

Power Generation Tariff Design



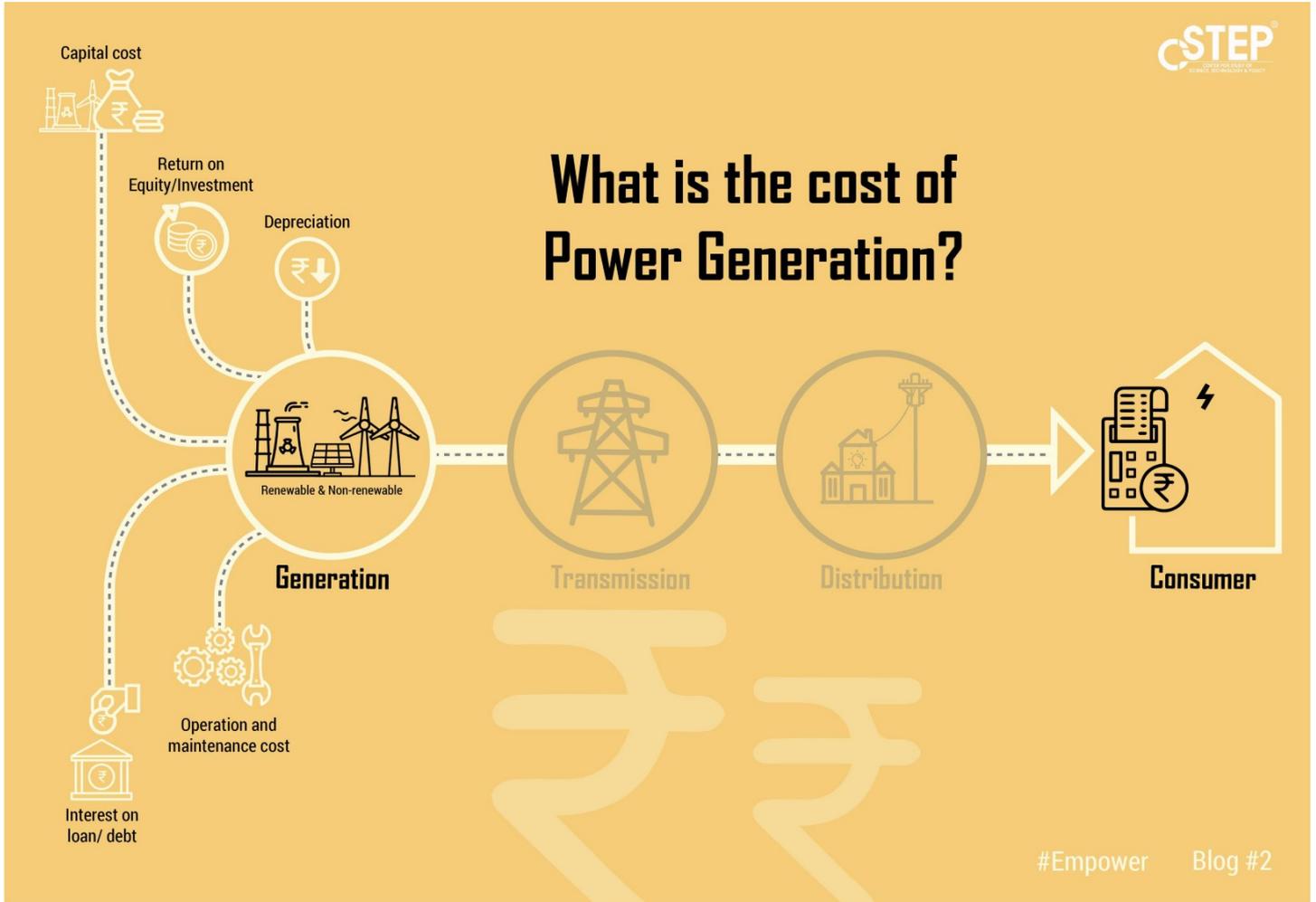
Center for Study of Science, Technology and Policy

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CSTEP launched the Empower series of blog articles to simplify the power sector for non-technical readers. Through the series, we hope to explain how every step of the electricity journey affects the consumer. In the first article, we introduced you to the many actors involved in the electricity journey. In this article, the second of the series, the author explains the costs involved in generation of electricity (the first step of the journey) that is finally reflected in the consumers power bill. We hope you enjoy reading it.

The power sector is a composite group of institutions that work together in a supply chain, to provide reliable and affordable electricity to us — the end-consumers. The setup primarily includes power-generation, transmission, and distribution. Generating companies (GENCOs) produce power and transmit it — over long distances through transmission lines — to distribution companies (DISCOMs). DISCOMs transfer the electricity to our homes, offices, and industries via a system of distribution lines/feeders and transformers. Generating companies incur the cost of generating power, which needs to be recovered through revenue from customers.



Our electricity bills reflect the total cost incurred on generation, transmission, and distribution of power. In this blog, we discuss the costs associated with the electricity generation process. Each of the cost elements of a generating plant are categorised as either fixed cost or variable cost. These two major categorisations affect the final tariff the buyer (DISCOM / end consumer) pays in each billing cycle.

The fixed cost of a plant is recovered within a particular time period, annually. It remains quite stable for each year. As the fixed cost is charged per megawatt (MW) of contracted capacity, it reflects as the minimum fixed payment in the billing. On the other hand, variable costs include those generation expenses that are dependent on numerous external factors such as fuel price, transportation cost, inflation, and government policies. Therefore, it affects the final tariff significantly. Let us look at the composition of both cost elements in detail.

1. Fixed Cost

The fixed element comprises:

- a. **Capital Cost:** It includes the cost of land, construction, machinery, and manpower. The cost amount is predefined, according to the technology used (such as thermal, hydro, nuclear, solar photovoltaic, or wind power).
- b. **Interest on loan/debt:** The finance for constructing the plant is arranged mainly through two sources: loan/debt from bank and equity/net worth of the generator. The GENCO has to pay interest on the debt (plant-development loan and working-capital loan), which is considered part of the fixed cost (as it is a fixed annual payment).
- c. **Return on Equity/Investment (RoE/RoI):** To earn capital returns on the investment made by the GENCO, the regulatory commission permits GENCOs to recover some percentage (approx. 15%) of their capital investment annually, through fixed cost charges of the plant. The ROI represents the percentage of the initial investment that can be recovered every year.

d. Operation and maintenance cost: This cost component involves the regular servicing of machinery, furnace oils, and regular replacement of equipment due to wear and tear.

e. Depreciation: Depreciation presents the reduction in the value of the assets/machinery/equipment used in the plant over time. As a plant gets older, its asset value reduces. This reduced value cannot be recovered while selling or replacing these assets. However, the plant has to recover its original cost; therefore, the commission approves a fixed depreciation value to be recovered by generator annually by adding it into the electricity tariff.

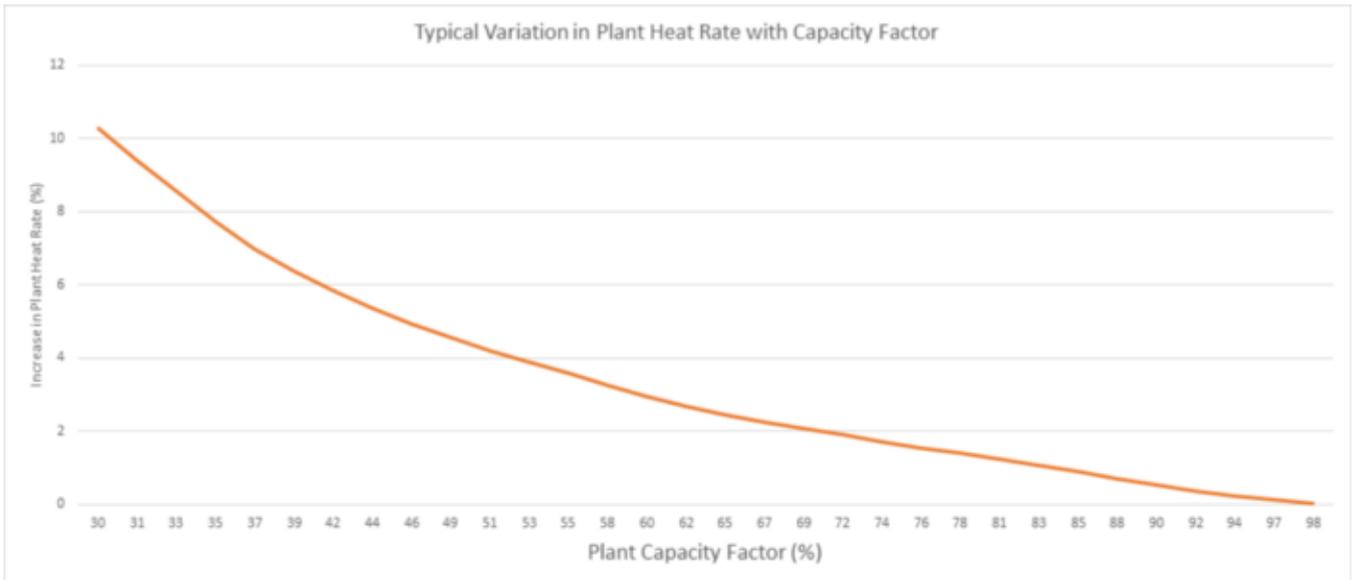
All of the above expenses are components of the fixed cost and recovered on a yearly basis, through power purchase agreement (PPA) signed between a generator and a DISCOM.

2. Variable Cost

The variable cost, as the name suggests, keeps varying for a power plant during its operation. This is because this cost component depends on the fuel and the power generated. The variable cost is measured on a per unit electricity generation basis (₹/MWh).

Fuel cost accounts for a majority of the variable cost of power plants. The fuel cost also includes the cost of transporting the fuel from the source to the destination. As power plants are usually located away from fuel sources, the fuel cost varies according to the distance between the plant site and fuel source.

Another factor that determines the variable cost is the *station heat rate* of the plant. The station heat rate is the amount of fuel used for generating one unit (one kilowatt-hour) of electricity. Higher the fuel efficiency, lower the heat rate, and thus, lower the per unit variable cost.



Source: Optimising Thermal Power Plant with Generation Flexibility and Heat Rate Factor (Chemical Engineering Transactions vol. 70, 2018)

The chart represents a typical variation in the heat rate of a plant with respect to plant capacity factor or plant loading. Monthly variable cost can be simply determined as:

The generation plant has a life of over 25 years and to compute the present value of the plant and machinery and the cost of operating the plant over its lifetime, the levelised cost of energy (LCoE) is calculated.

LCoE is the cost that GENCOs have to recover from the DISCOM/consumer for the expenses incurred in producing power over the lifetime of the plant. In other words, LCOE is the average price of electricity throughout the lifetime of a power plant. It mainly depends upon the variable cost, which changes by a significant margin every year. This change is because of changing fuel prices, transportation cost, and inflation. The LCOE helps compare the financial performance of different types of power plants.

The various costs associated with generation of power — as discussed in this blog — are the starting point of our tariff structure. The more fuel-efficient the generating plant, the lower would be the cost of power produced, which would finally reflect on our bills. In the next blog of the series, we will discuss the expenses borne by DISCOMS to supply electricity to us, which are also instrumental in shaping our final tariff.

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