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Tables for Assessing the Profitability of Energy Saving Measures with Explanatory Notes and Worked Examples

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THE ENERGY SAVING GUIDE

Tables for Assessing the Profitability of Energy Saving Measures with Explanatory Notes and Worked Examples

by

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THE
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TO
L. R. H.

Foreword

This book is intended to give non-specialists a simple, yet rigorous, means of comparing investment in energy saving measures with other types of financial investment. It shows, through a variety of worked examples, how attractive some energy saving measures can be and how measures can be ranked according to their cost-effectiveness. Use of this book by those contemplating energy saving investments should, therefore, help to ensure that their money is spent in the most cost-effective way, with maximum benefit to the nation.

I believe this to be important, since, if conservation measures are to have a significant impact on energy demand, they will have to be implemented by us *all*, industry and individuals alike.

The importance of individual decisions on energy conservation is clear once we realize that in the United Kingdom, for example, 30% of total energy demand goes to the 20 million households. If householders were to invest in the more cost-effective of the measures discussed in this book, they could quite easily reduce their energy consumption by a third. On a national scale, this would amount to a saving of the equivalent of about 150 million barrels of oil per year, the value of which, at today's oil price, would be considerable.

The same distributed decision process applies to the adoption of energy saving measures by industry where, since total energy demand is higher, we may expect even larger energy savings.

The reader will see that I have concentrated on the "earnings" of energy saving measures, saying little about how the capital cost is to be met. This is because most countries have different tax laws affecting capital investment and most companies have their own accounting procedures. In addition, many countries are currently offering incentives to investment in energy saving measures, whilst others are considering them. The incentives range from cash grants towards the capital cost, to tax rebates and low interest loans. There can also be disincentives due to the fact that energy saving improvements to a building may increase its value and hence attract higher rates or local taxes. To go into detail on these matters, therefore, would require a separate book which would, unfortunately, soon be out of date.

Readers are advised, however, to investigate carefully the incentives and disincentives existing locally and to determine their effects on the capital cost. One can expect the salesman of an energy saving device to be particularly well versed in this matter.

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Introduction

Since the 1973 oil crisis, there can scarcely have been a day when we have not come across the word ENERGY. Never before have we been so conscious of the importance of energy in our daily lives. Never before have we had such fuel bills! The continual rises in oil, electricity and gas prices must have made most people wish that they could cut their consumption of these products without loss of amenity or productivity. If they look into the possibilities, however, they will soon discover that, apart from measures of the "freezing in the dark" variety, energy saving generally requires capital investment. Herein lies the main stumbling block.

Investing our hard-earned capital in energy saving is not like depositing it in a bank or building society* which will tell us the interest we are going to earn and credit our account with it at the end of the year. The earnings are in energy saved, which is essentially invisible. Nevertheless, once we have the appropriate means of assessing it, we will see that energy saving investment can be highly profitable.

At first sight, it may seem a relatively simple matter to estimate, for example, the pay-back time of an investment. We know the estimated capital cost and the likely annual value today of the fuel saved. The former, divided by the latter, should give the number of years needed to recover the initial investment.

This argument, however, takes no account of:

1. The interest that the capital could earn if invested elsewhere;
2. The interest that the sums saved could earn;
3. The effect of inflation on the sums saved.

Neglect of these details can lead to erroneous conclusions. In particular, it can greatly underestimate the financial return of energy saving investments in times of rapid energy price inflation.

This book offers the would-be energy saver a more rigorous, yet still simple, way of assessing the quality of an investment in terms of its probable rate of return

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*Building societies are institutions, unique to Britain, that accept deposits, pay interest and make loans for house purchase secured by mortgages. They are somewhat analogous to the American Savings and Loans Associations.

or "income". Such a procedure allows the "income" to be compared with those expected from alternative investments and the best choice to be made.

The method uses the widely accepted Present Value concept. Mathematical details are given in the Appendix for those who are interested, but everything finally comes down to use of the specially compiled tables for which no mathematical knowledge is required. Several examples are given to illustrate the use of the tables and show just how profitable certain types of energy saving investment can be. They are mostly taken from the home for the sake of clearness. However, the method is equally applicable to industrial or commercial problems, and examples such as roof insulation are, of course, relevant to all types of building.

It is to be hoped that this book will help people to judge an energy saving investment in terms of its financial rate of return rather than, as at present, in terms of crude pay-back time. Industrial managers might then abandon the present commonly held opinion that, to be worth while, energy saving measures should pay-back within 2 years, as opposed to the 15 years often allowed for other ventures. Similarly, home owners may come to realize that energy saving improvements are good long term investments whose earnings are, generally, tax free and indexed to the rising price of fuels. Such improvements should ultimately add to the market value of a house making the investment even more cost-effective.

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1

The Present Value Concept

The main difficulty, in comparing present expenditure with future receipts, lies in the fact that a sum of money in the hand *now* is worth more than the same sum one year hence, since interest can be earned on it in the meantime. For example, if £100 is invested today at an interest rate of 10% per annum, it will be worth £100 x (1+1/10) or £110 in one year's time. We, therefore, say that the *Present Value* of £110 in one year's time with 10% interest is £100. Similarly, £100 in one year's time, with 10% interest, has a Present Value of £100 ÷ (1+1/10) = $\frac{100}{1.1}$ or £90.91.

Going further into the future, £100 invested today at 10% interest per annum will be worth £100 x (1+1/10) x (1+1/10) = 100 x 1.21 = £121 in 2 years' time. The factor 1.21 is, of course, the compound interest earned by £1. The Present Value of £100 in 2 years' time, with the same interest rates is, therefore, £100 ÷ 1.21 = £82.6.

We see, in this way, that any sum occurring in the future can be reduced to its Present Value if we simply divide it by the compound interest that £1 could earn, between now and then, at the going rate.

The advantage of using the Present Value concept should thus be clear. All sums of money arising at various times in the future can be reduced to equivalent sums of money today, enabling us to compare future earnings directly with present expenditure.

2

The Present Value of Future Energy Savings: Effects of Inflation

With energy saving investments we can usually say, fairly precisely, how much energy they will save per year, on average. Thus, if the price of energy were to remain constant, we would know the average value, in money terms, of the energy saved per year, far into the future.

In practice, of course, the price of energy does not remain constant for long but tends to rise as part of the general inflationary trend – although not always at the same rate. At times, energy prices have risen faster than the retail price index and at other times more slowly. Many observers think energy prices will rise faster as the more accessible reserves of oil and natural gas are used up and extraction becomes more difficult. Others, however, believe that increased energy prices will lead to matching increases in other goods, so that, in the long run, they will all tend to increase at about the same rate. This opinion though, ignores the effects of improved conservation techniques which will gradually reduce the energy content of goods. Retail prices should thus tend to rise less rapidly than energy prices. Investors in energy conservation are, consequently, in a fortunate position since, the more energy they save, the more likely they are to bring this about and hence increase the value of their savings.

To sum up, we do not know what the energy price inflation rate will be in the future but we can make reasonable guesses and see what effect the rate will have on the value of our energy savings.

If, at the time of making our energy saving investment, the value of the energy likely to be saved per year is £100 and the expected energy price inflation rate is 10% per annum, the value of the energy saved will increase by 10% each year. Over the first year the expected saving will have increased in value from £100 to 100 x (1+1/10) = £110. By the second year, it will have become 100 x (1+1/10) x (1+1/10) = 100 x 1.21 = £121 and by the third year 100 x (1+1/10) x (1+1/10) x (1+1/10) = 100 x 1.331 or £133.1.

In other words, the value of the energy saved, in any future year, turns out to be:

> the value of the energy saving expected at the beginning of the project, that is now, *multiplied by* a factor, equal to the compound interest that £1 could earn between now and then at the *energy price inflation rate*.

To compare the value of the energy saved, in a future year, with the capital cost, we must reduce it to its Present Value. We have seen that to do this we *divide* the sum saved by the compound interest that £1 could earn over the intervening years, if invested at the *prevailing rates*.

Clearly, if we think that the energy price inflation rate is going to be *equal to* the prevailing interest rates, the two compound interest factors will cancel out. The Present Values of the energy saved in all future years will then be equal to the annual sum expected at the outset.

If, however, we think that the energy price inflation rate will be *greater* than the prevailing interest rates then the Present Value of the energy saved in any future year will be greater than that expected at the outset.

The converse will, of course, be true if we think that the energy price inflation rate is going to be smaller than prevailing interest rates.

3

Explanation of the Tables and their Use

To assess the *cost-effectiveness* of an energy saving investment, we need to compare the capital cost with the sum of the annual savings expressed in Present Value terms. If this sum, over a specified number of years, is greater than the capital cost, we say that the measure is cost-effective over that time period. The difference between capital cost and Present Value summed over the specified period is known as the *Net Present Value*. If a measure's Net Present Value is positive, we say it is cost-effective and the larger the Net Present Value, the more cost-effective we say it is. When its Net Present Value is zero, we say that a measure *breaks even* and the period, over which it does so, we call the *break even time*.

Given the wide range of interest and fuel price inflation rates possible, calculation of Present Value, Net Present Value and break even time could be very tedious. Fortunately, mathematical formulae can be derived (see Appendix) which allow us to tabulate the summations of Present Value over many years and for a very wide range of interest and fuel price inflation rates. The tables which form the greater part of this book are, in fact, the results of many thousands of individual summations. Each tabulated number, when multiplied by the value of the annual energy saving expected at the outset, gives the Present Value of all the savings for a specified number of years and for specified rates of interest and energy price inflation.

A simple example will serve to explain the composition of the tables. Suppose we are considering a conservation measure which would cost £200 and would save £25 worth of fuel per year at today's prices.

What would the Present Value of the fuel saved be in the first eight years?

We know, from the previous section, that if we choose the same rates for fuel price inflation and interest, then the Present Value of each annual savings will be £25. The sum of the Present Value of the first eight years will, therefore, be 25 x 8 or £200. Under these conditions, the project would break even in eight years.

Suppose, however, that we choose a fuel price inflation rate of 15% per annum and an interest rate of 10%. These rates are given as $\frac{15}{100}$ or 0.15 and $\frac{10}{100}$ or 0.10 in the tables.

We turn to the table headed $R = 0.15$ (where R stands for the fuel price inflation rate) and go down column $I = 0.10$ (where I stands for the interest rate) until the 8th row (year). The number we find at this point is 9.822.

The Present Value of the fuel saved in the first eight years under these conditions of fuel price inflation and interest is, therefore:

£25 x 9.822 = £245.55

and the Net Present Value is £45.55.

We also see that the number in the row above (year seven) is 8.395, so that the Present Value of the fuel saved in the first seven years is

£25 x 8.395 = £209.875

and the Net Present Value is £9.875.

The project would, therefore, break even in less than seven years under these conditions.

NOMENCLATURE

We have already seen that the letters R and I are used to denote the fuel price inflation and interest rates respectively. More letters are used in the examples which follow, and a complete list is given below:

C	Capital cost of project.
S	Value of annual energy saving expected at commencement of project.
I	Likely average interest rate $\left(\frac{\%}{100}\right)$ that could be earned, over the lifetime of the installation by your money if invested; also known as the *Discount Rate*.
i	Interest rate expressed as a percentage; $i = 100\ I$.
R	Average rate $\left(\frac{\%}{100}\right)$ at which you believe energy prices will inflate over the lifetime of the installation.
r	Energy price inflation rate expressed as a percentage; $r = 100\ R$.
n	Lifetime, in years, of the installation, or the period in which you are interested.
$\left[A_{(I,R,n)}\right]$	Number in the tables corresponding to the Present Value (per £1 saved annually at outset), of the fuel saved in the first n years with an interest rate of I and a fuel price inflation rate of R. For further details see Appendix.
P.V.	Present Value, i.e. $\text{P.V.} = S \times \left[A_{(I,R,n)}\right]$ (1)
N.P.V.	Net Present Value. This is the difference between the Present Value and the Capital Cost, i.e. $\text{N.P.V.} = \text{P.V.} - C = S \times \left[A_{(I,R,n)}\right] - C$ (2)
I'	Likely average inflation rate $\left(\frac{\%}{100}\right)$.
t	Number of years deferment of investment in order to achieve cost-effectiveness within a specified period.

CHOICE OF INTEREST AND FUEL PRICE INFLATION RATES

Clearly, the choice of values we give to the interest and energy price inflation rates is critical. As we are all aware, actual rates fluctuate, so that what we would like to know would be their *average values* over the period of our investment. As with all aspects of the future, however, we can do no more than make intelligent guesses at them.

One thing we do know is that interest rates available to the small investor are generally not very different from the inflation rate, so that, in the long term, we might use estimates of this as our anticipated interest rate. A good way of thinking about inflation rates is in terms of how long it would take for prices to double. Doubling times and their corresponding annual inflation rates are given in the table below, where we see, for example, that a rate of 7% per annum leads to price doubling in 10 years.

Annual rates of inflation needed to bring about a price doubling in n years

Number of years	Corresponding inflation rate (%)	Number of years	Corresponding inflation rate (%)
1	100	11	6.5
2	41.5	12	6
3	26	13	5.5
4	19	14	5
5	15	15	4.6
6	12	16	4.4
7	10.5	17	4.2
8	9	18	3.9
9	8	19	3.7
10	7	20	3.5

Combination of Two Inflation Rates

If, for example, general inflation rate is	8% p.a.
and if energy prices relative to general inflation double in 20 years	(p.a. = per annum) i.e. 3.5% p.a.
overall energy price inflation is $(1.08 \times 1.035 - 1) \times 100$	or 11.78% p.a.
Conversely, if overall energy price inflation is	12% p.a.
and if general inflation rate is	8% p.a.
energy price inflation relative to general inflation is $\left(\frac{1.12}{1.08} - 1\right) \times 100$	or 3.7% p.a.
i.e. energy prices, relative to general inflation, double in	19 years