IEMS 326, Homework 3, Due 2/2/2011

1. (From GRIN-ESW) At the start of 2011, Northwestern University installed a 5kW solar photovoltaic system on the Ford Design Center. The initial cost of the system was $30,000. Each year, the system generates 6,500kWh of electricity. The price of electricity is $0.10 per kWh. The system will last for 30 years.

a) Calculate the net present value of the solar photovoltaic system.
Answer:

$$C = 6500 \times 0.10 = \$650$$

$$\begin{aligned} NPV &= -\,installation\ \cos t + \frac{C}{r}\left(1-(1+r)^{-n}\right) \\ &= -30000 + \frac{650}{0.07}\left(1-(1+0.07)^{-30}\right) \\ &= -\$21{,}934 \end{aligned}$$

b) Now, say the state of Illinois provided a 60% rebate on the initial cost of the system. Calculate the new present value of the system.
Answer:

$$\begin{aligned} NPV &= -\,40\% \times installation\ \cos t + \frac{C}{r}\left(1-(1+r)^{-n}\right) \\ &= -12000 + \frac{650}{0.07}\left(1-(1+0.07)^{-30}\right) \\ &= -\$3{,}934 \end{aligned}$$

c) Keep the assumptions from question 2. Now, say a carbon cap and trade law is passed at the beginning of 2013, raising electricity prices. How much must the new price be for the system to be profitable.
Answer:

$$NPV = -\,40\% \times installation\ \cos t + \frac{650}{1+r} + \frac{650}{(1+r)^2} + \frac{\frac{p \times 6500}{r}\left(1-(1+r)^{-28}\right)}{(1+r)^2}$$

$$0 = -12000 + \frac{650}{1.07} + \frac{650}{1.07^2} + \frac{\frac{p \times 6500}{0.07}\left(1-(1.07)^{-28}\right)}{(1.07)^2}$$

$$p \approx \$0.157$$

2. Newnan et al., Chapter 6 Problem 27 (p. 204). You don't need to use an annual cash-flow analysis if you don't wish to.

Answer:
a) Let r=8%
Equivalent uniform annual cost (EUAC) =
$\$6000\frac{r}{(1-(1+r)^{-30})}$ +\$3000 for labor +\$200 for material-500 bales * \$2.30/bale -12 * \$200/month for trucker
=\$182.96
Therefore, it's not economical.

(Note that PV = -\$6000+ $(-\$3000-\$200+500*\$2.30+12*\$200)\frac{(1-(1+r)^{-30})}{r}$ =-\$2060 < \$0)

b) The need to recycle materials is an important intangible consideration. While the project does not meet the 8% interest rate criterion, it would be economically justified at a 4% interest rate.

3. Newnan et al., Chapter 6 Problem 46 (p. 207).
Answer:
Let r=10%

(a) 12-month tire EUAC = $\$39.95\frac{r}{(1-(1+r)^{-1})}$ =\$43.95

(b) 24-month tire EUAC = $\$59.95\frac{r}{(1-(1+r)^{-2})}$ =\$34.54

(c) 36-month tire EUAC = $\$69.95\frac{r}{(1-(1+r)^{-3})}$ =\$28.13

(d) 48-month tire EUAC = $\$90\frac{r}{(1-(1+r)^{-4})}$ =\$28.40

Buy the 36-month tire.

4. Newnan et al., Chapter 9 Problem 66 (p. 316).
Answer:
Let r=10%
The annual cost of the untreated part:
$\$350\frac{r}{(1-(1+r)^{-6})}$ =\$80.36

The annual cost of the treated part must be at least this low:
\$80.36 = $\$500\frac{r}{(1-(1+r)^{-n})}$ has the solution n=10.2.
For the treated part to be the preferred alternative, it should last at least 11 years (rounding up).

5. Newnan et al., Chapter 5 Problem 29 (p. 175).

Answer:

We need to find i such that $\$12000=\$250\frac{(1-(1+i)^{-60})}{i}$.

i=0.763% per month = 9.16% per year