

DOE OFFICE OF INDIAN ENERGY

Levelized Cost of Energy (LCOE)



U.S. DEPARTMENT OF
ENERGY

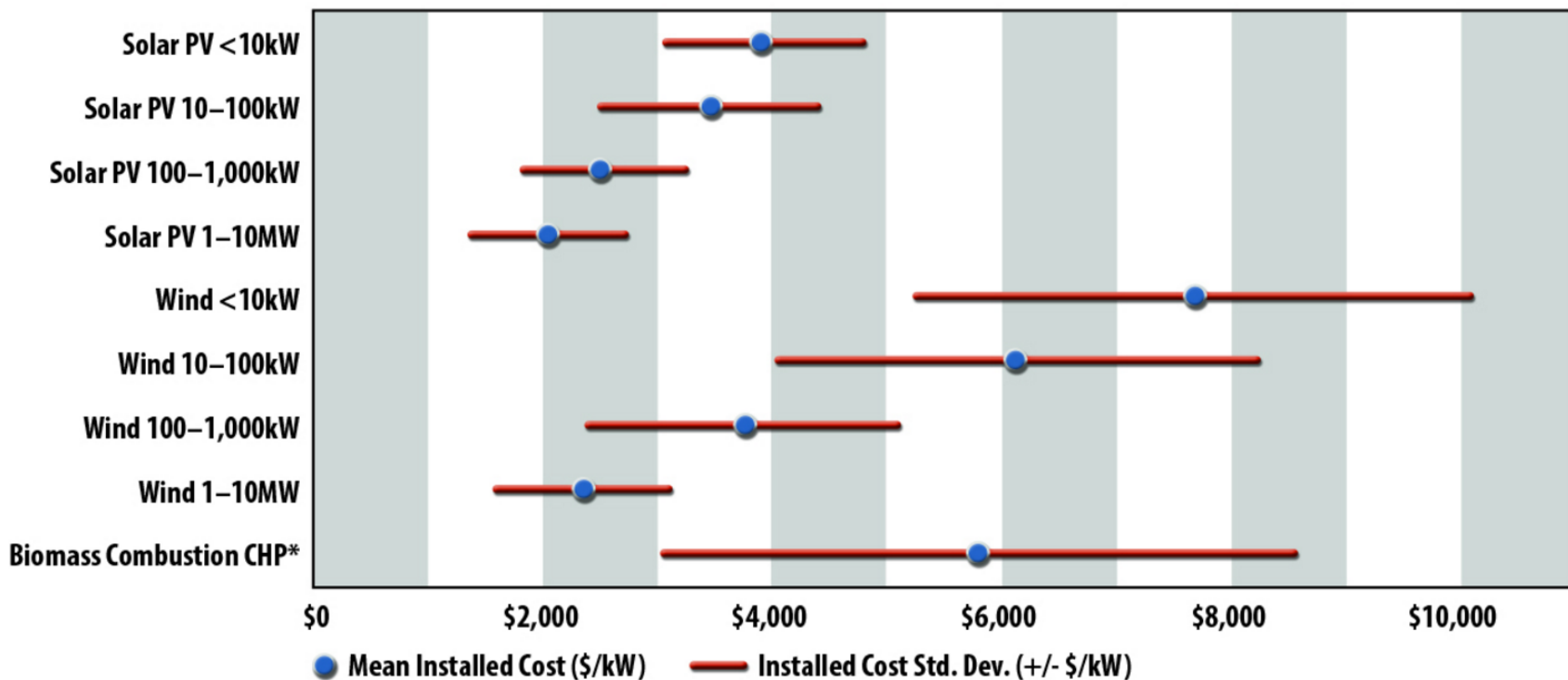
Office of
Indian Energy

Upfront Capital Costs for Renewables



Not a complete picture

Installed Costs



* Unit cost per unit of the electrical generator, not the boiler heat capacity

Last updated: February 2016

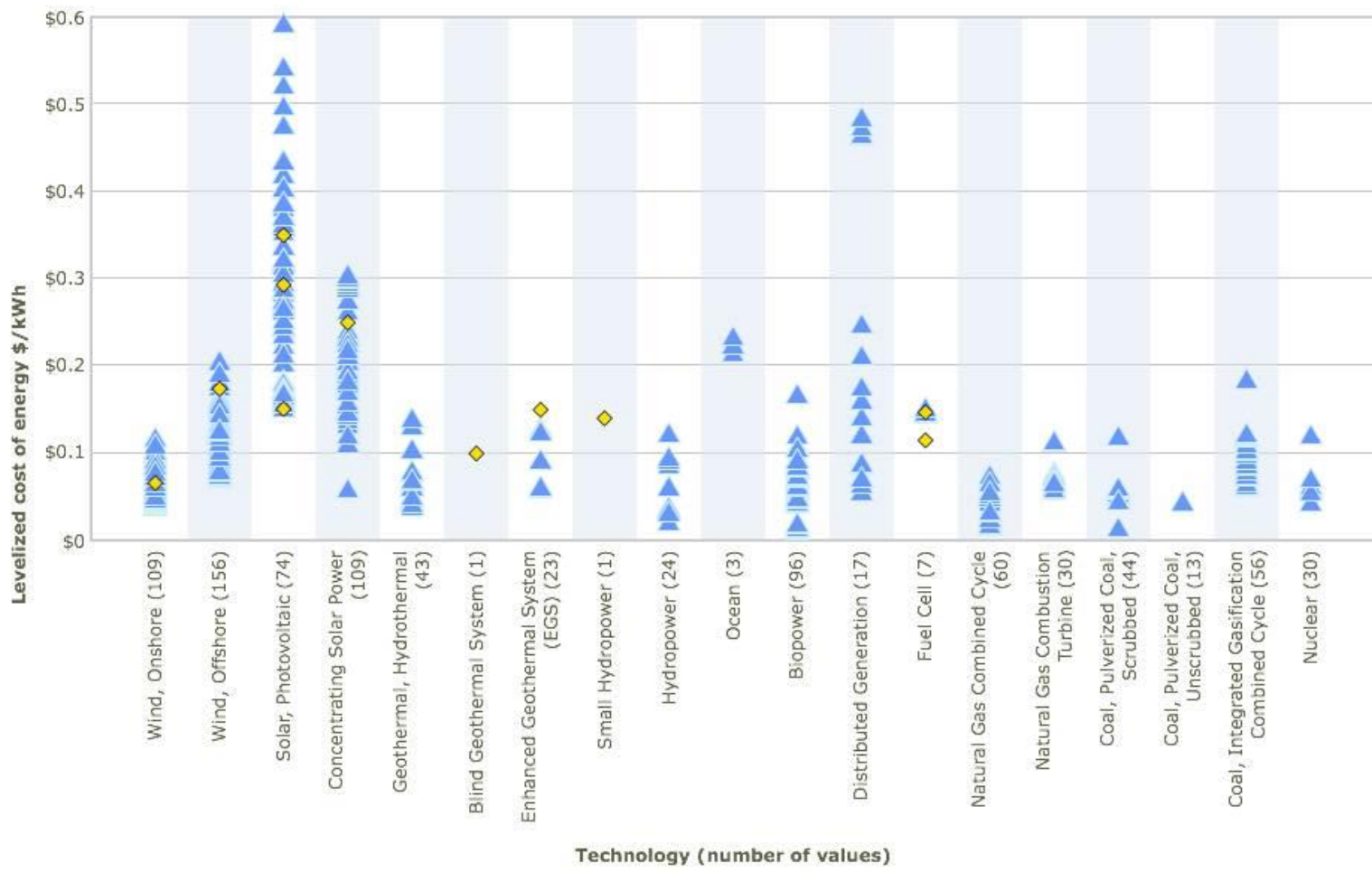


Key Concept: Levelized Cost of Energy (LCOE)



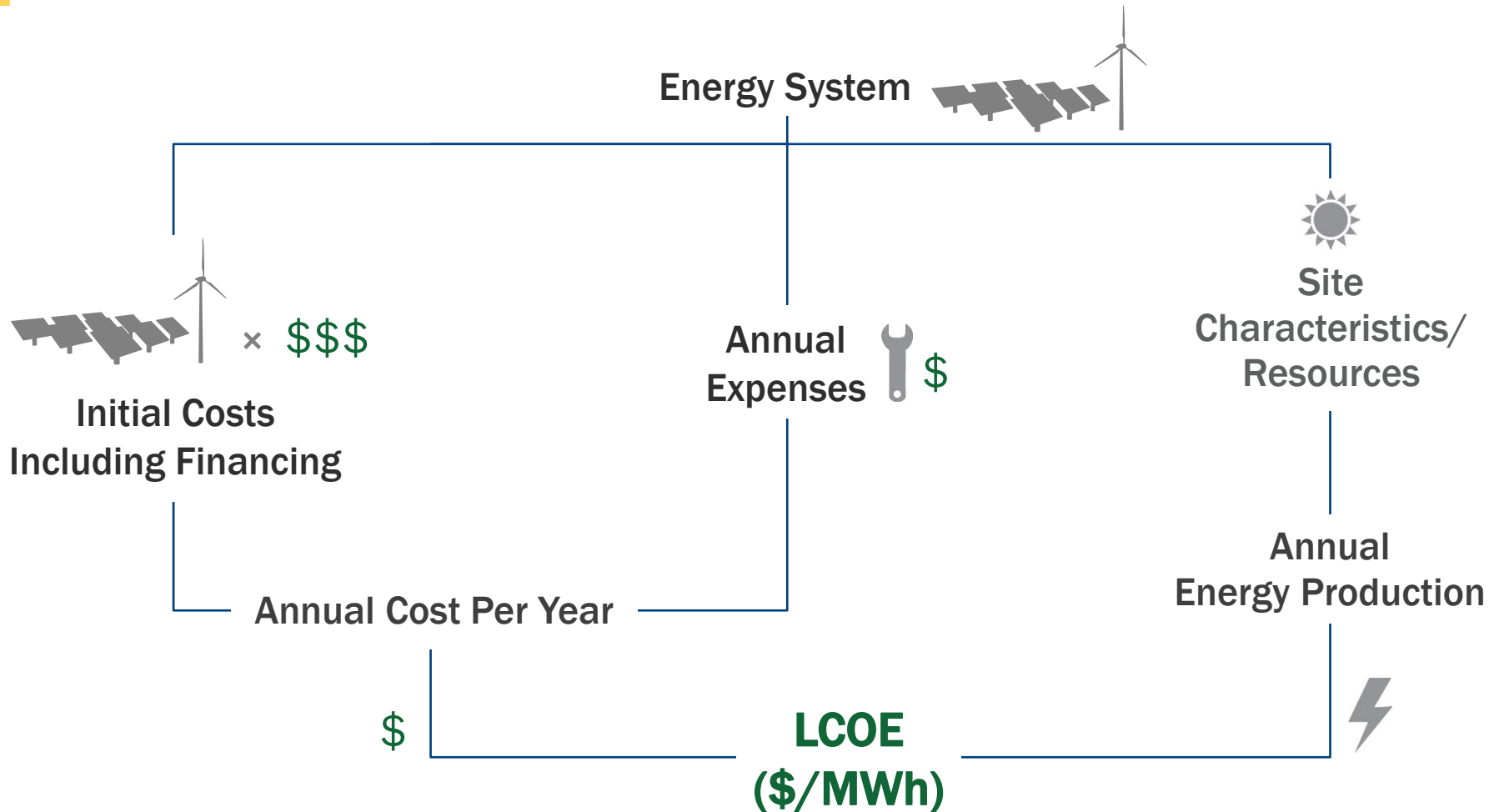
- Measures lifetime costs divided by energy production
- Calculates present value of the total cost of building and operating a power plant over an assumed lifetime. Expressed in real or nominal dollars on a megawatt-hour (MWh) or kilowatt-hour (kWh) basis
- Allows the comparison of different technologies (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



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

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

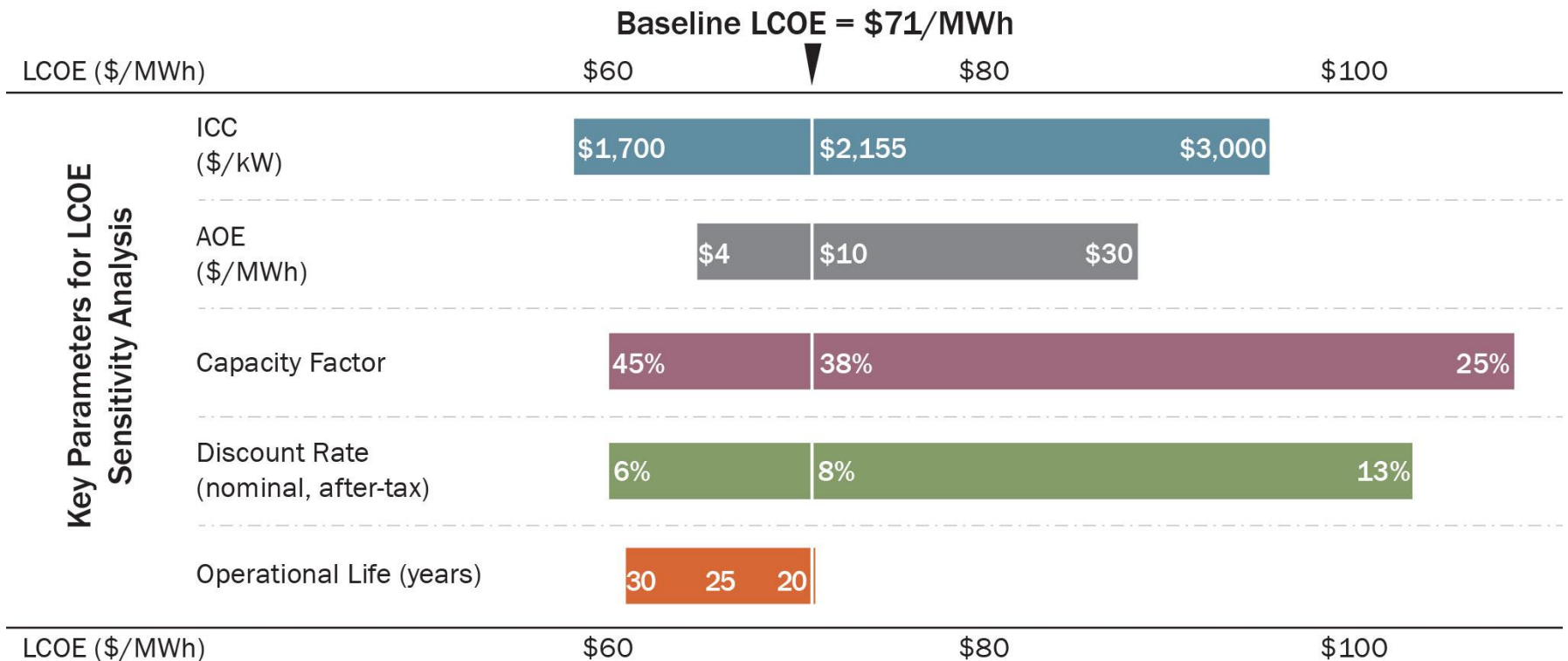
E_t = Electricity generation in year t

r = Discount rate

n = Life of the system

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. The 'Performance, Cost, Operating, Tax & Financing Inputs' section includes:

- Selected Technology:** Photovoltaic
- Project Size and Performance:**
 - Generator Nameplate Capacity: 2,000 MW dc
 - Net Capacity Factor: State Average
 - Net C.F.: CO
 - Net Capacity Factor, Yr 1: 0.7%
 - Production, Yr 1: 3,101,354 kWh
 - Annual Production Degradation: 0.0%
 - Project Useful Life: 25 years
- Capital Costs:**
 - Total Installed Cost: \$1.50 \$/Watt dc
 - Total Installed Cost (before rebates/grants, if any): \$5,000,000
 - Total Installed Cost (before rebates/grants, if any): \$2,500
- Operations & Maintenance:**
 - Fixed O&M Expense, Yr 1: \$6.00 \$/kW-yr dc
 - Variable O&M Expense, Yr 1: 0.00 \$/kWh
 - O&M Cost Inflation, initial period: 1.0%
 - Initial Period ends last day of: 10 year
 - O&M Cost Inflation, thereafter: 1.0%

LCOE Calculator

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

The screenshot shows the NREL Energy Analysis LCOE Calculator web interface. The 'Renewable Energy System Cost and Performance' section includes:

- Capital Cost (\$/kW): 1050
- Capacity Factor (%): 13.6
- Fixed O&M Cost (\$/kW-yr): 5
- Variable O&M Cost (\$/kWh): 0.002
- Heat Rate (Btu/kWh): 10000
- Fuel Cost (\$/MMBtu): 5

The 'Today's Utility Electricity Cost' section includes:

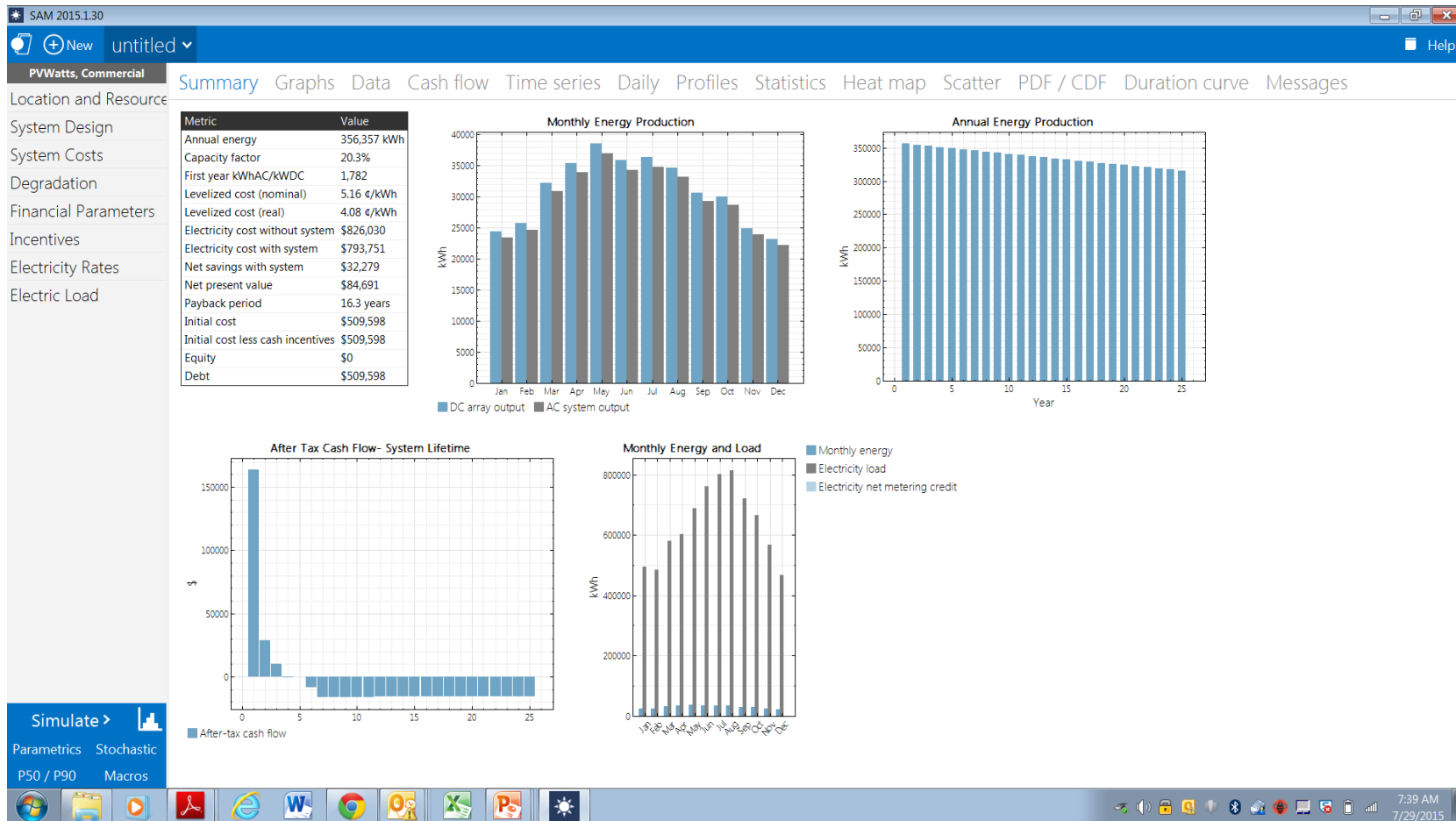
- Electricity Price (cents/kWh): 12
- Cost Escalation Rate (%): 3.0

The 'Results' section shows:

- Levelized Cost of Utility Electricity (cents/kWh): []
- Simple Levelized Cost of Renewable Energy (cents/kWh): []

At the bottom, it states: "How are these numbers calculated? See [documentation](#)".

System Advisor Model (SAM)



<https://sam.nrel.gov/>

Using LCOE

Calculating and comparing LCOE can:

- Measure value across the longer term, showing probable 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)

Some Caveats with LCOE

- Just because it has a lower lifetime cost, doesn't mean you can afford to buy it.
- Very interest rate sensitive
- Doesn't capture all risks or necessarily factor in benefits of diversification.
 - Higher LCOE could be the better choice than a lower LCOE in certain instances.
 - Access to fuel and spare parts
 - Volatility in fuel prices