# NATIONAL UNIVERSITY OF SINGAPORE
Department of Electrical Engineering

EE4511
Tutorial 4

1. A 30 kW photovoltaic system on a building reduces the peak demand by 25 kW and reduces the annual electricity demand by 60,000 kWh/yr. The PV system costs $135,000 to install, has no annual maintenance costs, and has an expected lifetime of 30 years. The utility rate structure charges $0.07/kWh and $9/kW per month demand charge.

   a. What annual savings in utility bills will the PVs deliver?
   b. What is the internal rate of return on the investment with no escalation in utility rates?
   c. If the annual savings on utility bills increases 6% per year, what is the IRR?

2. A small, 10-kW wind turbine that costs $15,000 has a capacity factor of 0.25. If it is paid for with a 6-%, 20-year loan, what is the cost of electricity generated (¢/kWh)?

3. The cost of fuel for a small power plant is currently $10,000 per year. The owner's discount rate is 12 percent and fuel is projected to increase at 6% per year over the 30-yr life of the plant. What is the levelized cost of fuel?

4. A photovoltaic system that generates 8000 kWh/yr costs $15,000. It is paid for with a 6%, 20-year loan.
   a. Ignoring tax implications, what is the cost of electricity from the PV system?
   b. With local utility electricity costing 11¢/kWh, at what rate would that price have to escalate over the 20-year period in order for the levelized cost of utility electricity be the same as the cost of electricity from the PV system? Use the following figure and assume the buyer's discount rate is 15%.
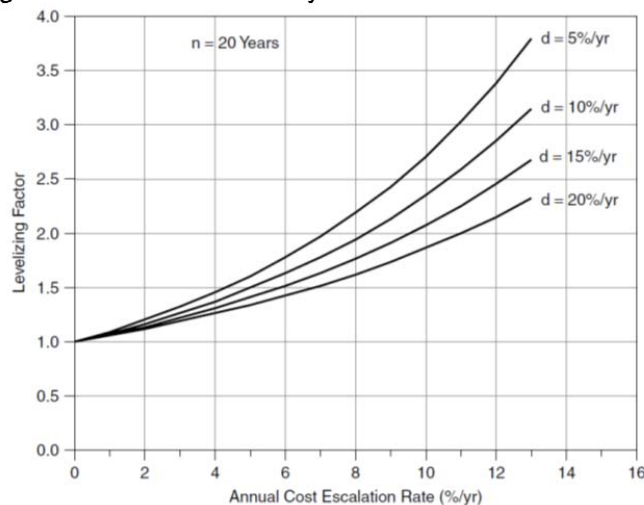
5. Consider the following energy conservation supply curve:

Thousand kWh/yr
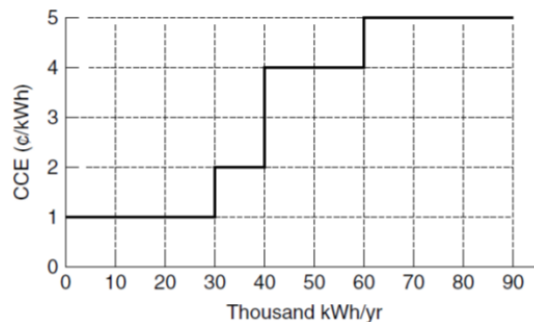
a. How much energy can be saved at a marginal cost of less than 3 ¢/kWh?
b. How much energy can be saved at an average cost of less than 3 ¢/kWh?

6. The owners of a small home in Singapore wish to install a 2 kW photovoltaic (PV) system with capacity factor 0.20. The cost of PV system is $8000 after various incentives have been accounted for. What would be the cost of electricity in the first year, if the owners take a 20-year loan for S$8000 at an interest rate of 5%?

7. Suppose that a customer subject to the rate structure shown below uses 1200 kWh/mo during the summer.
a. What would be the total cost of electricity ($/mo, ignoring the monthly service charge)?
b. What would be the value (¢/kWh) of an efficiency project that cuts the demand to 900 kWh/mo?

Tier Level	Winter: November–April		Summer: May–October	
Tier I	First 620kWh	7.378¢/kWh	First 700kWh	8.058¢/kWh
Tier II	621–825	12.995¢/kWh	701–1000	13.965¢/kWh
Tier III	Over 825	14.231¢/kWh	Over 1000	15.688¢/kWh

8. A customer's highest demand for power comes in August when it reaches 100 kW. The peak in every other month is less than 70 kW. A proposal to dim the lights for 3 h during each of the 22 workdays in August will reduce the August peak by 10 kW. The utility's energy charge is 8¢/kWh and its demand charge is $9/kW-mo with an 80% ratchet on the demand charges.
a. What is the current annual cost due to demand charges?
b. What annual savings in demand and energy charges will result from dimming the lights?
c. What is the equivalent savings expressed in ¢/kWh?