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Energy Efficiency Project Development

Identification and quantification

Process of project development

- Project Identification
- Prefeasibility Study
- Business Planning
- Financing
- Implementation
- Monitoring & Reporting

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Identification & Evaluation

Step 1: Develop ideas for

- reducing energy use,
- increasing process / equipment efficiency

Step 2: Estimate energy savings from identified measures

Step 3: Estimate implementation cost of identified measures

Step 4: Selection of project for further investigations / development

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Energy saving check list

The ’Energy Auditor’ should go through every important energy consuming process in the company, to check:

1. If the process design could be improved
2. If proper process equipment is being used
3. If better automatic control could be installed
4. If the operation of the process could be optimised

The following 4 slides show a general check list.

Energy saving check list

1 Process design

1.1 Clarify the main objectives of the process. What is the product or service?

1.2 Is the product or service from the process critical, or could it be replaced?

1.3 Could the product or service be obtained by a different process?

1.4 Could the capacity of the process be reduced?

1.5 Could the quality of the product or service be reduced?

1.6 Could the process be redesigned to obtain:

- reduced flow?
- reduced pressure and/or temperature level?
- reduced pressure drop?

1.7 Could the control valves and dampers be replaced by variable speed drives?

1.8 Compare actual energy consumption with:

- theoretical energy consumption required ?
- general branch key numbers?
- experience values from similar processes?

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Energy saving check list

2 Equipment selection

2.1 Is the equipment suitable for the task of the process?

2.2 Could pumps/compressors/fans with higher efficiency be installed?

2.3 Could motors/drivers with higher efficiency be installed?

2.4 Could variable speed drivers be used instead of control valves and dampers?

2.5 Could larger heat exchanger surfaces be installed to utilise more heat from effluent or waste gases?

2.6 Could larger equipment be installed to reduce pressure drop?

2.7 Could pressure drop across control valves and dampers be reduced?

2.8 Could boilers and furnaces efficiency be improved by:

- installing economiser?
- installing better burners?
- installing better combustion control system?
- installing better fuel preparation system?

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Energy saving check list

3 Control system design

3.1 Could timers be installed to reduce running time?

3.2 Could control be installed to optimise process parameters (pressure, temperature, flow, etc.)?

3.3 Are there sufficient indicators or meters (pressure, temperature, flow, etc.) to enable the operators to run the process under optimum process conditions?

Energy saving check list

4 Operation

4.1 Could the stand-by unit be closed down?

4.2 Could the stand-by unit be kept on pressure / temperature with less energy consumption?

4.3 Could the stand-by unit be operated at lower pressure or lower temperature?

4.4 Could number of units in operation be reduced?

4.5 Is the unit operating with optimal load?

4.6 Could some of the units be turned off during low load periods?

4.7 Could the process be operated at lower pressure or lower temperature on a permanent basis or part of the time?

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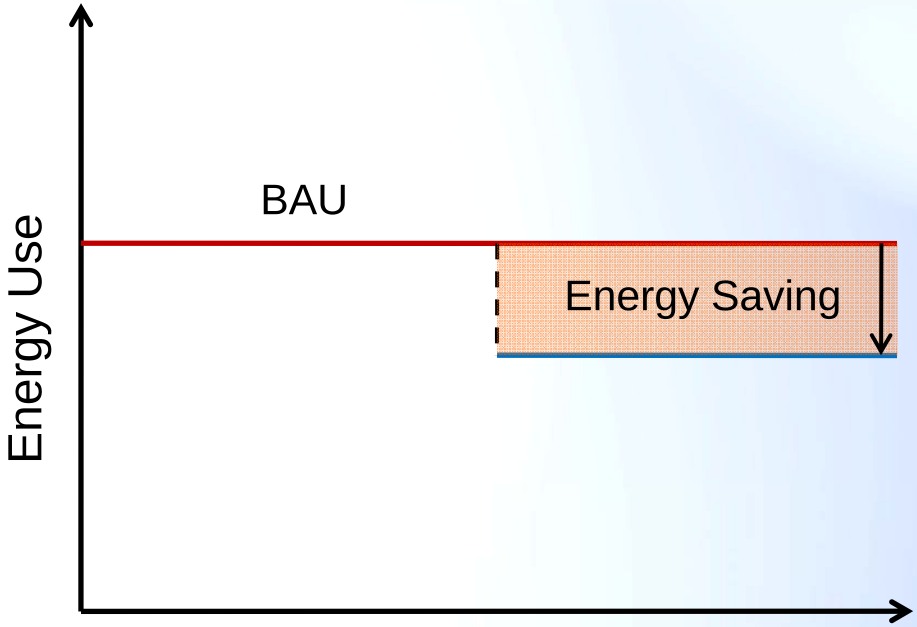
Quantifying energy savings

Energy savings is the difference between ‘Business as Usual’ and the amount of energy which would be used be implementing the identified measure.

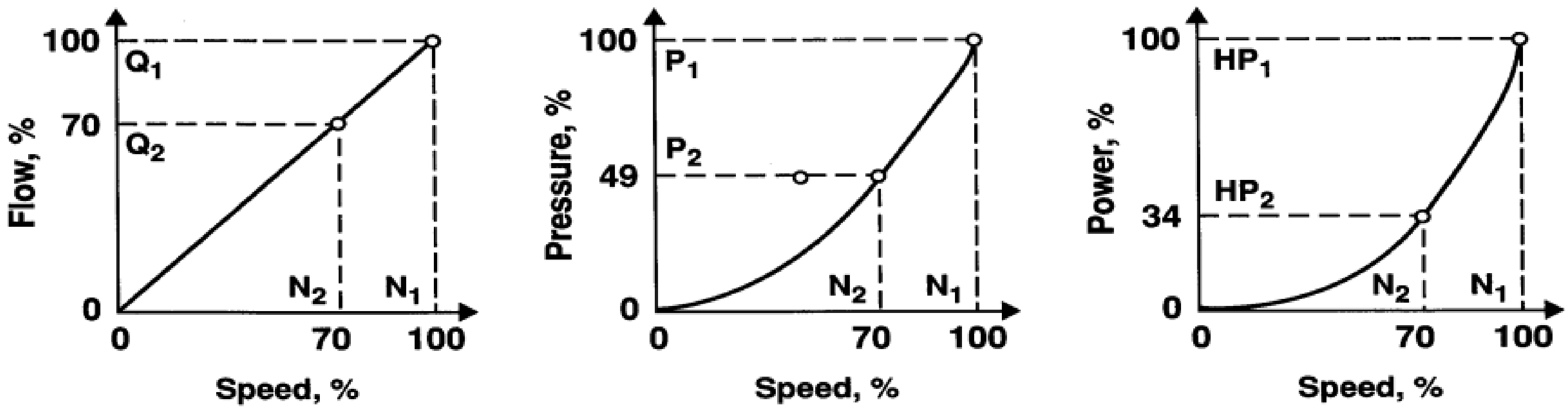


Example – VSD Control

Installation of a variable speed drive in place of control valve for flow control:

A 50kW pump is operating with downstream control valve, which throttles the flow to 60%. The pump operates 24 hours a day, 360 days a year

Affinity Laws for Centrifugal Equipment



$$\frac{Q_2}{Q_1} = \frac{N_2}{N_1}$$

$$\frac{P_2}{P_1} = \left(\frac{N_2}{N_1}\right)^2$$

$$\frac{HP_2}{HP_1} = \left(\frac{N_2}{N_1}\right)^3$$

N = Speed
Q = Flow
P = Pressure
HP = Horsepower

Example – VSD Control

Current energy use:

$$E_1 = 50kW \times 90\% \text{ motor load} \times 24 \text{ hrs/day} \times 360 \text{ days/year}$$

$$E_1 = 388{,}800 \text{ kWh/year}$$

New energy use:

$$E_2 = 50kW \times 0.6^3 \times 24\text{hrs/day} \times 360 \text{ days/yr}$$

$$E_2 = 93{,}312 \text{ kWh/year}$$

Energy Saving = 388,800 – 93,312 **= 295,488 kWh/year**

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Cost Saving

- What energy source/s will the project reduce?
- Make sure to take into account any ‘time of use’ charges based on the time of energy saving
- Are there any other energy charges which would be affected by the project, such as demand charges?

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Project Costs

- Capital / investment costs
- Installation costs
- Increased maintenance costs
- Increases in other fuels?
- Other fees or charges?

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Process of project development

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Economic Evaluation

How do you know which project is best to implement?

Simple Payback		
ROI	–	Return on Investment
NPV	–	Net Present Value
IRR	–	Internal Rate of Return

How are these used?

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Simple Payback

Simple definition: The amount of time it would take to recover initial investment costs

$$Payback = \frac{Cost\ of\ Investment}{Average\ Annual\ Earnings\ on\ Investment}$$

Often used for it's simplicity to calculate and understand, **however** this metric has limitations as it does not take into account the time value of money, risk, financing or other important considerations.

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Return on Investment

Simple definition: Comparison between magnitude and timing of investment gains with the magnetude and timing of investment costs.

$$ROI = \frac{(Gain\ from\ Investment - Cost\ of\ Investment)}{Cost\ of\ Investment}$$

Decision making:

ROI > 0 – The investment would add value over the project life

ROI < 0 – The investment would subtract value over the project life

ROI = 0 – The investment would neither gain nor lose value over the project life

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Net Present Value

Simple definition: The present value of future cash flows minus the purchase price

$$NPV = \sum_{t=1}^{n} \frac{R_t}{(1+i)^t}$$

t – the time of the cash flow

i – the discount rate (the rate of return which could be earned on an investment in the financial markets with similar risk)

R_t – the net cash flow (the amount of cash, inflow minus outflow) at time t

Decision making:

NPV > 0 – The investment would add value to your company

NPV < 0 – The investment would subtract value to your company

NPV = 0 – The investment would neither gain nor lose value for your company

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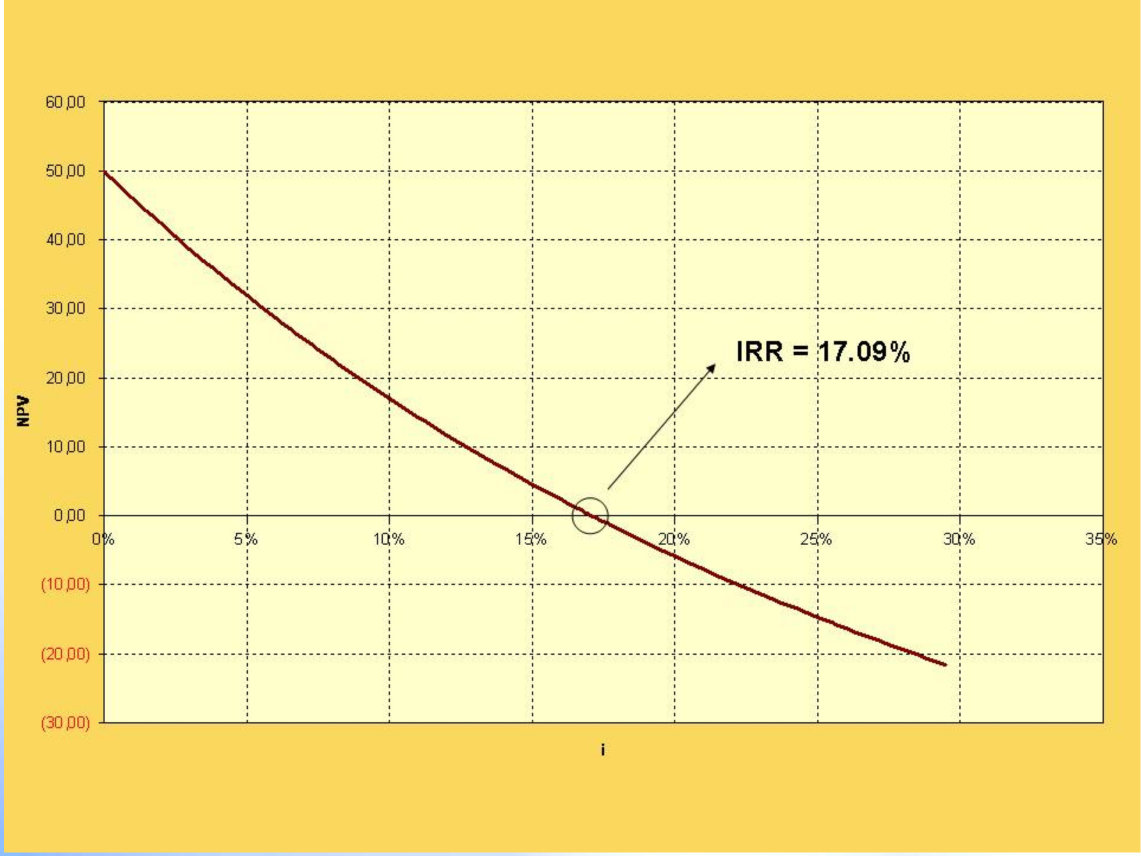
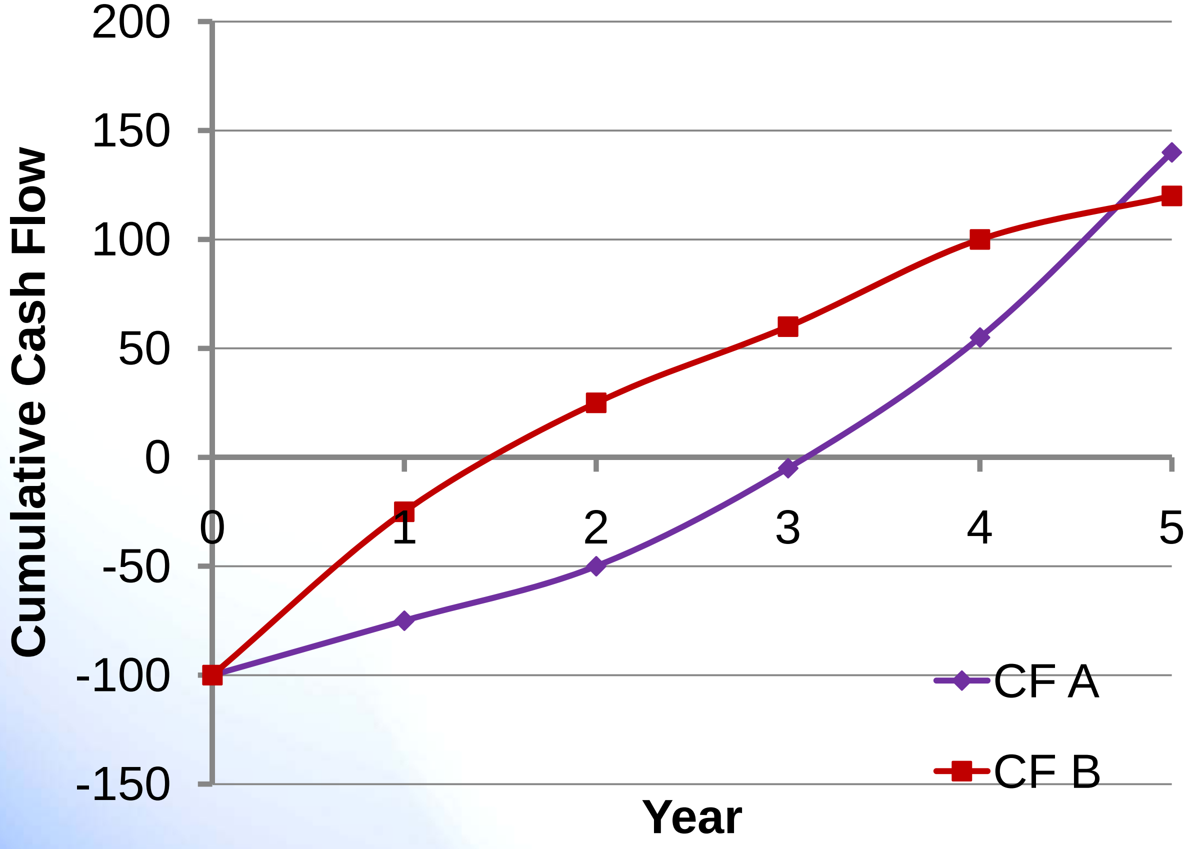
Internal Rate of Return

Simple definition: the ‘annualised effective compounded return rate’ or discount rate that makes the NPV of all cash flows equal zero

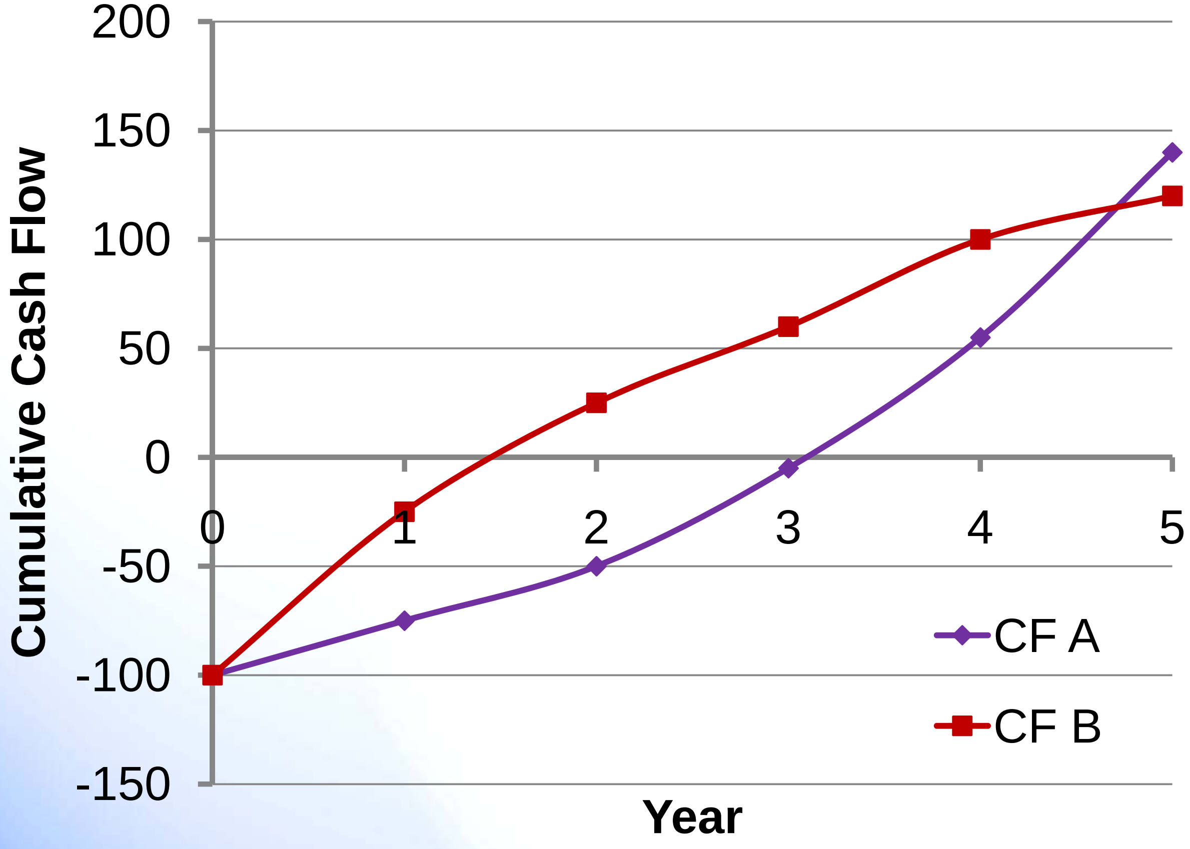


Cumulative Cash Flow and Payback



Question: Which investment, A or B is a better business decision?

Cumulative Cash Flow and Payback

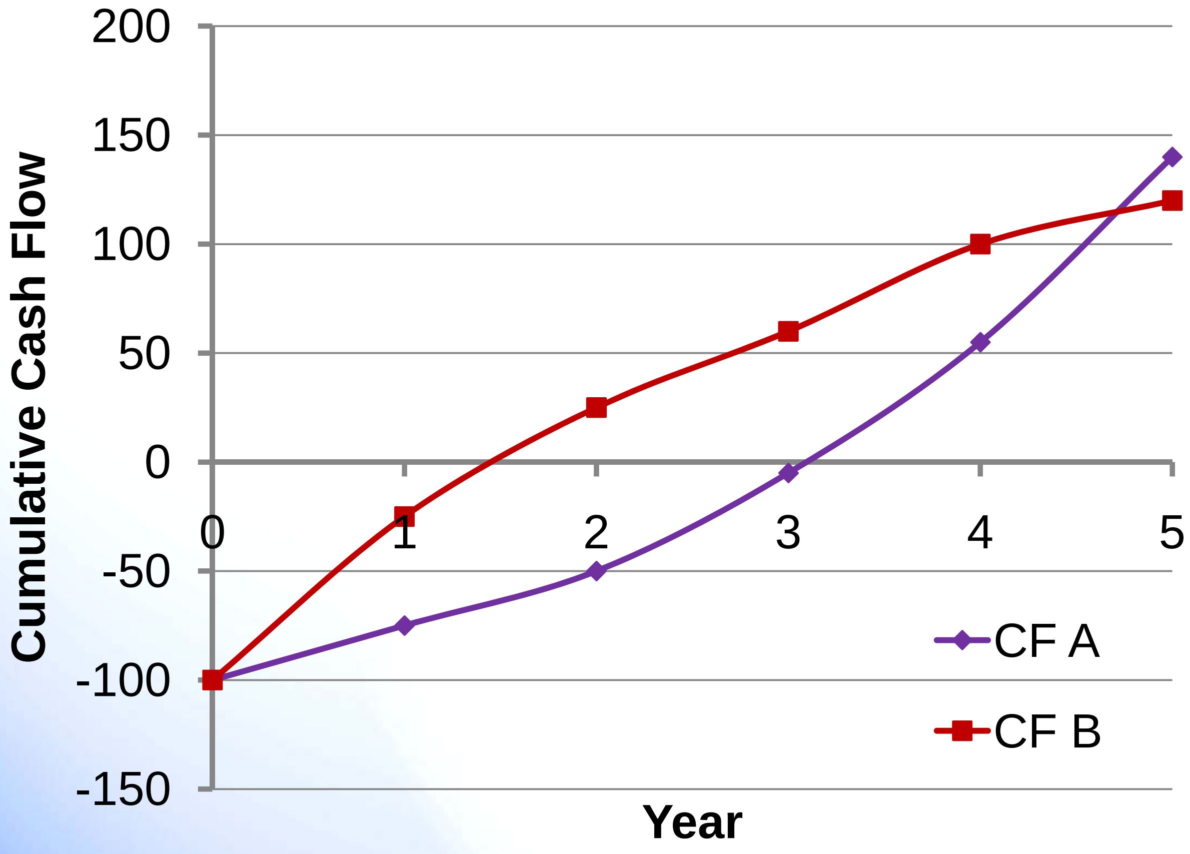


ROI: Over a 5 year period, investment A has a higher ROI.

A: 62.2%

B: 51.1%

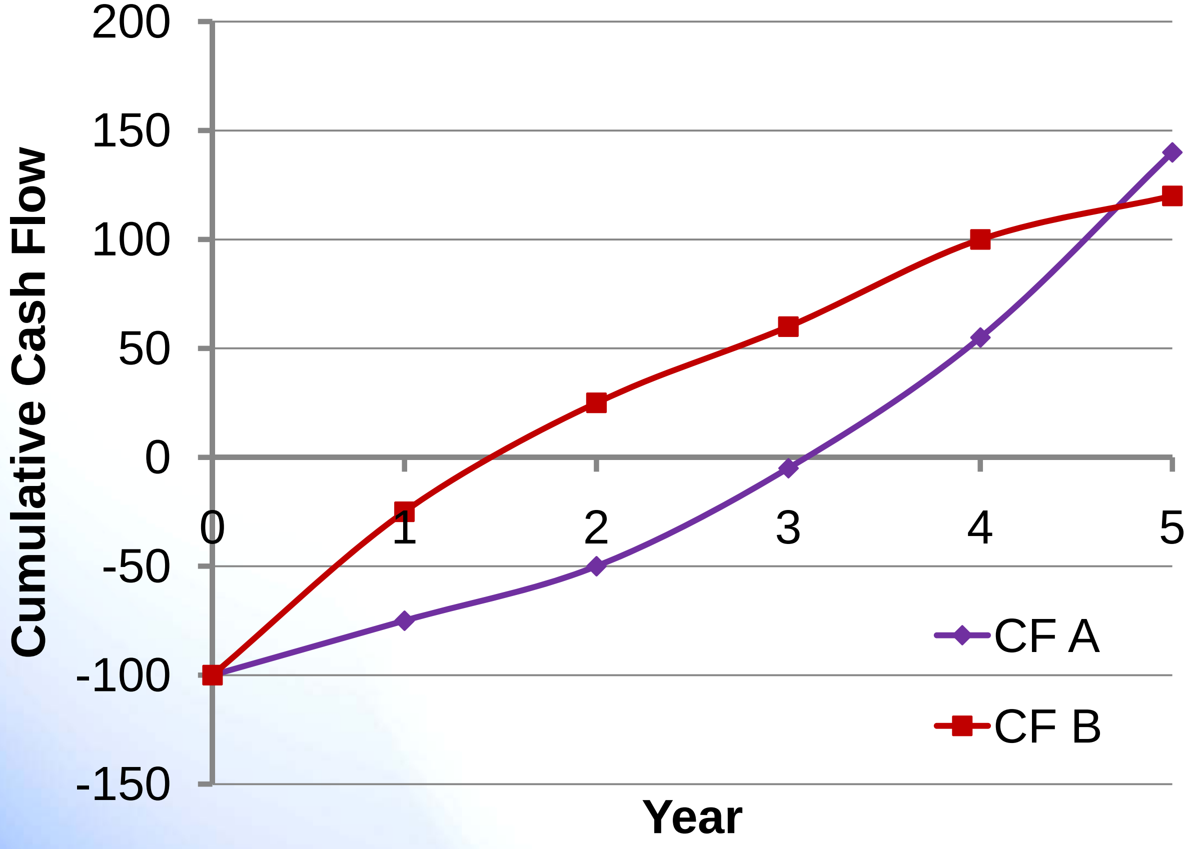
Cumulative Cash Flow and Payback



Future Performance: The curve only covers 5 years, but what if the project has a longer lifespan?

Investment A looks set to outperform investment B in the longer term.

Cumulative Cash Flow and Payback

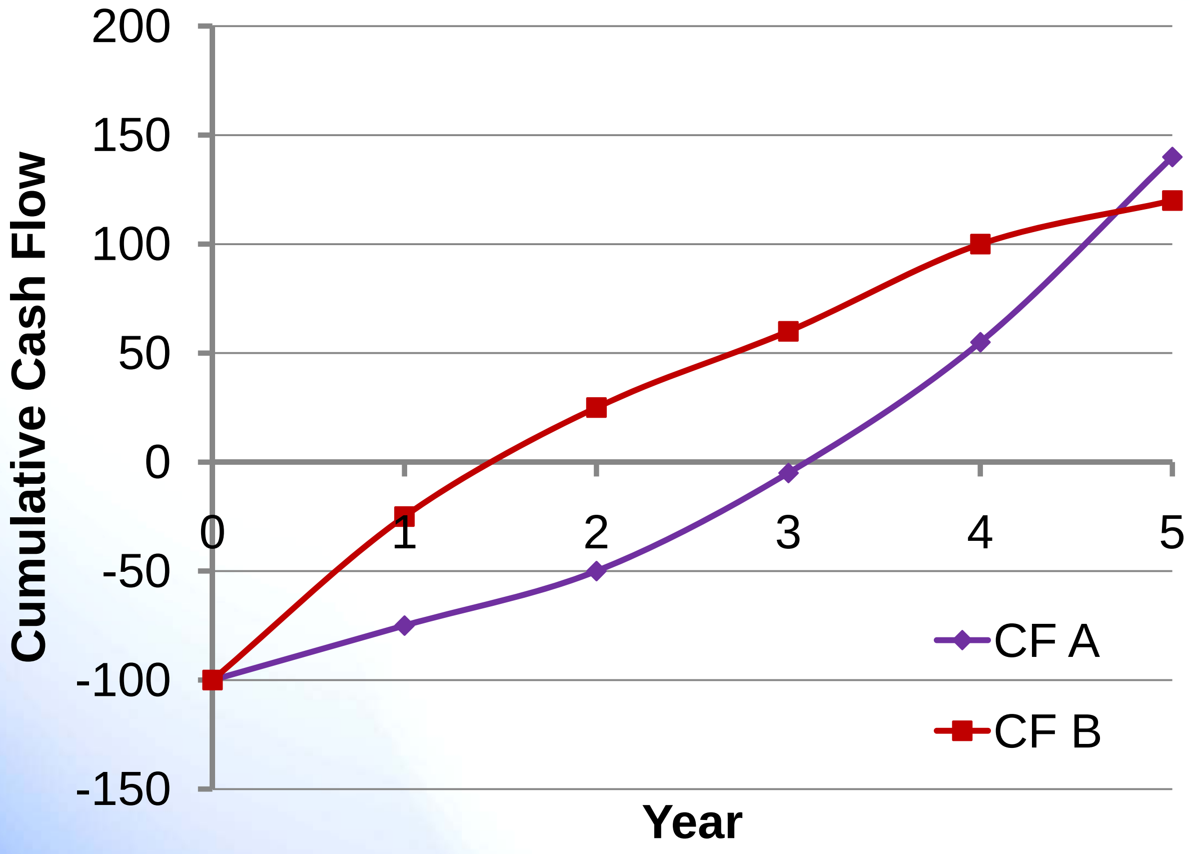


Payback Period: This is the point when the initial investment costs are recovered by earnings.

A: 3.1 years

B: 1.5 years

Cumulative Cash Flow and Payback



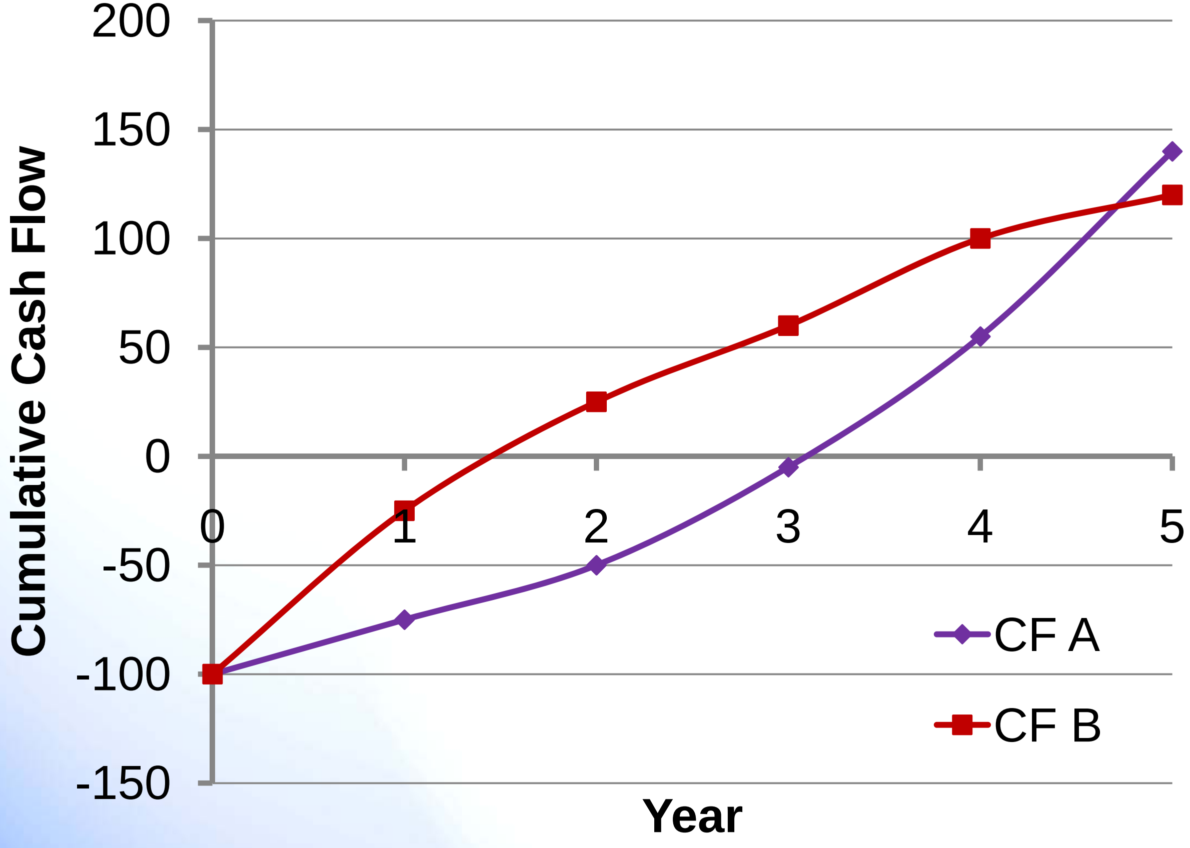
NPV: Using a 10% discount rate, investment B is worth more today than investment A, even though in 5 years investment A will return more funds.

A: 70.51

B: 76.18

This is due to the time value of money rationale.

Cumulative Cash Flow and Payback



IRR: This is the interest rate which produces an NPV of 0.

A: 28.9%

B: 44.9%

Roughly speaking, financial officers will consider investments with an IRR above their cost of borrowing.

For competing investments, the higher IRR will be preferred

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Cumulative Cash Flow and Payback

Based on this analysis, which investment is the better business decision?

- Clearly there is no one answer which suits all companies at all times.
- All these parameters should be considered and financial planners will apply a ‘weight’ to each of these metrics depending on:
  - The companies business objectives
  - The current situation

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Thank you for your attention

EXAMPLES OF ENERGY SAVING

Example 1:	**Steam and hot water piping**
Example 2:	**Ventilation air unit**
Example 3:	**Cooling water pumps**

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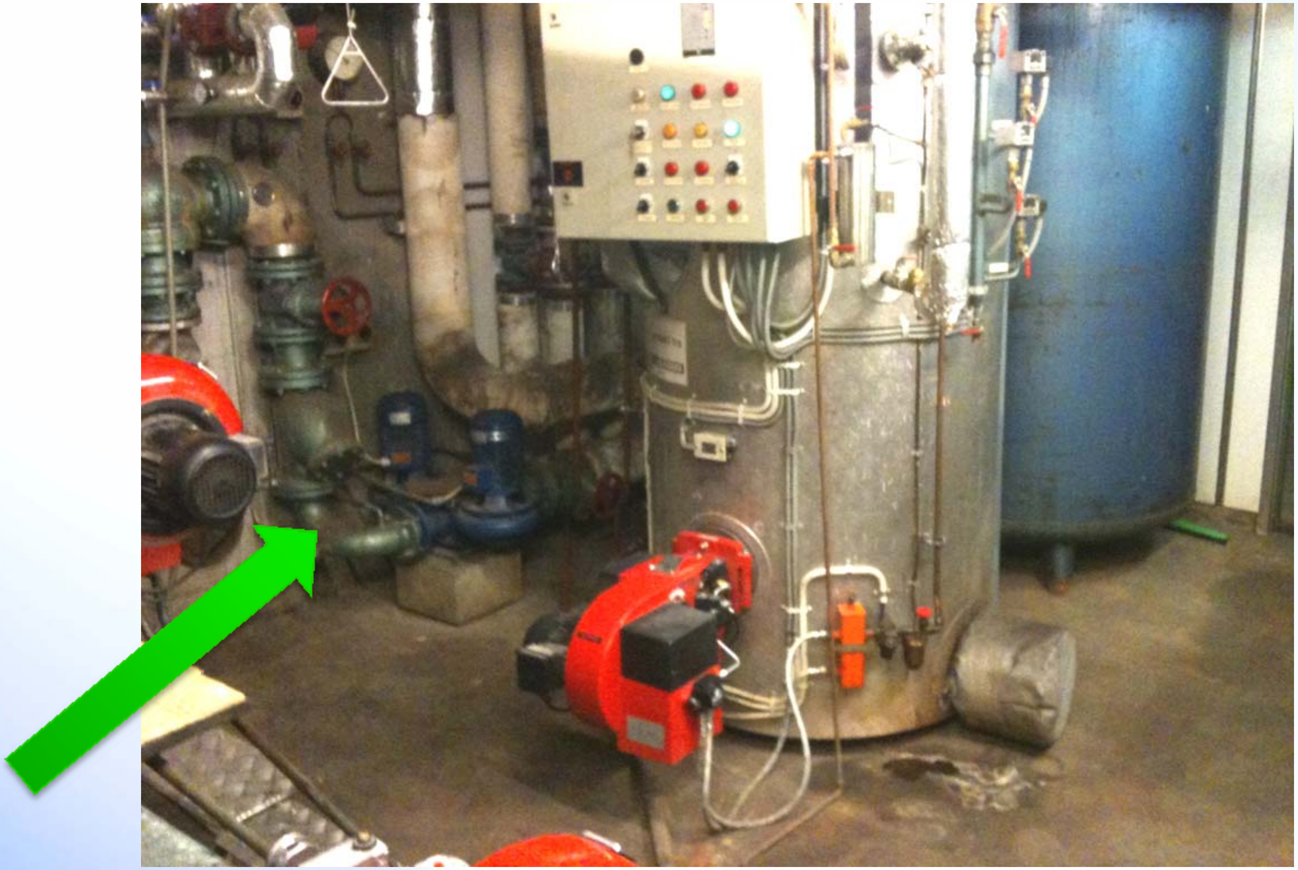
Example 1:

STEAM AND HOT WATER PIPING

UNINSULATED PIPES, VALVES AND PUMPS



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•UNINSULATED AND INSULATED VALVE

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•Key numbers for heat loss from pipes

•Hot water 80 ^{o}C / Steam 175 ^{o}C

•(inside building with air temperature 20 ^{o}C)

• HEAT LOSS (W/M)

•Pipe size Uninsulated Insulated

• 30 mm 100 mm

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CALCULATION OF ENERGY SAVING

- STEAM AND HOT WATER PIPING

- Uninsulated pipes: 70 meters
- Uninsulated valves: 115 off
- Uninsulated inline pump house: 2 off

- Pipes, valves and pump houses were insulated with mineral wool and premanufactured jackets.

- Energy reduction: 440.000 kWh/year

Example 2:
Ventilation air unit

1. Picture of air handling unit
2. Calculation of energy saving

•Ventilation air unit

OPERATING TIME 24 HOURS

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CALCULATION OF ENERGY SAVING

- Volumetric air flow: +- 15.000 m^3/h
- Fan motor power: 2 x 9,5 kW
- Type of heat recovery: Plate Heat Exchanger
- Operating time: 8.760 hours/year

- Optimalization of operating time by using a cycle timer to stop fans outside working hours (1700-0600), and in weekends.

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Example 3:
Cooling water pumps

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•COOLING WATER PUMPS

OPERATING WITHOUT FREQUENCY CONVERTER

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•FREQUENCY CONVERTERS INSTALLED FOR ENERGY EFFICIENT OPERATION OF PUMPS.

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•CALCULATION OF ENERGY SAVING

- •Volumetric flow (fixed): 60 m^3/h
- •Delivery pressure: 5,5 bar
- •Power used: 12 kW
- •Operational time: 8.400 hours/year
- •Energy consumption: 100.800 kWh/year

•The number of production machines in operation that required cooling water vary from day to day. Temperature

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