ENGINEERING ECONOMY

PRESENT WORTH FACTOR (NPV)

Present worth analysis

- Find the equivalence **at the present time**
- All the cash flow occurred must be convert to present condition
- Net Present Value (NPV) is **the difference** between the present value of cash **inflows** and the present value of cash **outflows**.
- NPV is used in capital budgeting to **analyze the profitability** of a projected investment or project.

Net Present Value

$$NPV = PW_{inflow} - PW_{outflow}$$

NPV outcome might be 2 condition

- **MEA** (mutually exclusive alternatives)→ only **one** alternative selected
- **Independent alternatives** → **more than one** alternatives selected

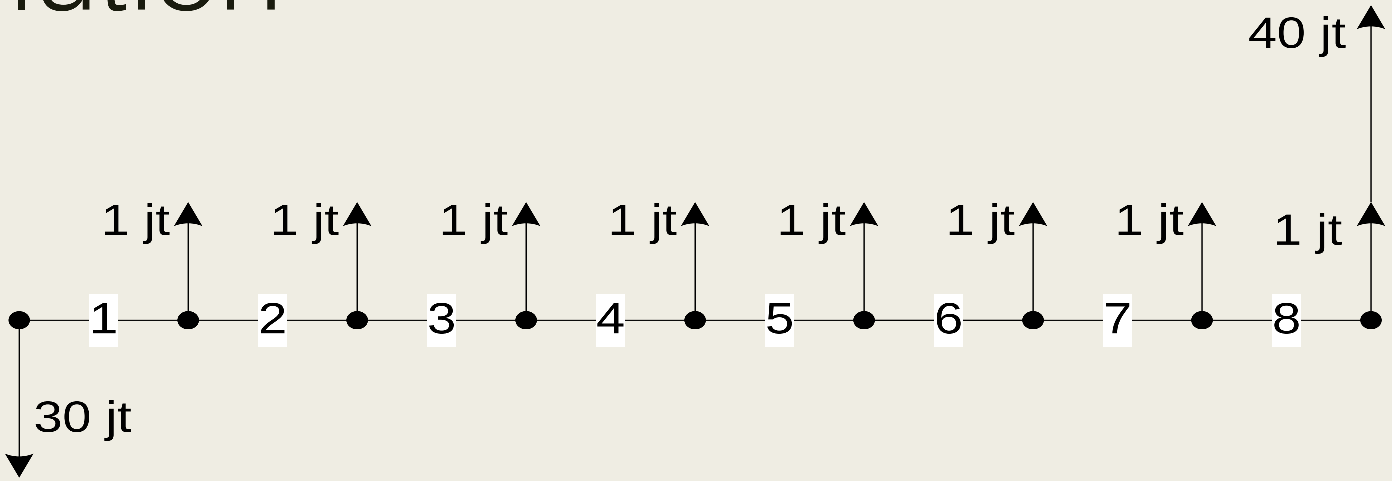
Net Present Value

- $NPV = PW_{inflow} - PW_{outflow}$
- For single alternative
  - *Select the alternative if NPV ≥ 0*
- More than one alternatives
  - *Select the greatest NPV among alternatives*
- For *independent alternatives*, select alternative which has NPV ≥ 0.

Analysis with single alternative

- A company consider to purchase the machine worth to **Rp 30.000.000,-. The machine could save up to Rp 1.000.000/year by 8 years useful life.** At the end of 8th year, it can be sold **Rp 40.000.000,-.**
- If the bank pays **12% annually**, analyze the purchase decision using Present worth method!

Solution



- NPV = 40.000.000(P/F,12%,8) + 1.000.000(P/A,12%,8)-30.000.000
- NPV = 40.000.000(0.40388) + 1.000.000(4.96764) - 30.000.000
- NPV = - 8.877.160
- NPV < 0, the purchasing is not profitable

Present Worth analysis with multiple alternatives

It consider useful life and the period which the analysis is taken

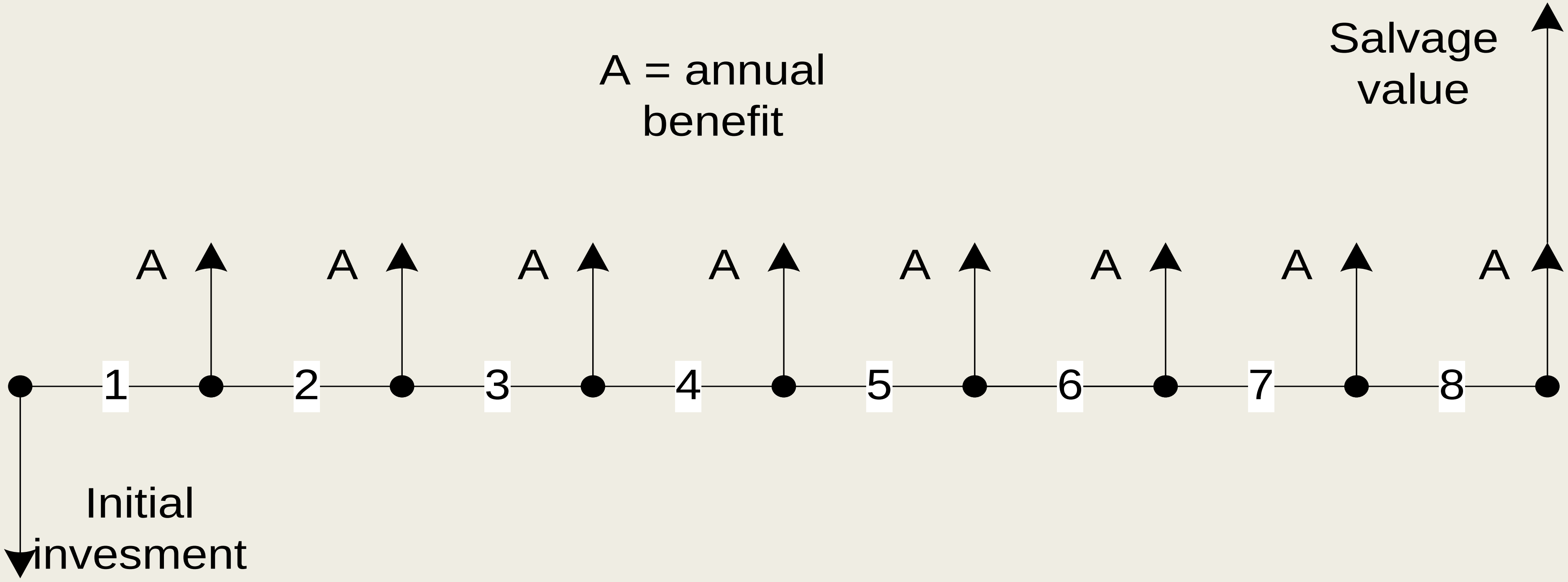
1. **PW evaluation of equal life mutually exclusive alternatives**
   → Find PW and select numerically larger PW value
2. **PW with different-life alternatives**
   → Must compare with equal service (must end at the same time)
   → apply Least common multiple (LCM) of lives
   → Find PW and select numerically larger PW value
3. **PW with capitalized cost (CC) analysis**
   → CC refer to the present worth of a project with a very long life
   → Project with infinite life

PW evaluation of equal life

A company purchase a machine to increase the productivity every year. 2 alternatives has been analyze with equal useful life. How ever the useful life in each alternatives is **8 years**. if the **APR is 15%,** which machine the company should be purchased?

machine	Initial investment	Annual benefit	Residual value (salvage value)
X	2.500.000	750.000	1.000.000
Y	3.500.000	900.000	1.500.000

Solution



A = annual benefit
Salvage value
A
A
A
A
A
A
A
A
1
2
3
4
5
6
7
8
Initial invesment

Solution:

Mahcine X :

- $NPV_X = 750.000(P/A,15\%,8) + 1.000.000(P/F,15\%,8) – 2.500.000$
- $NPV_X = 750.000(4.48732) + 1.000.000(0,32690) – 2.500.000$
- $NPV_X = 1.192.390$

Machine Y :

- $NPV_Y = 900.000(P/A,15\%,8) + 1.500.000(P/F,15\%,8) – 3.500.000$
- $NPV_Y = 900.000(4.48732) + 1.500.000(0.32690) – 3.500.000$
- $NPV_Y = 1.028.938$

Therefore, select machine X

PW with different-life alternatives

A company purchase a machine to increase the productivity every year. 2 alternatives has been analyze with **different useful life.** If **the APR is 15%,** which machine the company should be purchased?

machine	Useful life (years)	Initial investment	Annual benefit	Salvage value
X	8	2.500.000	750.000	1.000.000
Y	16	3.500.000	900.000	1.500.000

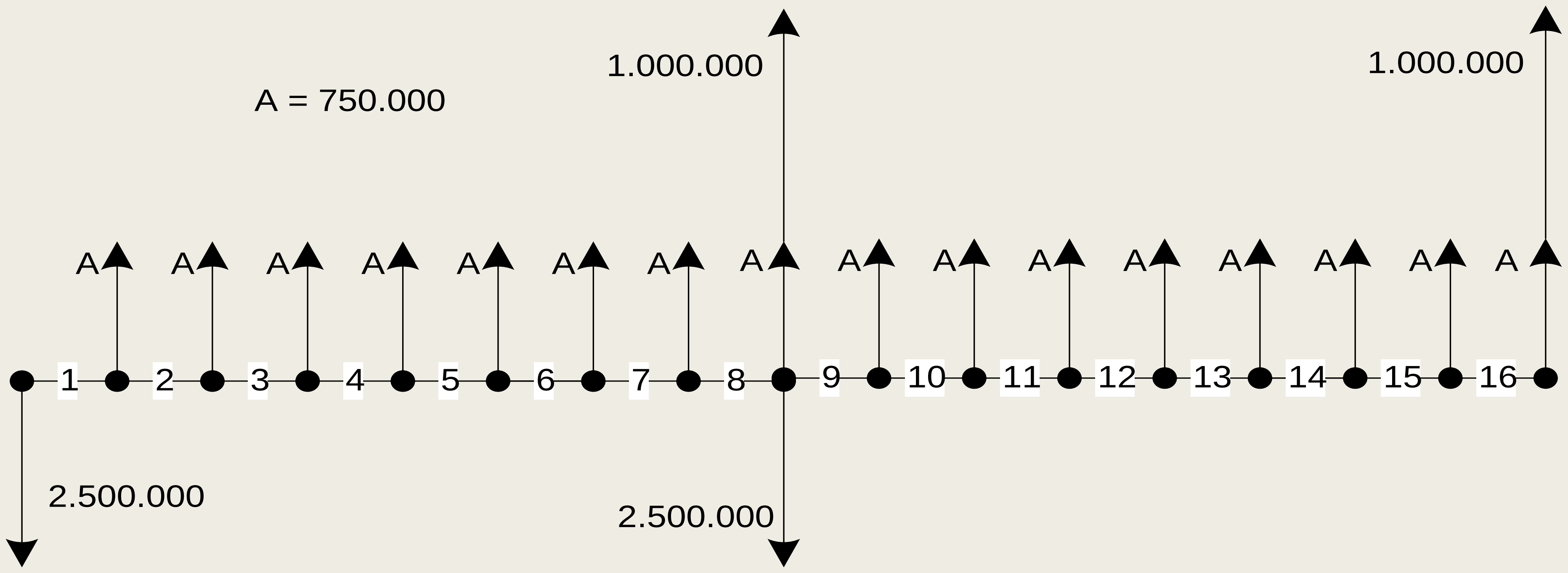
PW with different-life alternatives

Remember!

THE PRESENT WORTH OF THE ALTERNATIVES MUST BE COMPARED OVER THE SAME NUMBER OF YEARS!

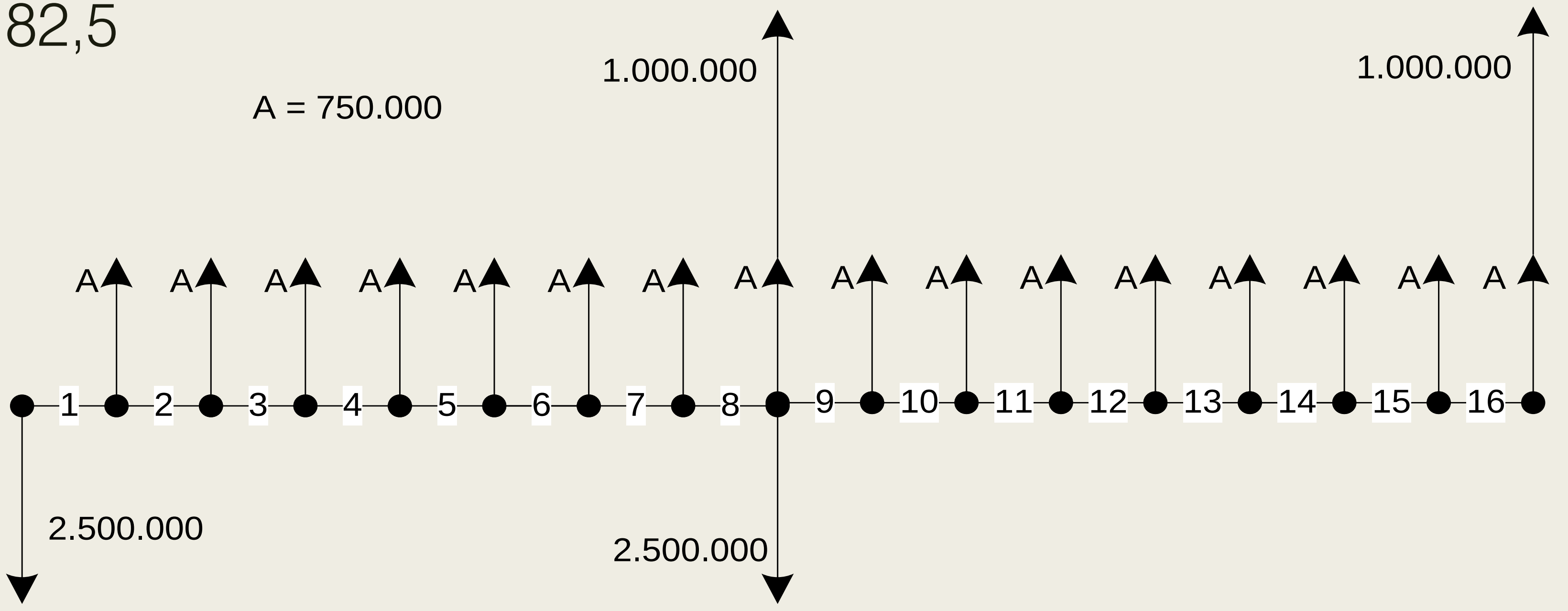
Solution:
apply Least common multiple

- Cash Flow X



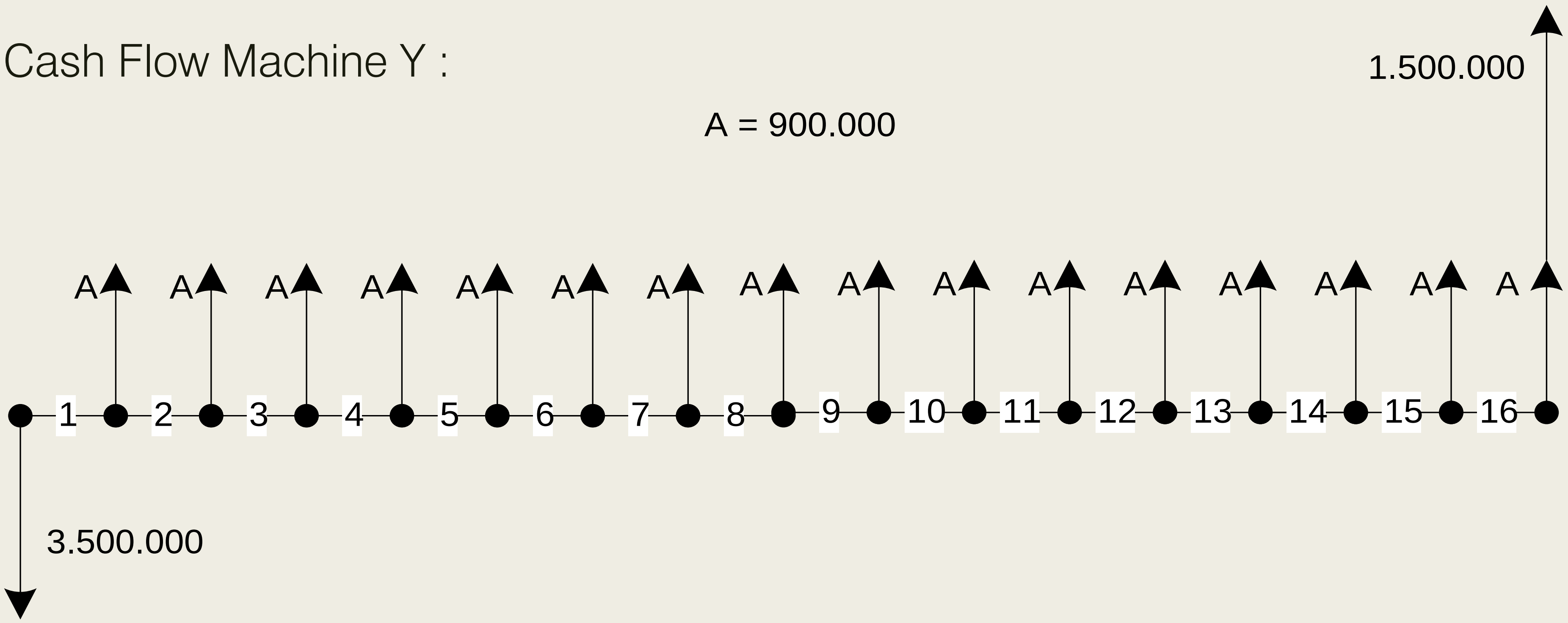
Solution:

- NPV_X = 750.000(P/A,15%,16) + 1.000.000(P/F,15%,8) + 1.000.000(P/F,15%,16) – 2.500.000(P/F,15%,8) – 2.500.000
- NPV_X = 750.000(5.95423) + 1.000.000(0.32690) + 1.000.000(0.10686) – 2.500.000(0.32690) – 2.500.000
- NPV_X = 1582182,5



Solution:

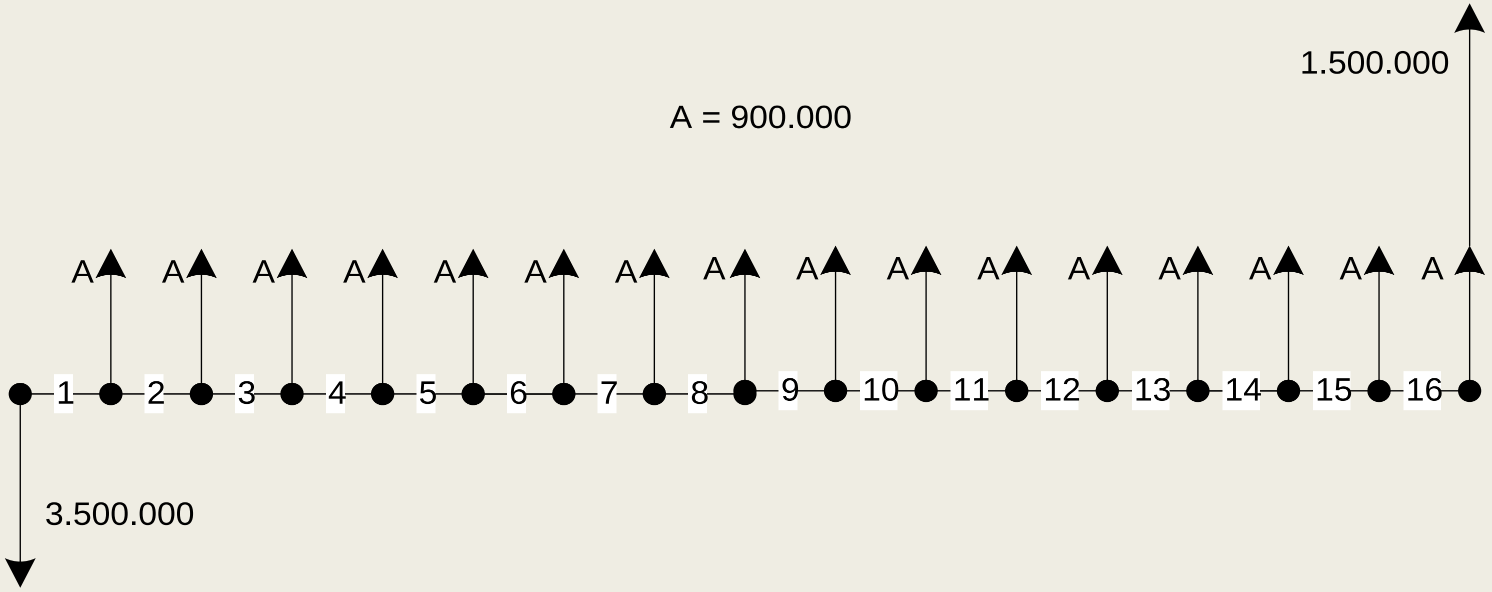
- Cash Flow Machine Y :



Solution:

- $NPV_Y = 900.000\ (P/A, 15\%, 16) + 1.500.000 (P/F, 15\%, 16) - 3.500.000$
- $NPV_Y = 900.000\ (5.95423) + 1.500.000 (0.10686) - 3.500.000$
- $NPV_Y = 2.019.097$

Since NPV machine Y, Rp 2.019.097,- is larger than NPV machine X then select machine Y.



PW with capitalized cost (CC) analysis

- If Least Common Multiple is difficult to be applied you can use CC analysis
- Effective for infinite alternative period

$$CW = PW_{n \to \infty} = A(P/A, i, \infty) = A\,(1/i)$$

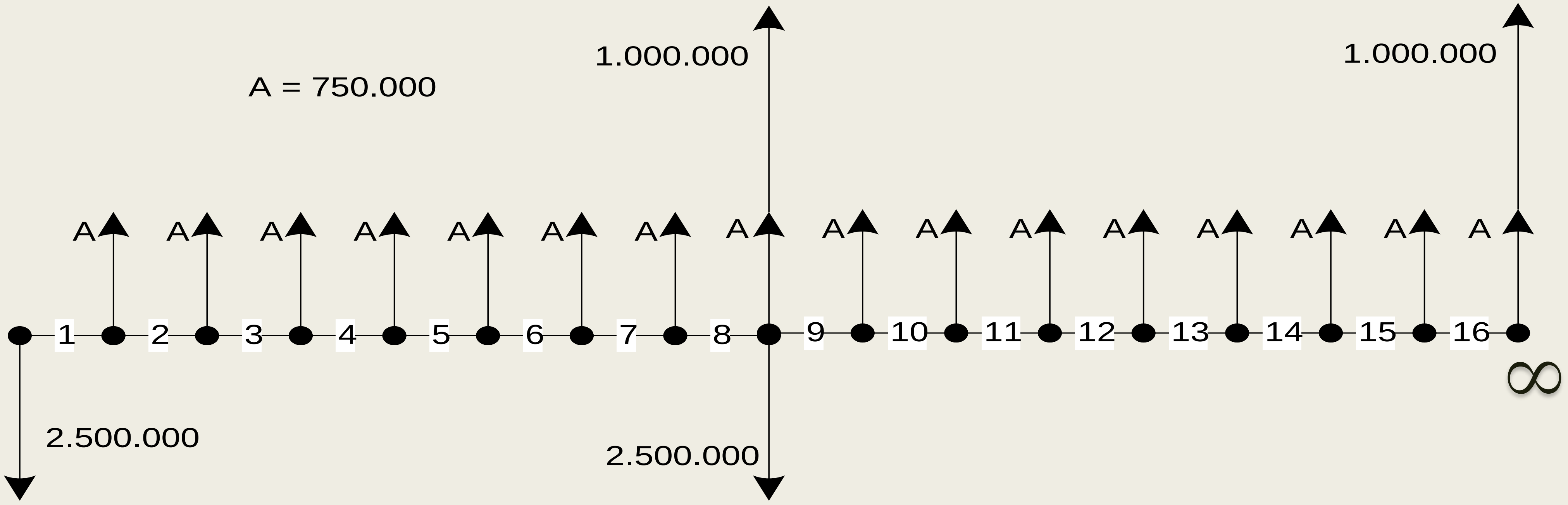
PW with capitalized cost (CC) analysis

A company purchase a machine to increase the productivity every year. 2 alternatives has been analyze with different useful life. **If the APR is 15%,** which machine the company should be purchased?

Machine	Useful life (years)	Initial investment	Annual Beneft	Salvage value
X	8	2.500.000	750.000	1.000.000
Y	9	3.500.000	900.000	1.500.000

Solution:

- Machine X:



$$CW = PW_{n \to \infty} = A(P/A, i, \infty) = A\,(1/i)$$

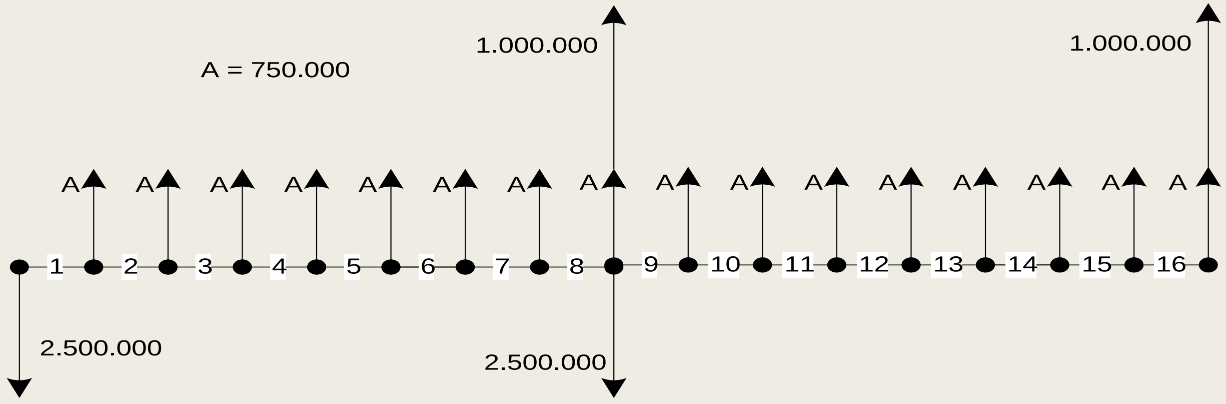
Machine X

Convert salvage value into Annual, however the next 2,5 million is present for the next period

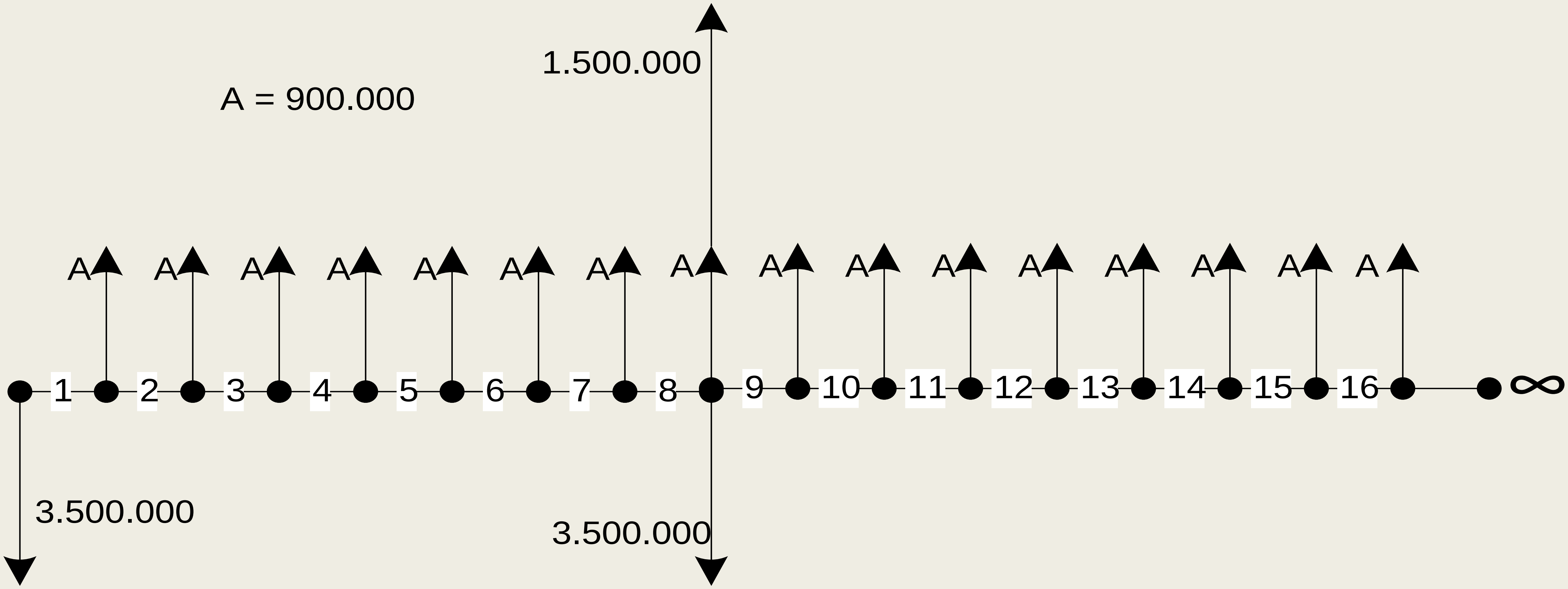
- $CW_X = 750.000(P/A,15\%,\infty) + \mathbf{1.000.000(A/F,15\%,8)}(P/A,15\%,\infty) - \mathbf{2.500.000(A/P,15\%,8)}(P/A,15\%,\infty) - 2.500.000$

- $CW_X = 750.000(1/0.15) + 1.000.000(0.07285)(1/0.15) - 2.500.000(0.22285)(1/0.15) - 2.500.000$

- $CW_X = 1.771.500 - 2.500.000$
- NPX = -728500



- Machine Y:



1.500.000
A = 900.000
A A A A A A A A A A A A A A A A
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 ∞
3.500.000
3.500.000

$$CW = PW_{n \to \infty} = A(P/A, i, \infty) = A\,(1/i)$$

Machine Y :

- CW_Y = 900.000(P/A,15%,∞) + 1.500.000(A/F,15%,9)(P/A,15%,∞) – 3.500.000(A/P,15%,9)(P/A,15%,∞)- 3.500.000
- CW_Y = 900.000(1/0.15) + 1.500.000(0.05957)(1/0.15) – 3.500.000(0.20957)(1/0.15)-3.500.000
- CW_Y = 1.705.733,33-3.500.000
- NPV=-1794266,67

Select machine X

Present Worth with Multiple Alternatives

Project owner hire a consultant expert worth to **$8000 for evaluating the inherited land as $30.000**. The consultant gives 4 options toward the land investment as follow:

Alternative	Total investment	Annual benefit	Residual value in 20 years useful life
A: Do nothing	$ -	$ -	$ -
B: plantation	50000	5100	30000
C: gas station	95000	10500	30000
D: Hotel	350000	36000	150000

If the APR 10%, which alternative should be taken?

Solution:

Alternative A : NPW = 0 (do nothing)

Alternative B (Plantation) :

NPW = -50000 + 5100(P/A,10%,20) +30000(P/F,10%,20)

= -50000 + 5100(8,514) + 30000(0,1486)

= -2120,6

Alternative C (Gas Station):

NPW = -95000 + 10500(P/A,10%,20) + 30000(P/F,10%,20)

= -1145

Alternative D (hotel) :

NPW = -350000 + 36000(P/A,10%,20) +150000(P/F,10%,20)

= -21206

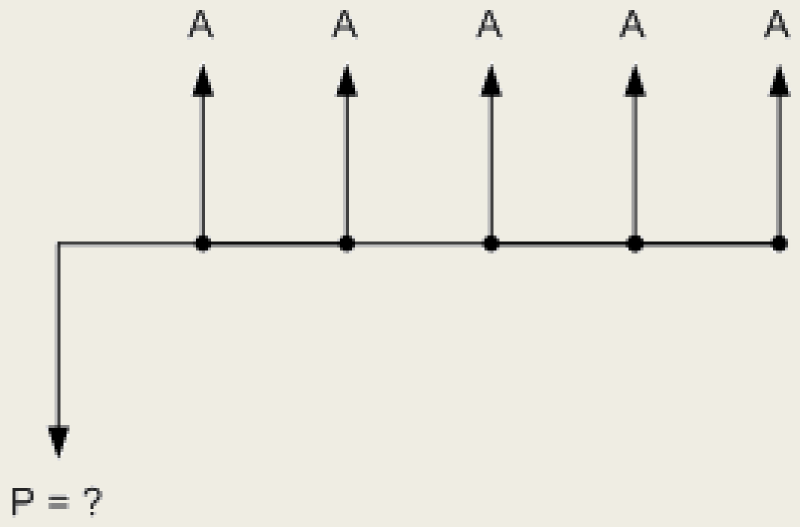
Select Alternative A, DO NOTHING

Do nothing alternative

- If none of the mutually exclusive alternatives are considered economically viable the “Do Nothing” alternative is accepted by default.

Present worth factor mostly used:

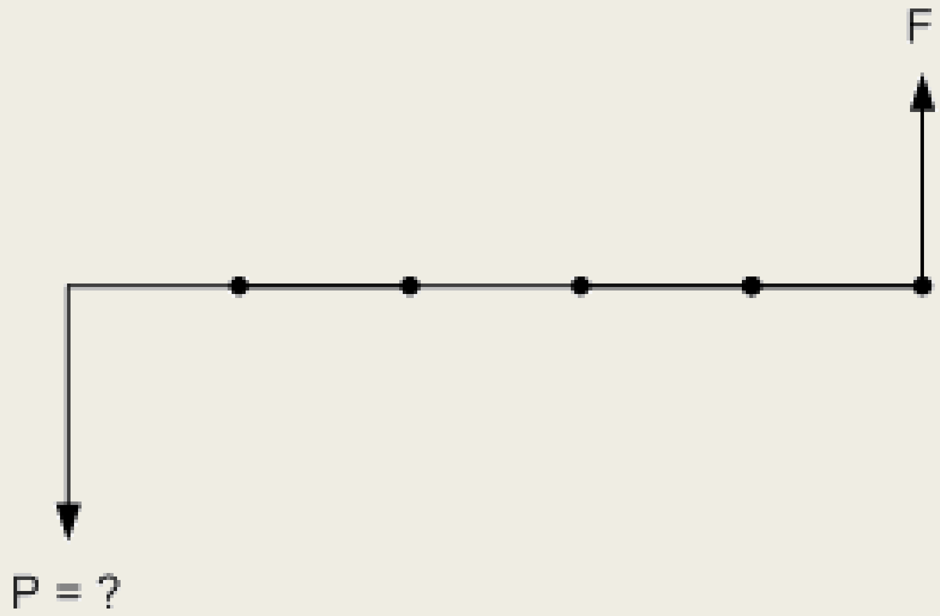
- $P = A\ (P/A,i,n)$



- Annual cost : operational cost, maintenance, tax, etc
- Annual benefit

Present worth factor mostly used:

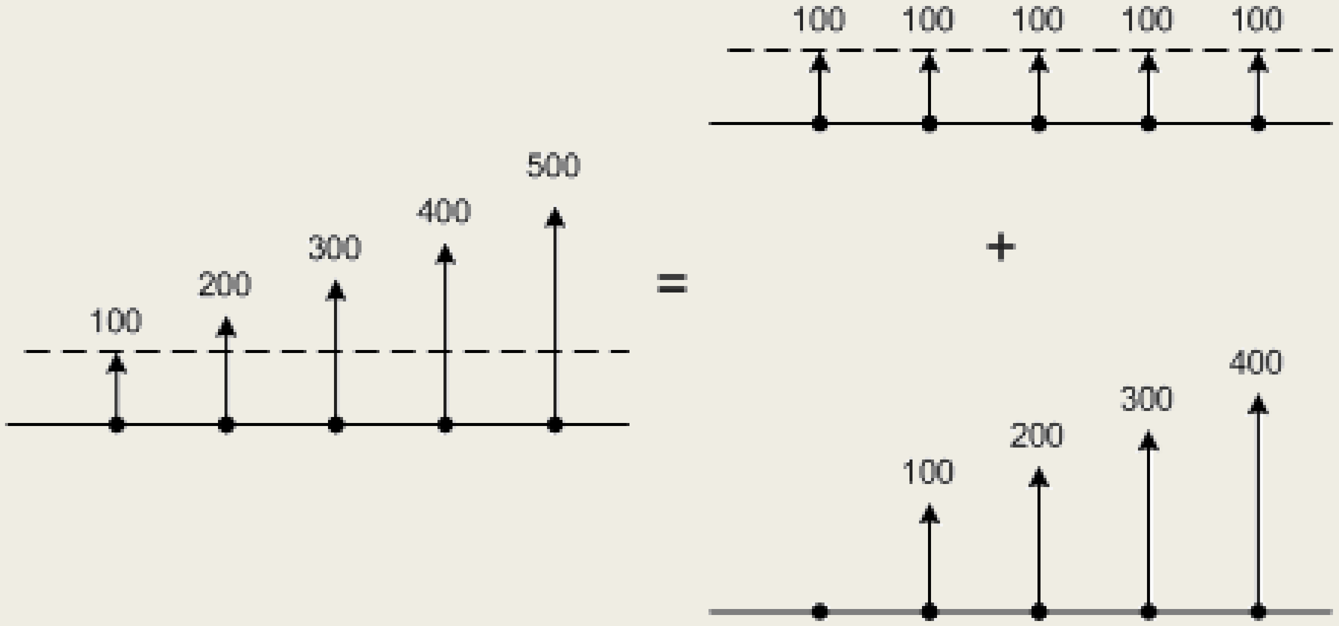
- $P = F\ (P/F,i,n)$



- Salvage Value

Present worth factor mostly used:

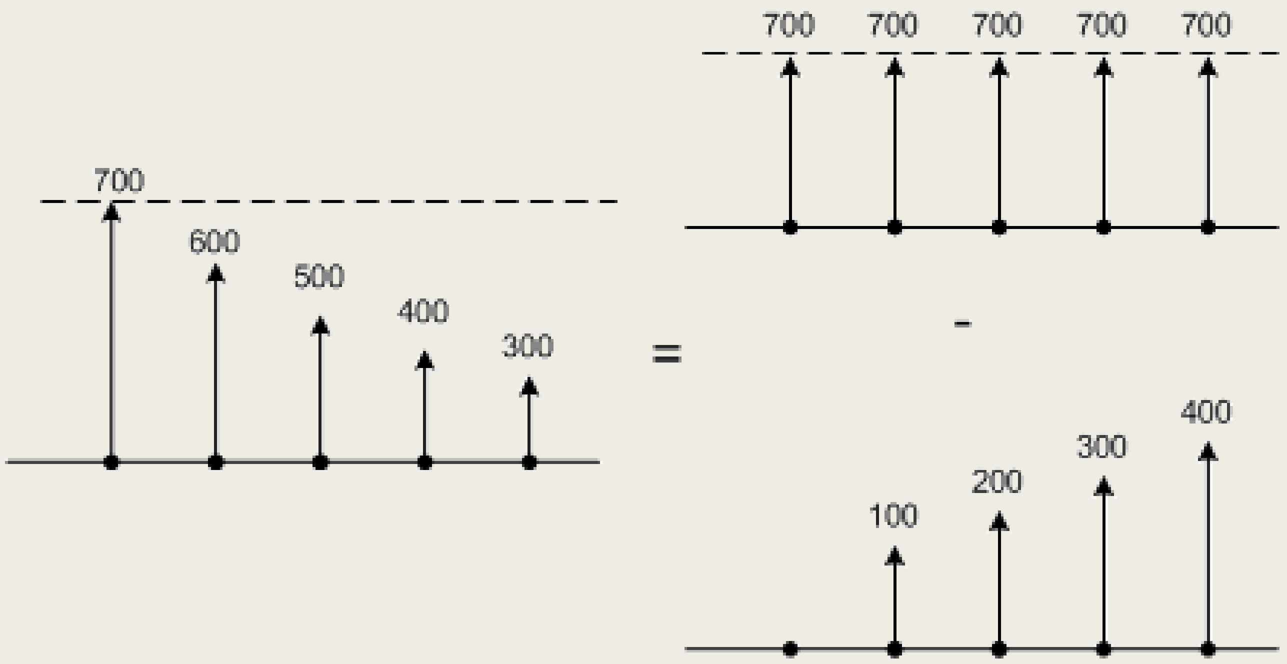
- $P = A(P/A,i,n) + G(P/G,i,n)$



- Annual cost or benefit is increasing

Present worth factor mostly used:

- P = A(P/A,i,n) - G(P/G,i,n)



- Annual cost or benefit is decreasing