Homework 2 Energy project economics

1. Installing solar is not an easy decision

Background

Mr. XYZ lives in Stony Brook, and installed a rooftop solar system in July 2021. Now he has one-year's system operation data, and please go through the following questions to discuss if this is a good investment for Mr. XYZ.

Questions

1. Learn to use PVWatts to simulate the monthly and annual generation of a distributed PV system. Please use the below system information: Location: 11794
   DC Systems Size(kW): 6.4
   All other parameters use defalt settings
   Please compare your simulated monthly results with actual system daily generation data over a year, compare the monthly generation and annual generation and show the margin of error in each month and annual sum (**1pt**). Discuss the risks/uncertainties to use simulation results to make purchase desision (**1pt**)?

2. Calculate the simple payback time (in years, no discounting) of the solar system assuming the following (**0.5pt**):
   System costs (including panel and installation): $14,000
   State tax rebate: 25% (with a maximam of $5,000) of system costs
   Federal tax credit: 26% of system costs
   Household average monthly electricity payment before installation: $140
   Household monthly PV system connection fee (cost): $15
   What's the payback time without the State and Federal tax credit (**0.5pt**)?

3. Now taking into acount of discounting:
   Annual discount rate: 5%
   Mr. XYZ got bank loan to pay half of the system costs: Annual Percentage Rate (4%). Monthly payment for two years.
   Mr. XYZ would received the tax credit in April during the tax filing month the following year.
   Use July 2021 as the baseline month.
   What's the payback time (in months) (**1pt**)?

4. Building on question 3 and now calculating the leverized cost of electricity of Mr. XYZ's system (**1pt**)
   The system life time: 25 years
   Assume an annual system degradation rate: 1% (meaning each year its annual total generation is 1% less than previous year)
   Comparing your results with PSEG Long Island's residential electricity rate (on average 21.22 cents/kWh in 2020).

5. Now think about more nuanced considerations when making intallation decisions (using simple payback time or describe qualitatively) if:
   Mr. XYZ found that his roof is too old and he has to replace the roof before installation (cost: $11,000) (**0.5pt**)

Mr. XYZ noticed that a big tree nearby created too much shade for the panel and is debating if he should cut the tree down (cost: $3000, and will lose a loving green space) (**0.5pt**)
Mr. XYZ had checked with the insurance company that the attachment of PV would impact the insurance policy (**0.5pt**)
Mr. XYZ will potentially move and sell the house in two years, how will that impact the investment decision (**0.5pt**)
Mr. XYZ can sell extra electricity back to the grid as in California's case (**0.5pt**)
Mr. XYZ can only bank extra generation and will pay market rate if generation can not cover consumption as in New York's case (**0.5pt**)

Further modeling practice

Learn to use NREL's System Advisory Model (SAM) to do more nuanced simulations.

- Downlod the software
- Follow the instuction
- Get the weather data of nearest location
- Using default parameters to simulate hourly generation
- Try to play with the specific parameters to get familiar with the software

2. A tale of two nuclear plants

Background

Please read the story of the Shoreham Nuclear Power Plant and the Diablo Canyon Power Plant. One plant never commerically operated and was decommisioned and the rate-payers are still paying the construction costs, while the other is offered to extend operation in the midist of California's clean energy quest.

Questions

1. How long does it take for Long Island residents to pay off the construction and decommission of Shoreham Nuclear Power Plant? (Bad energy investment decisions have drastic consequences) (**1pt**)

Key assumptions: LILCO attaches a **3 percent** surcharge to LI electric bills for 30 years to pay off the nuclear facility's approximately **$6 billion** price tag in 1989.
Residential rates in 2020: **21.22 cents/kWh**
Total electricity consumption in 2020: **20 TWh**
Discount rate: **4%**
Assuming the real value of total annual surcharge stays the same. You can use 2020 as a base year, and convert the 6 billion price tag to 2020 value, and then divided by the 2020 total surcharges.

2. Diablo Canyon generated nearly 9 percent of Cailifornia's electricity last year and roughly 15 percent of the State's clean energy production. Diablo Canyon Power Plant is granted a 5 year extention beyond its scheduled shutter at 2025. What's the LCOE of Diablo Canyon Power Plant in its extended operation period (2026-2030)? (**1pt**)

Key assumptions: **1.4** billion forgivable loans
Nameplate capacity: **2,256 MW**
Capacity factor: **80%**
Discount rate: **4%**

Further readings

Get to understand what composites the 6 billion price tag, and what are the hidden costs? Check the political economy of the energy policy and investment decisions.

New York Times, June 19, 1983. How Long Island Will Pay For Shoreham

Timothy Bolger and Christopher Twarowski, June 11, 2009, Nuclear Waste: 20 Years After Shoreham's Closure

Nathan Rott, September 1, 2022. California lawmakers extend the life of the state's last nuclear power plant

Rai, Reeves, and Margolis (2016), Yu et al. (2018), Hultman, Koomey, and Kammen (2007).

References

Hultman, Nathan E., Jonathan G. Koomey, and Daniel M. Kammen. 2007. "What History Can Teach Us about the Future Costs of u.s. Nuclear Power." *Environmental Science & Technology* 41 (7): 2087–94. https://doi.org/10.1021/es0725089.

Rai, Varun, D. Cale Reeves, and Robert Margolis. 2016. "Overcoming Barriers and Uncertainties in the Adoption of Residential Solar PV." *Renewable Energy* 89 (April): 498–505. https://doi.org/10.1016/j.renene.2015.11.080.

Yu, Jiafan, Zhecheng Wang, Arun Majumdar, and Ram Rajagopal. 2018. "DeepSolar: A Machine Learning Framework to Efficiently Construct a Solar Deployment Database in the United States." *Joule* 2 (12): 2605–17. https://doi.org/10.1016/j.joule.2018.11.021.