Given: $USD := 1$

Consider a building whose annual air conditioning load is estimated to be 40,000 kWhr in an area where the unit cost of electricity is \$0.10/kWhr. Two air conditioners are considered for the building. Air conditioner A has a seasonal average COP of 2.3 and costs \$5,500 to install. Air conditioner B has a seasonal average COP of 3.6 and costs \$7,000 to install.

Required:

In how many years, will the total cost to install and operate be equal between the two conditioners?

Solution:

The estimated air conditioning load per year is defined as

$$Q'_L := 40000 \ \frac{kW \ hr}{yr} = 144 \ \frac{GJ}{yr}$$

The unit cost of electricity is defined as

$$R_{elec} := 0.10 \cdot \frac{USD}{kW \ hr}$$

The coefficient of performance of the two air conditioner units are defined as

$$COP_A := 2.3 \qquad COP_B := 3.6$$

The installation costs of the two air conditioner units are defined as

$$IC_A := 5500 \cdot USD \qquad IC_B := 7000 \cdot USD$$

The net work input of the two air conditioner units are found by

$$COP \equiv \frac{Q'_L}{W'_{netin}} \qquad \text{or} \qquad W'_{net,inA} := \frac{Q'_L}{COP_A} = 62.61 \ \frac{GJ}{yr}$$

$$W'_{net,inB} := \frac{Q'_L}{COP_B} = 40 \ \frac{GJ}{yr}$$

The operating cost per year of the two air conditioner units are found by

$$OC_A := R_{elec} \cdot W'_{net,inA} = 1739.13 \ \frac{USD}{yr}$$

$$OC_B := R_{elec} \cdot W'_{net,inB} = 1111.11 \ \frac{USD}{yr}$$

The cost savings per year of using air conditioner B instead of air conditioner A is given by

$$CS_{BA} := OC_A - OC_B = 628.02 \ \frac{USD}{yr}$$

The pay back period is then found by

$$\boxed{PBP := \frac{IC_B - IC_A}{CS_{BA}} = 2.388 \ yr}$$

So in $PBP = 2.388 \ yr$ air conditioner B will pay for it self as compared to air conditioner A.