Economic and financial evaluation of measures and projects

Exercice 1: Calculate the simple pay-back period for the installation of a new industrial equipment.

.The capital cost of installing the new machine is 500,000 €.
Assume that the capital expenditure consists of a single payment at the start of the project, at the same time as the new equipment begins operating. There are no non-energy costs or savings.

Investment	500 000 €
% of gain	16 %
Gas consumption	650 GJ/year
Gas prices	2,72 €/GJ

Exercice 2: Calculate the net present cost of a new industrial new equipment.

The cost and performance parameters are the same as for exercise 1.

Evaluate the costs and savings over the expected technical lifetime of the equipment, which is 5 years, at a discount rate of 10%. Do the exercise in two stages.

i) Given the percentage gain resulting from the action, the gas consumption of the furnace and the gas price, calculate the present value of the energy savings in £. Note that the present value of the savings over 5 years is the sum of the present values of the savings in each year.
ii) Calculate the net present cost of the action in €. Is the action cost-effective?

Statistical tables (net present cost)
$\sum 1/(1+i)^n$

n \ i	**0,05**	**0,1**	**0,12**
1	0.952	0.909	0.893
2	0.859	1.736	1.69
5	4.329	**3.791**	3.605
10	7.722	6.145	5.65
20	12.462	8.514	7.469

Exercice 3: Calculate the simple pay-back period for the installation of a new equipment in industry.

Fixed costs (7000 €/y) are incurred through increased maintenance requirements, and variable costs of 1500 € per million litres of product (Ml) are incurred through slightly increased electricity consumption. However, consumption of fuel oil in the boilers is reduced by 28%.

(i) Calculate the payback period using cash-flow analysis. Ignore depreciation and tax, and assume that the capital expenditure occurs in a single sum in Year 1.
(ii) Assume that the price of oil decreases by 7% each year. Re-calculate the payback period.

Capital cost	270 000
Fixed costs	7 000 / year
Variables costs	1 500 /Ml
production	2,90 Ml / year
Percent gain	28%
Specific consumption	0,048 J / l
Fioul price	2,23 / GJ

Exercice 4: Calculate the net present cost of a new equipment in industry.

Do this in three stages.

i) Given the capital cost, the fixed and variable non-energy costs and the output of the unit, calculate the present costs of the action.

Assume that the technical lifetime of the equipment is 5 years, and assume a discount rate of 25%.
Assume that the capital expenditure occurs in a single payment at the start of the project.
In order to enable comparison of this furnace with others of different sizes, express your answer both in € and in € /t/ y.

ii) Given the percent gain resulting from the action, the gas consumption of the equipment and the gas price, calculate the present value of the energy savings in both € and €/t/y.

iii) Calculate the net present cost of the action in both € and €/t/y. Is the action cost-effective?

Capital cost	35 000
Fixed costs	2 000 / year
Variables costs	0,04 / t
production	63 200 t /year
Discount rate	25%
Lifetime	5 year
Gas consumption	650 000 J/year
Percent gain	3,60%
Gas price	2,72 / GJ

Exercice 5:

The energy consumption of a gas furnace can be reduced by installing an advanced control system on the furnace, incurring fixed costs for maintenance of the system, but attaining variable operating savings due to an improved quality product.

A market survey has ascertained that the standard rate of return for capital investments in this sector is 8%. However, energy-saving investments in general demand a 25% rate of return as they are not perceived to be core business. If the investment offers a substantial improvement in the quality of the finished product, a rate of 15% might be more applicable.

Calculate the cost of energy saved for discount rates of 8%, 15% and 25%. For a gas price of 2.72 €/GJ, is the energy-saving technology cost-effective at each of these rates?

Capital cost	40 000	
Fixed costs	4 000	/ year
Variables costs	-0,25	/t
production	25,00	kt/year
Gas consumption	37224	GJ/year
Percent gain	10,00	%
Discount rate	8	%
Lifetime	5	years

Exercice 6: Calculate the cost of energy saved and the technical energy-saving potential for four cases:

i) Applying oxygen trimming to a glass melting furnace
ii) Installing an expert control system on a glass melting furnace
iii) Installing oxygen trimming to a furnace on which an expert control system has already been applied.
iv) The combined cost of the control system and the oxygen trimming.

Ignore non-energy operating costs, and assume a discount rate of 25% and a lifetime of 5 years for both technologies. The furnace consumes 650,000 GJ/y.

		Case 1	Case 2	Case 3	Case 4
Initial Energy consumption	GJ/year	650000	650000	585000	650000
Percent gain	%	3,60	10,00	3,60	
Energy savings	GJ/year				
Capital cost		60 000	100 000	60 000	
Lifetime	year	5,00	5,00	5,00	5,00
Discount rate		0,25	0,25	0,25	0,25
Annualised capital costs	/ year				
Cost of energy saved	**/GJ**				
Technical potenitial	**PJ/year**				

Payback period

The simple payback period introduced in Level 1 was defined as:

Simple Pay back period (y) = capital costs (€) / (annual savings (€/y) – annual operating savings (€/y))

In reality, costs and savings may change over time, and the capital expenditure may be spread over several years. In order to calculate an accurate payback period, a full cash-flow analysis must be undertaken. The payback period is the length of time taken for the cumulative cash-flow to become positive, where the cash-flow in year i is defined as:

Cash flow I = operating profit I – capital expenditure

In some analyses, depreciation and tax are deducted from the cash-flow before calculating the pay-back. For the purpose of calculating the payback period, costs are not usually discounted.

The payback period is the length of time taken for the cumulative cash flow to become positive.

Cost-effective

An energy-saving technology is cost-effective if the cost of saving energy is less than the price of the energy saved, i.e. the net present cost of implementing the energy-saving technology is negative.

Net present cost

The Net present cost of a project is the sum of all the savings and costs which will accrue over the whole lifetime of the project. The costs and savings are "discounted", i.e. they are adjusted to reflect the fact that a sum of money in the future is worth less than a sum of money today.

The net present cost is the present value (PV) of the costs of implementing the action less the present value of the expected energy savings which will result from the action. The action is said to be cost-effective if its net present cost is negative, i.e. if the present value of the energy savings exceeds the present value of the costs of the action.

net present cost = PV(operating costs) - PV(energy savings)

Note that if non-energy savings outweigh non-energy costs then the first term on the right-hand side will be negative.
The net present cost is sometimes called the net present value.

Present value

The Present Value (PV) of a sum of money V, n years from today is given by:

$PV = V / (1+ dr)^n$

where dr is the discount rate.

The Discount rate describes the value of money in the future compared to the present day. High discount rates indicate that money in the future is given a low value compared to money today. The discount rate reflects the fact that money today is worth more than money tomorrow, because money today can be invested or spent to bring immediate benefits to the owner, and because the future is uncertain so the potential benefits which money in the future might bring are risky.

The PV can be automatically calculated by Excel: use the function VA (valeur actualisée in French)

PV = VA (discount rate; lifetime; - annual costs)

Cost of energy saved

The Cost of energy saved is the discounted cost incurred to save one unit of energy. It is calculated as the sum of the annualised capital cost and the annual operating costs (which may be negative if non-energy savings are made) divided by the annual energy saved in GJ.

Cost of energy saved (€/ GJ) = Ac (€/y) + C_{op} (€/y) / ES (GJ/y)

where AC is the annualized capital cost,

Cop is the sum of the annual fixed and variable non-energy operating costs

ES is the annual energy saving in GJ.

The Cost of Energy Saved reflects the Critical fuel price, i.e. the fuel price which is necessary for the application of a given energy-saving technology to become cost-effective. If the critical fuel price is less than the actual fuel price then the technology is cost-effective.

Annualised capital costs

$AC = (dr * Cc_{op}) / (1-(1+dr)^n$

or

$AC = CRF * Cc_{op}$

with Cc_{op} : initial capital cost

CRF is the “capital recovery factor”, depending on discount rate and lifetime (this value is read in a statistical table)

This value can be calculated on Excel using the function:

VPM (discount rate; lifetime; - capital cost)