MSCE in Energy Infrastructure

Brief on Energy Financial Terminology

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Introduction

This brief will cover the basics associated with financial models and terminology associated with energy projects with a specific focus on renewable energy.

Project Financial Models

Three financial types for electrical generation projects:

- **Residential and commercial projects** that buy and sell electricity at retail rates and displace purchases of power from the grid.
- **Third party owners** who install, operate, and own a system that benefits a property owner (or customer) either by a lease or power purchase agreement (PPA).
- **PPA projects** that sell electricity at a wholesale rate to meet internal rate of return requirements. There are more options to the PPA financial model. These are:
  - Single owner (utility)
  - Partnership Flip
  - Sale leaseback

Residential and Commercial Projects

Residential and commercial projects are typically smaller than 500 kW.

The rate structure may include any of the following:

- Flat buy and sell rates (with or without net metering)
- Time-of-use energy charges

• Monthly demand charges (either fixed or time-of-use)
• Tiered rates
• Fixed monthly charges

Third Party Owners

The third-party ownership model calculates the net present value of a renewable energy system installed on a residential or commercial property. The property owner, or customer, makes an agreement with a third party who installs, operates, and owns the system. The system reduces the customer's electricity bill, and the customer makes payments to the third-party owner for the system.

Power Purchase Agreement—Single Owner

The PPA financial models are typically appropriate for large-scale projects because of the costs. In the Single Owner model, one entity owns the project and has sufficient tax liability to utilize the tax benefits. This structure is less complicated than the Partnership Flip and Sale Leaseback structures because there is no need to allocate cash and tax benefits to different partners. The owner may be either the original developer or a third-party tax investor that purchases the project from the developer.

Financial Terminology

Project Costs

Project costs vary widely depending on the type of energy project infrastructure being built. The list below was developed for the EIA and represents the “cost and performance characteristics of new central station electricity generating technologies.” [EIA, “Cost and Performance Characteristics of New Generating Technologies, Annual Energy Outlook 2023,” March 2023]. It illustrates a range of costs but of specific interest are base overnight costs ($/kW).

Technology	First available year[a]	Size (MW)	Lead time (years)	Base overnight cost[b] (2022$/ kW)	Techno-logical optimism factor[c]	Total overnight cost[d,e] (2022$/kW)	Variable O&M[f] (2022$/ MWh)	Fixed O&M (2022$/ kWy)	Heat rate[g] (Btu/kWh)
Ultra-supercritical coal (USC)	2026	650	4	$4,507	1.00	$4,507	$5.06	$45.68	8,638
USC with 30% carbon capture and sequestration (CCS)	2026	650	4	$5,577	1.01	$5,633	$7.97	$61.11	9,751
USC with 90% CCS	2026	650	4	$7,176	1.02	$7,319	$12.35	$67.02	12,507
Combined-cycle—single-shaft	2025	418	3	$1,330	1.00	$1,330	$2.87	$15.87	6,431
Combined-cycle—multi-shaft	2025	1,083	3	$1,176	1.00	$1,176	$2.10	$13.73	6,370
Combined-cycle with 90% CCS	2025	377	3	$3,019	1.04	$3,140	$6.57	$31.06	7,124
Internal combustion engine	2024	21	2	$2,240	1.00	$2,240	$6.40	$39.57	8,295
Combustion turbine—aeroderivative[h]	2024	105	2	$1,428	1.00	$1,428	$5.29	$18.35	9,124
Combustion turbine—industrial frame	2024	237	2	$867	1.00	$867	$5.06	$7.88	9,905
Fuel cells	2025	10	3	$6,771	1.08	$7,291	$0.66	$34.65	6,469
Nuclear—light water reactor	2028	2,156	6	$7,406	1.05	$7,777	$2.67	$136.91	10,447
Nuclear—small modular reactor	2028	600	6	$7,590	1.10	$8,349	$3.38	$106.92	10,447
Distributed generation—base	2025	2	3	$1,915	1.00	$1,915	$9.69	$21.79	8,912
Distributed generation—peak	2024	1	2	$2,300	1.00	$2,300	$9.69	$21.79	9,894
Battery storage	2023	50	1	$1,270	1.00	$1,270	$0.00	$45.76	NA
Biomass	2026	50	4	$4,996	1.00	$4,998	$5.44	$141.50	13,500
Geothermal[i,j]	2026	50	4	$3,403	1.00	$3,403	$1.31	$153.98	8,881
Conventional hydropower[j]	2026	100	4	$3,421	1.00	$3,421	$1.57	$47.06	NA
Wind[e]	2025	200	3	$2,098	1.00	$2,098	$0.00	$29.64	NA
Wind offshore[i]	2026	400	4	$5,338	1.25	$6,672	$0.00	$123.81	NA
Solar thermal[i]	2025	115	3	$8,732	1.00	$8,732	$0.00	$96.10	NA
Solar photovoltaic (PV) with tracking[e, i, k]	2024	150	2	$1,448	1.00	$1,448	$0.00	$17.16	NA
Solar PV with storage[i, k]	2024	150	2	$1,808	1.00	$1,808	$0.00	$32.42	NA

Data source: Sargent & Lundy, Cost and Performance Estimates for New Utility-Scale Electric Power Generating Technologies, December 2019; Hydroelectric: Oak Ridge National Lab, An Assessment of Energy Potential at Non-Powered Dams in the United States, 2012, and Idaho National Engineering and Environmental Laboratory, Estimation of Economic Parameters of U.S. Hydropower Resources, 2003; Geothermal: National Renewable Energy Laboratory, Updated U.S. Geothermal Supply Curve, 2010.
Note: MW=megawatt, kW=kilowatt, MWh=megawatthour, kWy=kilowattyear, kWh=kilowatthour; Btu=British thermal unit
[a] The first year that a new unit could become operational.
[b] Base cost includes project contingency costs.

Debt Percent
The debt percent (%) is the size of debt as a fraction of the installed cost, adjusted to account for project costs, fees and incentives. For example, if a project is worth $100 million and the debt is $60 million, then the debt percent = 60%. The higher the percentage the greater the risk to the company or project.

Debt Service Coverage Ratio (DSCR)
The DSCR is the ratio of cash available to meet annual interest and principal payments on debt. A higher ratio is better. Banks might wish to set a minimum ratio or the minimum DSCR. A DSCR below 1.0 indicates that there is not enough cash flow to cover loan payments.

DSCR = (Annual Net Operating Income) / debt services.

Discount Rate
There are multiple ways that the discount rate can be defined and three will be noted. Fundamentally…it is a measure of the time value of money as an annual rate.
For our purposes, a reasonable definition is: "An interest rate used to determine the present value of future cash flows." The discount rate can be set multiple ways.

The term "discount" does not refer to the common meaning of the word, but to the meaning in computations of present value. A **current dollar** analysis requires the use of a **nominal discount rate**, and a **constant dollar** analysis requires the use of a **real discount rate**.

Three types of discount rates. (1) The **Federal discount rate** is an administered rate set by the boards of the Federal Reserve Banks and it is not a market rate [not used for energy projects], (2) **Project-related discount rates**, many companies use their weighted average cost of capital **(WACC)** if the project's risk profile is like that of the company. Broadly, the WACC = cost of equity + the cost of debt as a rate [This type of rate can apply to energy projects.], and (3) The discount rate at which **pension plans and insurance companies discount their liabilities**. [Does not directly apply to energy projects]

LCOE analyses (to be defined shortly) by IRENA assume a weighted average cost of capital (WACC) for a project of 7.5% (real). This rate was used in their analyses for OECD countries and China and represents the discount rate. Borrowing costs are relatively low in these countries, while stable regulatory and economic policies tend to reduce the perceived risk of renewable energy projects. For the rest of the world, a WACC of 10% is assumed. These assumptions are average values, but the reality is that the cost of debt and the required return on equity, as well as the ratio of debt to equity, varies between individual projects and countries. This can have a significant impact on the average cost of capital and the LCOE of renewable power projects.

A decrease in the discount rate makes it cheaper for commercial banks to borrow money, which results in an increase in the supply of money in the economy. Conversely, a higher discount rate will make it more expensive for the banks to borrow and decreases the money supply.

Internal Rate of Return (IRR)
The IRR is a rate of return to measure and compare the profitability of investments. The term internal refers to the fact that its calculation does not incorporate factors such as the interest rate or inflation.

Because the IRR is a rate quantity, it is an indicator of the efficiency, quality, or yield of an investment. This is in contrast with the net present value (NPV), which is an indicator of the value or magnitude of an investment.

An investment is considered acceptable if its IRR is greater than an established minimum acceptable rate of return or cost of capital.

Caveats about IRR. Some suggest when IRRs have a rate > 10% above the cost of capital (say the IRR = 18% and cost of capital = 8%) be extra cautious about the use of IRR in decision-making. Since IRR is a rate, small projects might appear to be more attractive than larger scale projects. The caution is which project has more risk?

Net Present Value
The NPV of a project is the value of all future cash flows (C_n), discounted at the discount rate (r), in today's currency over the life of the project (N). The following formula can be used to do the calculation:

$$NPV = \sum_{n=0}^{N} \frac{C_n}{(1+r)^n}$$

A positive net present value indicates an economically feasible project, while a negative net present value indicates an economically infeasible project.

The above equation can also be used to illustrate IRR. Just set the NPV = 0 and r = IRR:

$$0 = \sum_{n=0}^{N} \frac{C_n}{(1+IRR)^n}$$

C_n= cash flow for year "n" (includes both negative (such as construction costs) and income (such as the sale of electricity)).
IRR = the discount rate that causes the NPV of the project to = 0.
n = payment periods (typically years)
N = total number of periods (or the project life.)

Power Purchase Agreement (PPA)
Corporations (the buyer) commonly get their electricity from utilities (the seller). This model has worked well globally…and still does…but…there is no or limited long-term price certainty and, in more recent years, no control over the source of power generated and delivered…particularly if the corporation wishes to acquire only renewable generated power.

One alternative is a PPA which allows the purchase of electricity directly or indirectly from the renewable energy generator. The buyer can directly offtake the electricity or virtually…details follow.

A PPA is a contract between two parties, one who generates electricity (the seller) and one who is looking to purchase electricity (the buyer). The PPA defines all of the commercial terms for the sale of electricity between the two parties, including when the project will begin commercial operation, schedule for delivery of electricity, penalties for under delivery, payment terms, and termination. Contractual terms may last anywhere between 5 and 25 years. The contract length is typically a bit shorter than the expected lifetime of the project.
The PPA is often regarded as the central document in the development of independent electricity generating assets (power plants).

It is important to know that it is common for three (or four) parties to be involved in a PPA. The PPA typically focuses on the "generation" or generator and the buyer of the electricity (a city, county, company, etc). However, it is important to at least appreciate that the electricity will be carried by transmission and distribution lines—and the owners of these lines may not be either the generator or buyer and compensated for their services.

Levelized Cost of Electricity (LCOE)
The levelized cost of energy (LCOE) allows alternative generation technologies to be compared when different scales of operation, different investment and operating time periods, or both exist. Simply stated: the levelized cost of any particular energy technology is the break-even price that companies investing in that technology need in order to see a competitive rate of return. For example, the LCOE could be used to compare the cost of energy generated by a renewable resource with that of a standard fossil-fueled generating unit.

The LCOE for generating electricity is the total cost of installing and operating a project expressed in $/kWh (or $/MWh) of electricity generated by the system over its life. It accounts for:

- Installation costs
- Financing costs
- Taxes
- Operation and maintenance costs
- Salvage value
- Incentives (such as tax incentives)
- Revenue requirements (for utility financing options)
- Quantity of electricity the system generates over its life

Basically, the cost to build and operate a power plant ÷ total power output.

Incentives

There are generally three sources for financial incentives for renewable energy projects:

- Federal
- State
- Local

The primary incentive programs by the federal government focus on two types for renewable energy projects:

- The **investment tax credit (ITC)** which is an upfront credit against the capital expense used to build a project (typically associated with solar projects), and
- The **production tax credit (PTC)** is a credit over time based on the amount of energy produced (typically associated with wind projects).

The investment tax and production tax credits for renewables got their start during the George H.W. Bush administration with the Energy Policy Act of 1992. The goal then was to place emphasis on alternative energy sources vs fossil fuels. Over the last 30 years, the PTC has been extended 13 times. It might help to know that incentives have been part of our national landscape since the 1800s. An example is the federal government providing rights of way and substantial land to railroads to expand their systems westward…which also aided energy…namely the shipment of coal throughout the US. This contributed to reduced wood burning once coal was broadly available.

The federal incentives are likely the best known, but a listing of all known incentives is contained in the DESIRE database.

Useful Websites

- Database of State Incentives for Renewables & Efficiency (DESIRE) database, https://www.dsireusa.org/
- EIA Glossary, https://www.eia.gov/tools/glossary/index.php?id=A
- Investopedia Dictionary, https://www.investopedia.com/financial-term-dictionary-4769738
- NREL System Advisor Model (SAM)—Financial Models, https://sam.nrel.gov/financial-models.html
- UW MSCE Energy Infrastructure, https://www.energy-infrastructure.uw.edu/