

DOE OFFICE OF INDIAN ENERGY

Levelized Cost of Energy (LCOE)



U.S. DEPARTMENT OF
ENERGY

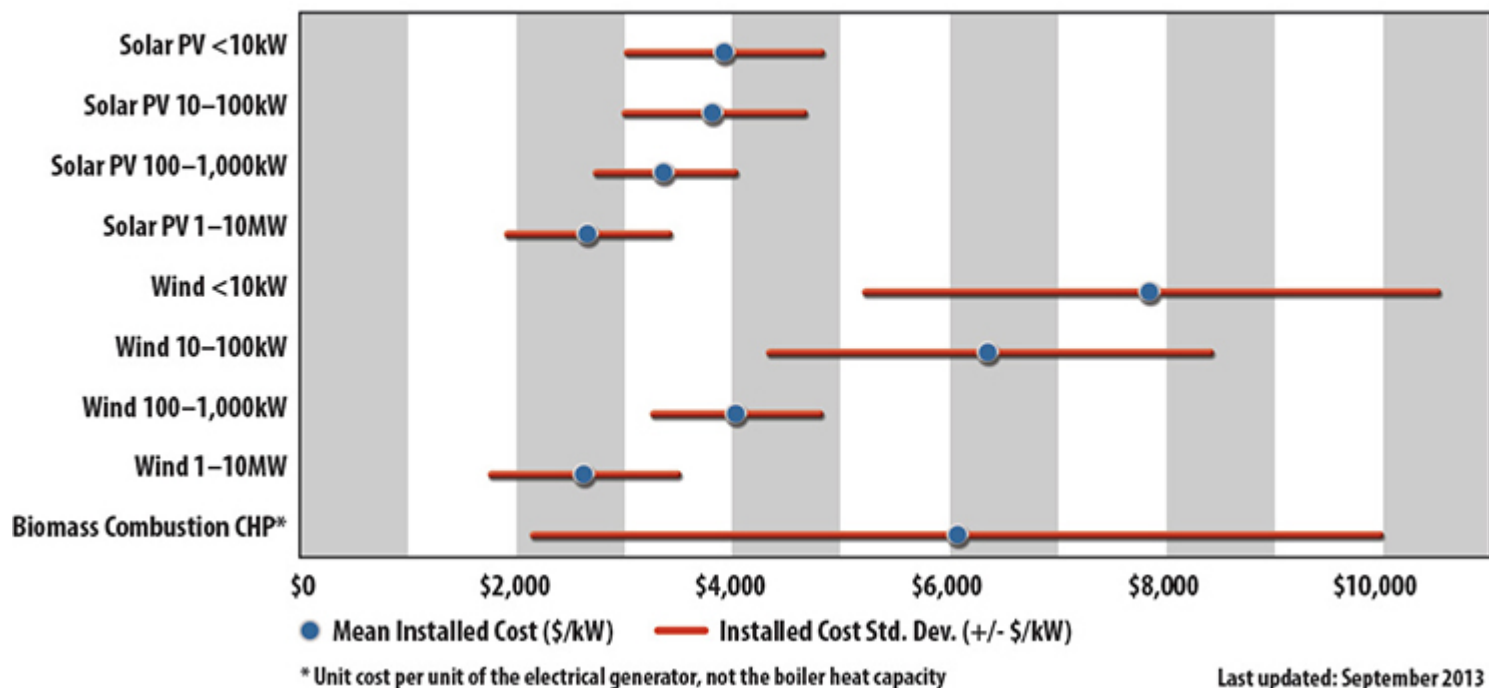
Office of
Indian Energy

Upfront Capital Costs for Renewables



Upfront costs do not paint a complete picture

Installed Costs



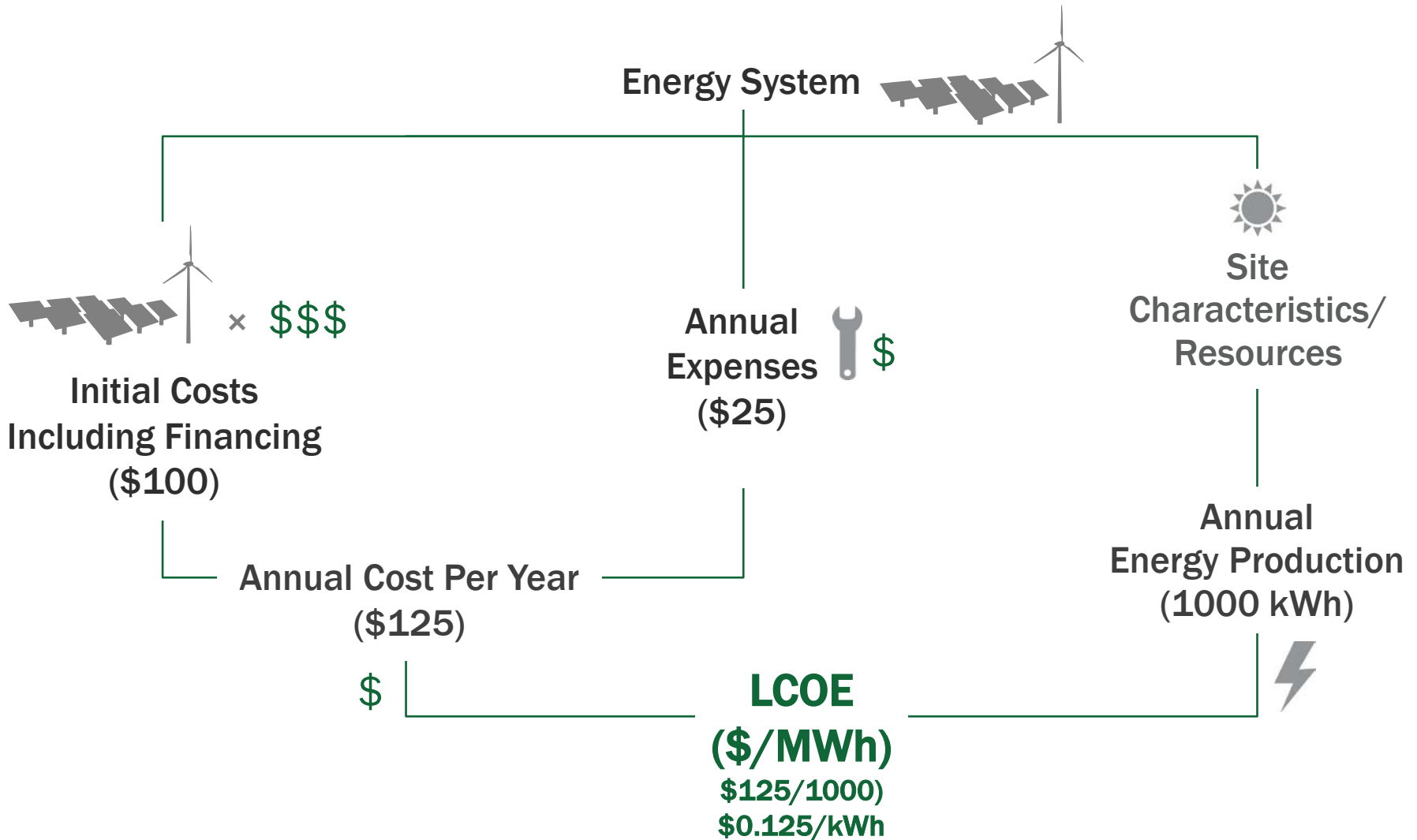
Key Concept: Levelized Cost of Energy (LCOE)



- Measures lifetime costs divided by energy production
- Calculates present value of the total cost of building and operating a power plant over an assumed lifetime.
- Allows the comparison of different technologies (e.g., wind, solar, natural gas) of unequal life spans, project size, different capital cost, risk, return, and capacities

Critical to making an informed decision to proceed with development of a facility, community or commercial-scale project

Simple LCOE Concept



Adapted from European Wind Energy Association, "Economics of Wind Energy,"

http://www.ewea.org/fileadmin/ewea_documents/documents/00_POLICY_document/Economics_of_Wind_Energy_March_2009_.pdf

Simplified LCOE Calculation

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

I_t = Investment expenditures in year t (including financing)

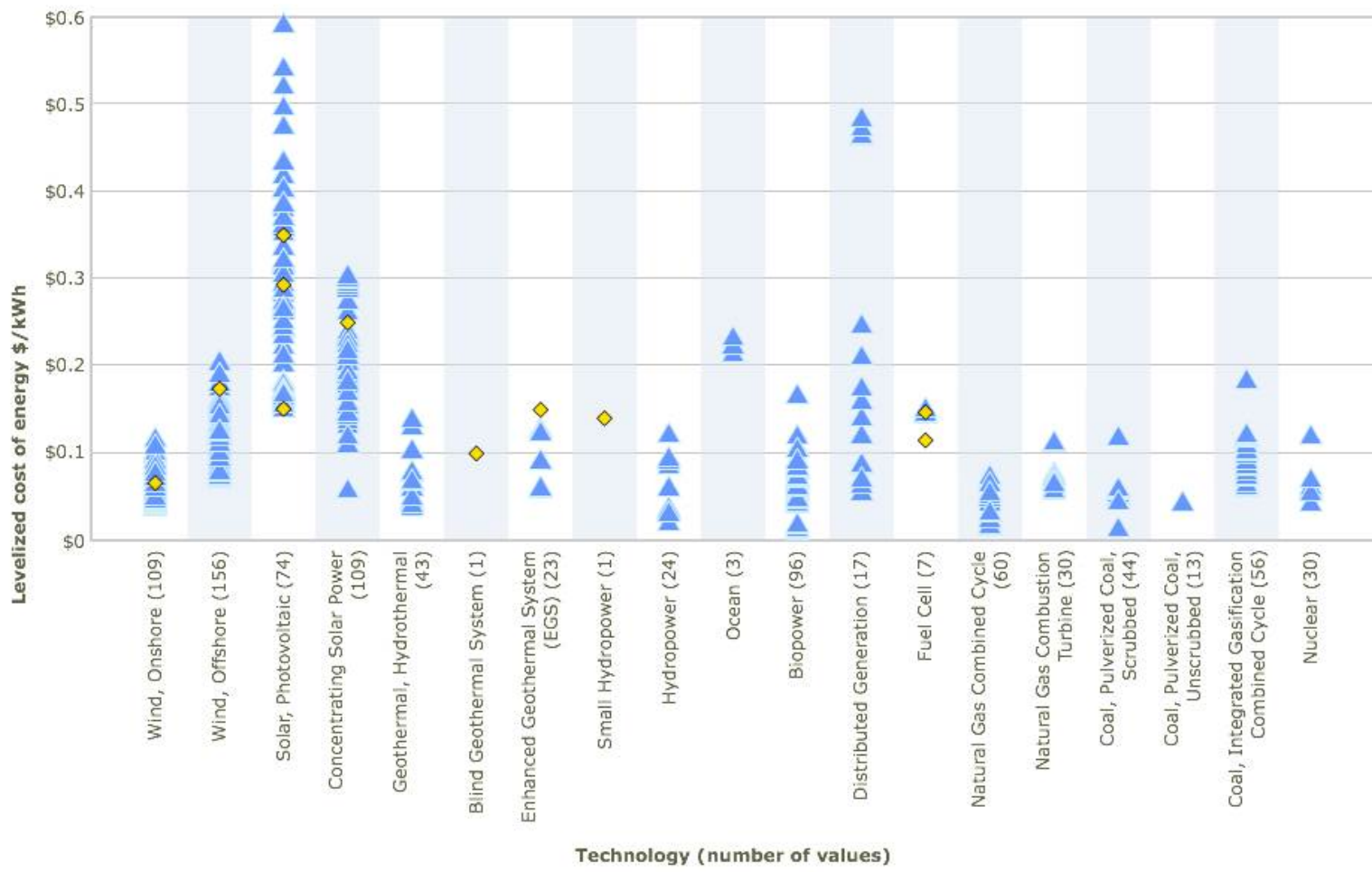
M_t = Operations and maintenance expenditures in year t

F_t = Fuel expenditures in year t

E_t = Electricity generation in year t

r = Discount rate

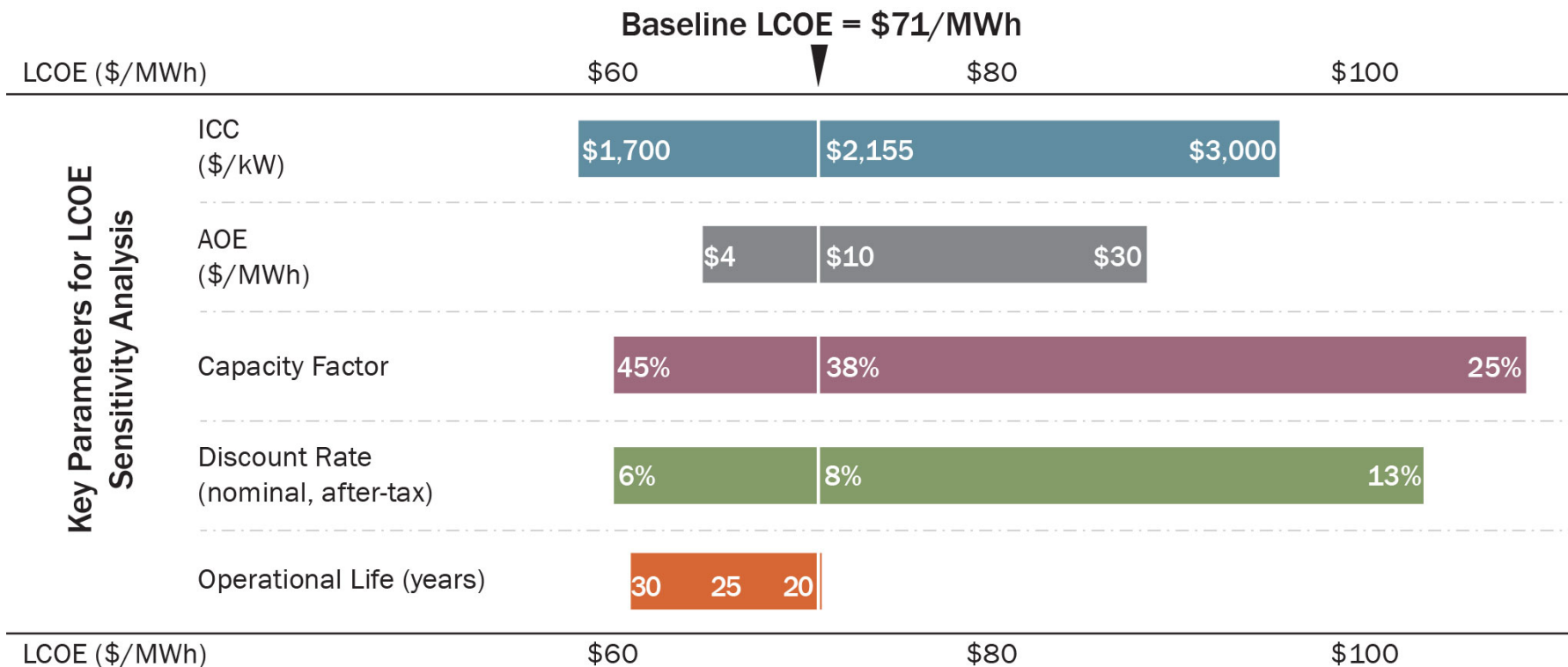
n = Life of the system



http://en.openei.org/wiki/Transparent_Cost_Database

Wind LCOE Sensitivity: What Are the Big Drivers?

Initial capital cost (ICC) and capacity factor are two critical drivers, but discount rate (financing costs) and annual operating expenses (AOE) are non-trivial. Wind LCOE example shown below:



Source: Tegen et al. 2012

LCOE Models

CREST

<https://financere.nrel.gov/finance/content/crest-cost-energy-models>

The screenshot shows the CREST spreadsheet interface with several input tables:

- Project Size and Performance:**

Generator Name/Type	Capacity	Units	Input Value
Generator Name/Type	Capacity	Units	Input Value
Net Capacity Factor	Select "State Average" or "Custom"	State Average	?
Net C.F. if "State Average" method. Then select state	CO	?	?
Net Capacity Factor, Yr 1		0.75	?
Production, Yr 1	kWh	3.10E+04	?
Annual Production Depreciation	%	0.00	?
Project Useful Life	years	25	?
- Capital Costs:**

Select Cost Level of Detail	Units	Input Value
Select Cost Level of Detail	Units	Input Value
Total Installed Cost	\$/kW ac	\$2.68
- Operations & Maintenance:**

Select Cost Level of Detail	Units	Input Value
Select Cost Level of Detail	Units	Input Value
Fixed O&M Expense, Yr 1	\$/kW ac	\$2.00
Variable O&M Expense, Yr 1	\$/kWh	0.00
O&M Cost Inflation, initial period	%	1.00
Initial Period ends last day of	year	00
O&M Cost Inflation, thereafter	%	1.00
- Cost-Based Tariff Rate Structure:**

Payment Duration for Cost-Based Tariff	Units	Input Value
Payment Duration for Cost-Based Tariff	years	25
% of Year-One Tariff Rate Escalated	%	0.00
Cost-Based Tariff Escalation Rate	%	0.00
- Federal Incentives:**

Select Form of Federal Incentive	Units	Input Value
Select Form of Federal Incentive	Units	Input Value
Investment Tax Credit (ITC) or Cash Grant?	Cost-Based	?
ITC or Cash Grant Amount	%	30%
ITC utilization factor, if applicable	%	100%
ITC or Cash Grant	\$	\$0
- State Rebates, Tax Credits and/or REC Revenue:**

Select Form of State Incentive	Units	Input Value
Select Form of State Incentive	Units	Input Value
	Neither	?

LCOE Calculator

http://www.nrel.gov/analysis/tech_lcoe.html

The screenshot shows the NREL LCOE Calculator web interface with the following inputs and results:

- Renewable Energy System Cost and Performance:**
 - Capital Cost (\$/kW): 1050
 - Capacity Factor (%): 43.6
 - Fixed O&M Cost (\$/kW-yr): 0.00
 - Variable O&M Cost (\$/kWh): 0.00
 - Heat Rate (Btu/kWh): 10000
 - Fuel Cost (\$/MMBtu): 0
- Today's Utility Electricity Cost:**
 - Electricity Price (cents/kWh): 12
 - Cost Escalation Rate (%): 3.0
- Results:**
 - Levelized Cost of Utility Electricity (cents/kWh): []
 - Simple Levelized Cost of Renewable Energy (cents/kWh): []

How are these numbers calculated? See [documentation](#)

Did you find what you needed?
 Yes No

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

Using LCOE

Calculating and comparing LCOE can:

- Measure value across the longer term, showing projected life-cycle costs
- Highlight opportunities for Tribes to develop different scales of projects (facility, community, or commercial)
- Inform decisions to pursue projects on an economic basis, compared to utility rates

Most renewable energy projects have zero fuel costs (with biomass being the possible exception)