

Compare that percentage with what your money might earn in a simple saving or money market account. Energy Efficiency is a great investment – even compared to Wall Street!

Lifetime Costing

- Fridge #1 costs $550 to buy, and consumes $69.70 per year in electricity. It comes with a one-year warranty.
- Fridge #2 costs $750 to buy, and consumes $36.90 per year in electricity. It has an Energy Star ® label and comes with a three-year warranty.
- My old refrigerator is costing me $123 per year in power, and I expect maintenance to become a large part of its operating expense fairly soon.

Whichever model I buy, I plan on keeping it for at least 15 years. I really *don't* like shopping, and when I do shop, I like to think of the things I buy as long-term investments, rather than a "consumer purchase."

Over 15 years, Fridge #1 would cost me $1,045.50 in power ($69.70 per year x 15 years), while Fridge #2 will consume $554 worth of electricity.

Over its 15-year lifetime, fridge #1 will cost me:
$550 (purchase price) + $1,045.50 (electricity cost) = $1,595.50.

The cost of electricity is 66 percent of the total lifetime cost of refrigerator #1 ($1,054 divided by $1,595).

Over its 15-year lifetime, fridge #2 will cost me:
$750 (purchase price) + $554 (electricity cost) = $1,304

The electricity cost of refrigerator #2 is only 42 percent of the total lifetime cost.

Note: You can expect electricity prices to rise a few percent every year, so the actual lifetime cost of each fridge will also rise proportionally, making Fridge #2 an even more attractive long-term investment. There may be other costs associated with owning and operating home appliances, which might include shipping, installation, maintenance, repairs, and finally, disposal a the end of its life. These costs must be factored into the lifetime cost analysis to arrive at a realistic figure.

Information from Solar Energy International (www.solarenergy.org)

Estimating the Payback Period of Additional Insulation
(from the US Department of Energy's Energy Efficiency and Renewable Energy program : http://www.eere.energy.gov)

Use the equation below to estimate the cost effectiveness of adding insulation in terms of the "years to payback" for savings in heating costs. Years to payback is the time required for the insulation to save enough fuel from heating (at present prices) to pay for itself. A simple payback is the initial investment divided by annual savings after taxes.

The equation works only for uniform sections of the home. For example, you can estimate years to payback for a wall or several walls that have the same R-values, if you add the same amount of insulation everywhere. Ceilings, walls, or sections of walls with different R-values must be figured separately. Subtract the areas of windows and doors when estimating payback for wall insulation.

The cost of the energy source is also a key factor in determining payback. Energy prices vary widely from region to region and season to season. Other factors, such as the rate of production and inventories of fuels nationwide, can also affect local energy prices. The weather from year to year also varies, so your energy costs from year to year will vary as well. To figure the cost of energy, consult your local utility for a rate schedule, or save your energy bills and plug your specific costs into this formula:

$$\text{Years to Payback} = (C(i) \times R(1) \times R(2) \times E) \div (C(e) \times [R(2) - R(1)] \times HDD \times 24)$$

To calculate the payback, you must supply the following information:

C(i) = *Cost of insulation in $/square feet*. Collect insulation cost information; include labor, equipment, and vapor barrier if needed.

C(e) = *Cost of energy*, expressed in $/Btu.

- To calculate the cost of energy, divide the actual price you pay per gallon of oil, kilowatt-hour (kWh) of electricity, gallon of propane, or therm (or per one hundred cubic feet [ccf]) of natural gas by the Btu content per unit of fuel.
- To figure the price you pay per unit, take the total amount of your bills (for oil, electricity, propane, or natural gas) during the heating season, and divide it by the total number of gallons, kWh, or therms you consumed during those months. Use the following values for fuel Btu content:
    - #2 Fuel Oil = 140,000 Btu/gallon
    - Electricity = 3,413 Btu/kWh
    - Propane = 91,600 Btu/gallon
    - Natural Gas = 103,000 Btu/ccf
    - or 100,000 Btu/therm

E = *Efficiency of the heating system*. For gas, propane, and fuel oil systems this is the Annual Fuel Utilization Efficiency or AFUE. Typical AFUE values are 0.6 to 0.88 for oil or propane furnaces, and 0.7 to 0.95 for natural gas furnaces. Older systems are usually less efficient. Use E = 1.00 for baseboard electric systems. For heat pumps, use the Coefficient of Performance or COP for E; where E = 2.1 to 2.5 for conventional heat pumps, and E = 3.2 to 3.5 for geothermal heat pumps.

R(1) = *Initial R-value of section*

R(2) = *Final R-value of section*

R(2) - R(1) = *R-value of additional insulation being considered*

HDD = *Heating degree days/year*. This information can usually be obtained from your local weather station, utility, or oil dealer.

24 = *Multiplier used to convert heating degree days to heating hours (24 hours/day)*.

Example:

Suppose that you want to know how many years it will take to recover the cost of installing additional insulation in your attic. You are planning to increase the level of insulation from R-19 (6-inch fiberglass batts with moisture barrier on the warm side) to R-30 by adding R-11 (3.5-inch unfaced fiberglass batts). You have a gas furnace with an AFUE of 0.88. You also pay $0.87/therm for natural gas. Let's also suppose that you supply the following values for the variables in the formula.

C(i) = $0.18/square foot

C(e) = ($0.87/therm)÷(100,000 Btu/therm) = $0.0000087/Btu

E = 0.88

R(1) = 19

R(2) = 30

R(2) - R(1) = 11

HDD = 7000

By plugging the numbers into the formula, you obtain the years to payback:

Years to Payback = (C(i) × R(1) × R(2) × E) ÷ (C(e) × [R(2) - R(1)] × HDD × 24)

Years to Payback = (0.18 × 19 × 30 × 0.88) ÷ ($0.0000087 × 11 × 7000 × 24)

90.288 ÷ 16.077 = 5.62 years