

Solution 1.CS

COST OF ELECTRICITY WITH RENEWABLE SOURCES ADDED

Background

Pedernales Electric Cooperative (PEC) is the largest member-owned electric co-op in the United States with over 232,000 members in 12 Central Texas counties. PEC has a capacity of approximately 1300 MW (megawatts) of power, of which 277 MW, or about 21%, is from renewable sources. The latest addition is 60 MW of power from a wind farm in south Texas close to the city of Corpus Christi. A constant question is how much of PEC's generation capacity should be from renewable sources, especially given the environmental issues with coal-generated electricity and the rising costs of hydrocarbon fuels.

Wind and nuclear sources are the current consideration for the PEC leadership as Texas is increasing its generation by nuclear power and the state is the national leader in wind farm-produced electricity.

Consider yourself a member of the board of directors of PEC. You are an engineer who has been newly elected by the PEC membership to serve a 3-year term as a director-at-large. As such, you do not represent a specific district within the entire service area; all other directors do represent a specific district. You have many questions about the operations of PEC, plus you are interested in the economic and societal benefits of pursuing more renewable source generation capacity.

Information

Here are some data that you have obtained. The information is sketchy, as this point, and the numbers are very approximate. Electricity generation cost estimates are national in scope, not PEC-specific, and are provided in cents per kilowatt-hour (¢/kWh).

Fuel Source	Generation Cost, ¢/kWh	
	Likely Range	Reasonable Average
Coal	4 to 9	7.4
Natural gas	4 to 10.5	8.6
Wind	4.8 to 9.1	8.2
Solar	4.5 to 15.5	8.8

National average cost of electricity to residential customers: 11¢/kWh

PEC average cost to residential customers: 10.27 ¢/kWh (from primary sources) and 10.92 ¢/kWh (renewable sources)

Expected life of a generation facility: 20 to 40 years (it is likely closer to 20 than 40)

Time to construct a facility: 2 to 5 years

Capital cost to build a generation facility: \$900 to \$1500 per kW

You have also learned that the PEC staff uses the well-recognized *levelized energy cost* (LEC) method to determine the

price of electricity that must be charged to customers to break even. The formula takes into account the capital cost of the generation facilities, the cost of capital of borrowed money, annual maintenance and operation (M&O) costs, and the expected life of the facility. The LCOE (levelized cost of electricity) formula, expressed in dollars per kWh for $(t = 1, 2, \dots, n)$, is

$$\text{LCOE} = \frac{\sum_{t=1}^n \frac{I_t + M_t + F_t}{(1+i)^t}}{\sum_{t=1}^n \frac{E_t}{(1+i)^t}}$$

where I_t = capital investments made in year t

M_t = annual maintenance and operating (M&O) costs for year t

F_t = fuel costs for year t

E_t = amount of electricity generated in year t

n = expected life of facility

i = discount rate (cost of capital)

Case Study Exercises

1. If you wanted to know more about the new arrangement with the wind farm in south Texas for the additional 60 MW per year, what types of questions would you ask of a staff member in your first meeting with him or her?
2. Much of the current generation capacity of PEC facilities utilizes coal and natural gas as the primary fuel source. What about the ethical aspects of the government's allowance for these plants to continue polluting the atmosphere with the emissions that may cause health problems for citizens and further the effects of global warming? What types of regulations, if any, should be developed for PEC (and other generators) to follow in the future?
3. You developed an interest in the LCOE relation and the publicized cost of electricity of 10.27¢/kWh for this year. You wonder if the addition of 60 MW of wind-sourced electricity will make any difference in the LCOE value for this next year. You did learn the following:

This is year $t = 11$ for LCOE computation purposes

$n = 25$ years

$i = 5\%$ per year

$E_{11} = 5.052$ billion kWh

LCOE last year was 10.22 ¢/kWh (last year's breakeven cost to customers)

From these sketchy data, can you determine the value of unknowns in the LCOE relation for this year? Is it possible to determine if the wind farm addition of 60 MW makes any difference in the electricity rate charged to customers? If not, what additional information is necessary to determine the LCOE with the wind source included?

Solution:

There is no definitive answer to case study exercises. The following is only an example.

Renewable Energy Sources for Electricity Generation

3. LCOE approximation uses $1/(1.05)^{11} = 0.5847$ and LCOE last year = 0.1022.

$$\text{Let } X_{11} = I_{11} + M_{11} + F_{11}$$

With the limited data, to estimate the value of X_{11} set the LCOE for year 11 equal to the consumer cost for year 10.

$$0.1027 = 0.1022 + \frac{(0.5847)X_{11}}{(0.5847)(5.052 \text{ billion})}$$

$$0.5847X_{11} = (0.0005)(2.9539 \text{ billion})$$

$$X_{11} = \$2.526 \text{ million}$$

If the sum of investments (I_{11}), M&O (M_{11}) and fuel (F_{11}) is significantly different than \$2.526 million, the breakeven value for year 11 may change. Next step is to find the values of I, M and F for year 11.