LCOE in SAM using FCR and Single Owner Financial Models

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SAM's LCOE Calculator financial model uses the fixed-charge rate (FCR) method to calculate the levelized cost of energy (LCOE):

$$LCOE = \frac{FCR \times TCC + FOC}{AEP} + VOC$$

Where TCC is the capital cost, FOC is the fixed operating cost, VOC is the variable operating cost, and AEP is the annual energy production in kWh.

SAM's LCOE Calculator allows you to provide the FCR as an input, or you can provide a set of financial parameters (analysis period, inflation rate, internal rate of return, etc.), and it calculates the FCR for you. For descriptions of model inputs and calculations, see the "LCOE Calculator" topic in SAM's Help system.

SAM's PPA Single Owner financial model calculates the LCOE from an annual cash flow:

$$LCOE = \frac{\dfrac{-C_0 - \sum_{n=1}^{N} C_n}{(1+d)^n}}{\dfrac{\sum_{n=1}^{N} Q_n}{(1+d)^n}}$$

Where C is the after-tax annual cost of the project, d is the annual discount rate, Q is the annual energy production in kWh, N is the analysis period in years, and n is the year. SAM determines the cash flow for each year from a set of financial inputs that determine the analysis period, inflation and discount rate, tax and insurance rates, debt options, construction financing costs, and reserve account funding. Because each of these may have different periods and escalation rates, and may vary non-linearly from year to year, the cash flow method must be carefully calibrated to be consistent with the FCR method.

When comparing the LCOE generated by the two methods, note the following:

- Compare real LCOE from the LCOE Calculator to the real levelized cost from the Single Owner model.
- The IRR and nominal discount rate inputs to the Single Owner model should be the same. This should result in an NPV equal to or very close to zero.
- NPV for the Single Owner model should be zero or slightly greater than zero. If the NPV is negative, the LCOE for the two methods will not be the same.
- IRR and IRR year in Single Owner results should be the same as IRR target and IRR target year inputs. In some cases the year IRR is achieved may be less than the target IRR year, in which case the LCOE for the two methods will not be the same.

To calibrate Single Owner inputs to be consistent with FCR method:

On Financial Parameters input page:

- Use Specify IRR target mode, use the same value for IRR target and nominal discount rate, and set the IRR target year to analysis period. Check results after simulation to be sure IRR and year IRR is achieved are the same as the input targets. Use the following equation to calculate the real discount rate input that results in a nominal discount rate equal to the internal rate of return:

$$d_{real} = \frac{1 + IRR}{1 + i} - 1$$

- Set PPA escalation rate to zero.
- Set sales tax, insurance rate, and property tax to zero. These costs can be accounted for in the annual O&M cost on the System Costs page.
- Set salvage value to zero.
- Choose the Debt Percent option with equal payments, and set tenor to analysis period. Set debt closing costs, up-front fee, and moratorium to zero.
- Set Cost of Acquiring Financing to zero.
- Set all reserve accounts to zero.

On Incentives input page:

- Set all incentives to zero.

On Depreciation input page:

- Set all allocations to zero, and clear all bonus depreciation and ITC qualification checkboxes. To model 5-yr MACRS, set its allocation to 100%.
- No reserve accounts
- For depreciation, 100% allocation to 5-yr MACRS

On System Costs page:

- Assign capital costs so that total installed is the same as the capital cost for the FCR method.
- For O&M costs, set all costs and escalation rates to zero. If the FCR method uses $/kW for the fixed operating cost, set fixed cost by capacity to that value. If the FCR method uses $, then use fixed annual cost. Set variable cost by generation to the FCR method's variable operating cost.

On Lifetime page:

- Set degradation rate to zero.

Table 1 Sample Comparison of Real LCOE for Two Methods

	FCR Method	Single Owner
No 5-yr MACRS, construction financing, or project debt	3.64	3.62
With project debt	2.60	2.70
With 5-yr MACRS	3.04	3.03
With construction financing	3.68	3.71
With project debt, 5-yr MACRS, construction financing	2.21	2.20