# ENERGY ECONOMICS WORKSHEET

Equations for the time value of money:

- If we start with a monthly discount rate ($r_M$) and we want to find out the corresponding annual discount rate ($r_A$), or vice versa:
  $(1+ r_A) = (1+ r_M)^{12}$ or, $(1+ r_A)^{1/12} = (1+ r_M)$
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| Name | Converts | Equation |
|---|---|---|
| Present value | $F$ to $P$ | $\frac{1}{(1+i)^n}$ |
| Uniform series present value | $U$ to $P$ | $\frac{1-(1+i)^{-n}}{i}$ |
| Single payment compound amount | $P$ to $F$ | $(1+i)^n$ |
| Capital recovery | $P$ to $U$ | $\frac{i}{1-(1+i)^{-n}}$ |

1. If you want to make a quick, simple calculation of a new technology investment that will result in energy (and money) savings, you can calculate the simple payback:

$$\text{Simple Payback (yr)} = \frac{\text{Capital Cost (\$)}}{\text{Annual Energy Savings } (\frac{\text{kWh}}{\text{yr}}) \text{ x Energy Price } (\frac{\$}{\text{kWh}})}$$

2. Calculating the annualized power plant costs: Total cost ($/yr) = capital cost ($/yr) + fixed O&M ($/yr) + variable O&M ($/yr)
   a. Convert capital cost to annualized cost using $U_{capital} = P\left[\frac{r}{1-(1+r)^{-n}}\right]$, where P is present value, r is discount rate, and n is project lifetime.
   b. Calculate fixed O&M based on planned plant capacity.
   c. Calculate variable O&M based on expected energy production (Nameplate x Capacity factor x 8760 hrs/yr).
3. If you want to find lifetime cost of energy, then you can use your annualized total cost divided by expected annual energy production: $\text{LCE} = \frac{\text{Discounted annual costs}}{\text{annual energy production}} = \frac{\$}{kWh}$
4. If you want to find the cost for reducing CO2, for switching from a dirtier to a cleaner technology, you can calculate it as:
5. $Cost\ of\ conserved\ carbon = \frac{Annualized\ cost\ of\ old\ technology - annualized\ cost\ of\ new\ technology}{tons\ of\ CO2\ reduced}$

## *Example: building a wind farm*

- PNM will retire 836 MW of generation in 2017 at San Juan Generation Station. If the generation station currently has a capacity factor of 0.6, how much energy is produced by these units each year?

- How many tons of $CO_2$ is released each year (assume coal has an emission of 0.32 $kgCO_2/kWh$). Assume a power plant efficiency of 0.35.

- If PNM found a wind site that would have wind turbines operating with a capacity factor of 0.32, what installed capacity would be needed to replace the lost generation?

- An engineering company tells PNM that it can build the needed wind farm at a capital cost of 2.2 $/W, and O&M costs of 39.55 $/kW-yr. Find the annualized project cost, if it is assumed that PNM can borrow money at 8% over the expected 20 year lifetime of the project.

- Find the lifetime cost of energy for the project.

- Calculate the cost for the emission reduction, in terms of $/$tCO_2$

- Explain why PNM can't actually contemplate replacing the energy generated by the coal power completely with wind energy.