Lecture 1.8

Various Tariff Methods

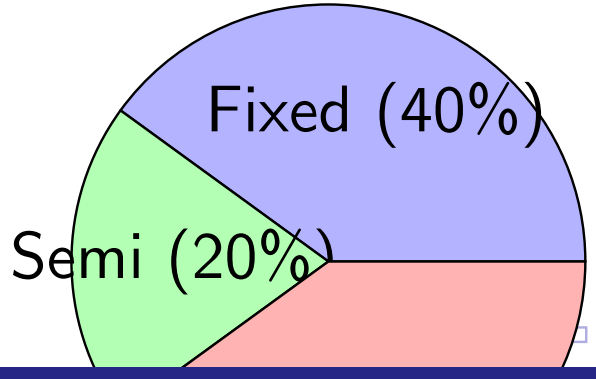
Agenda

- Introduction to Tariffs and Objectives
- Simple and Flat Rate Tariffs
- Block Rate Tariff
- Two-Part and Maximum Demand Tariffs
- Power Factor Tariffs
- Three-Part Tariff
- Summary and Preview

Introduction to Electricity Tariffs

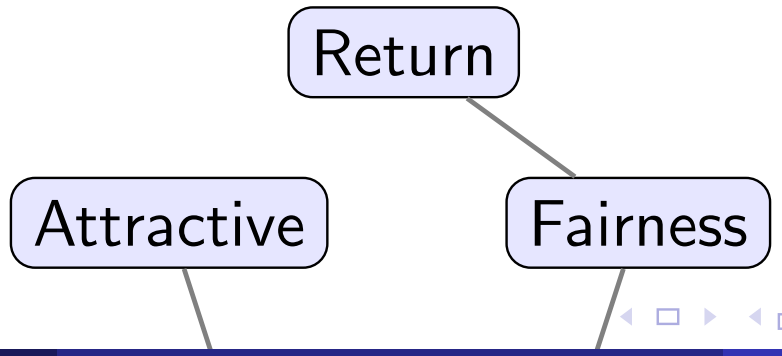
What is a Tariff?

- A tariff is the rate or schedule of rates at which electrical energy is sold to consumers.
- It must ensure the recovery of the total cost of producing electrical energy, including fixed, semi-fixed, and running costs.
- Total cost formula: Total Cost = Fixed Costs (land, equipment) + Semi-fixed Costs (management, taxes) + Running Costs (fuel, maintenance).
- Tariffs need to be fair to the consumer while ensuring a reasonable return on investment (ROI) for the power company.



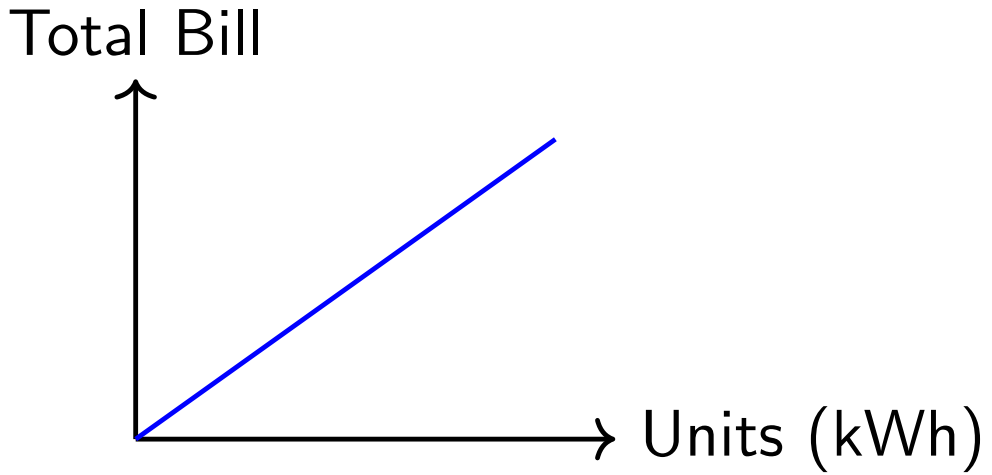
Objectives of a Desirable Tariff

- **Proper Return:** The tariff must recover the capital investment, operational, and maintenance costs.
- **Fairness:** Different types of consumers (residential, commercial, industrial) should be charged fairly based on their consumption patterns.
- **Simplicity:** The tariff structure should be simple enough for an ordinary consumer to understand.
- **Incentivize Efficiency:** It should encourage consumers to improve their power factor and utilize electricity during off-peak hours.
- **Attractive:** The cost must be competitive enough to encourage the widespread use of electrical energy.



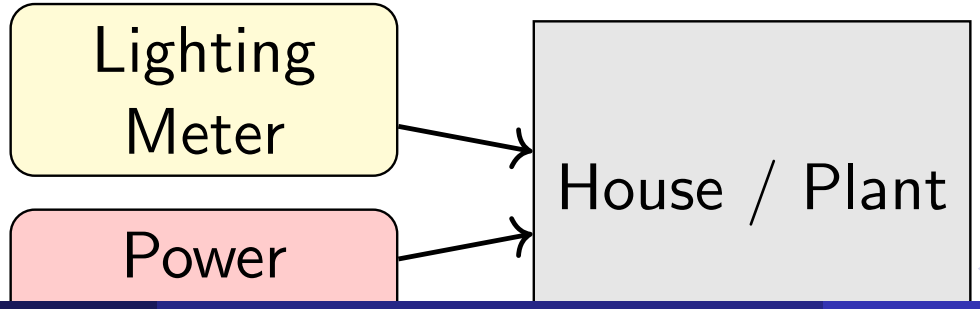
Simple Tariff (Uniform Rate Tariff)

- **Definition:** A fixed rate per unit (kWh) of energy consumed, regardless of the quantity used or the consumer's load profile.
- **Formula:** Total Bill = Rate per unit $\times$ Total units consumed.
- **Advantages:** Extremely simple to understand and easy to calculate.
- **Disadvantages:** Does not discriminate between high and low consumers, penalizes consumers with high load factors, and does not encourage off-peak usage.
- **Application:** Rarely used today, mostly applicable for very simple or temporary installations.



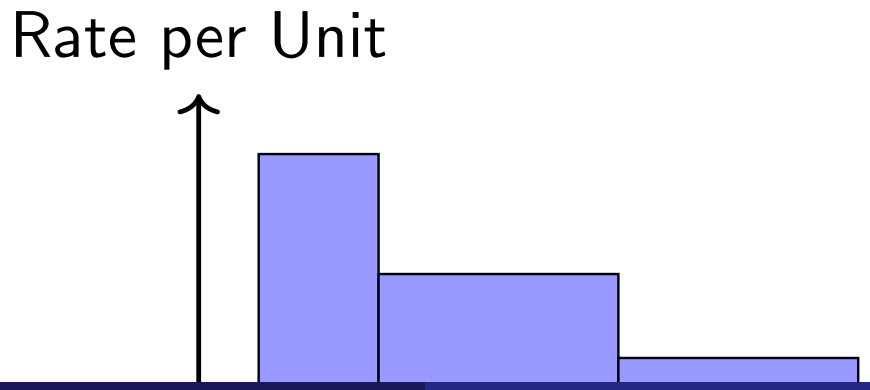
Flat Rate Tariff

- **Definition:** Different types of consumers (e.g., lighting, power) are charged at different uniform rates.
- **Mechanism:** Requires separate meters for different types of loads (e.g., one meter for lights/fans, another for heavy appliances).
- **Advantages:** More equitable than the simple tariff as it attempts to reflect the different load factors of different load types.
- **Disadvantages:** Requires multiple meters, increasing installation and maintenance costs. Complicated wiring is required.
- **Application:** Once common for domestic consumers to separate lighting from power loads.



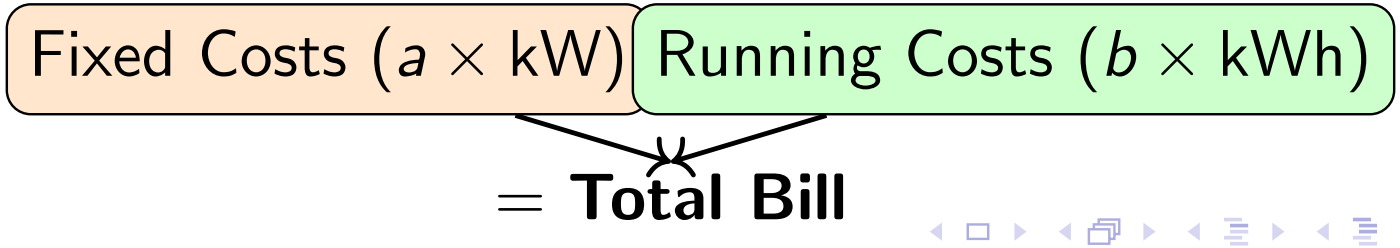
Block Rate Tariff

- **Definition:** The energy consumption is divided into blocks, and the price per unit is fixed for a given block but decreases for succeeding blocks.
- **Example:** First 100 units @ \$0.15/unit, next 200 units @ \$0.10/unit, exceeding 300 units @ \$0.05/unit.
- **Advantages:** Encourages consumers to use more electrical energy because the marginal cost decreases. Reflects the reduced unit cost of generation at higher volumes.
- **Disadvantages:** Lacks a direct penalty for high maximum demand if load factor is low.
- **Application:** Widely used for residential and small commercial consumers.



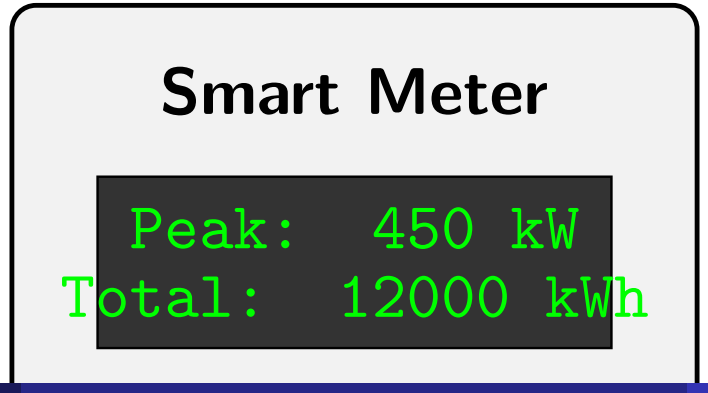
Two-Part Tariff (Hopkinson Demand Rate)

- **Definition:** The total bill is split into two parts: a fixed charge dependent on maximum demand and a running charge dependent on energy consumed.
- **Formula:** Total Bill $= (a \times \text{kW}) + (b \times \text{kWh})$, where '$a$' is the rate per kW of max demand and 'b' is the rate per kWh of energy.
- **Advantages:** Fairly recovers both fixed costs (via kW charge) and running costs (via kWh charge).
- **Disadvantages:** The consumer must pay the fixed charge even if zero energy is consumed. Assessing maximum demand requires special meters.
- **Application:** Standard for industrial consumers with significant maximum demand.



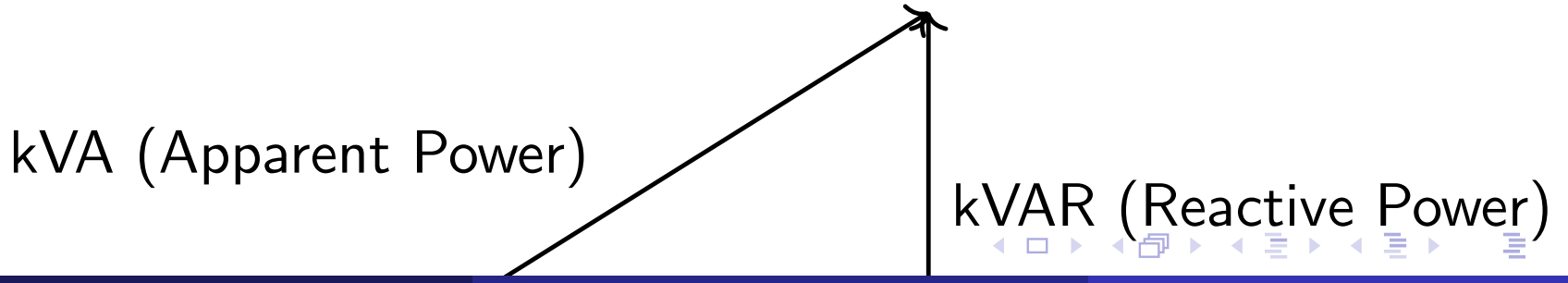
Maximum Demand Tariff

- **Definition:** Similar to the two-part tariff, but the maximum demand is actually measured using a maximum demand indicator rather than assessed based on connected load.
- **Mechanism:** A meter records the highest average load over a short time interval (typically 15 or 30 minutes) during the billing cycle.
- **Advantage:** Removes the guesswork from assessing connected load, charging exactly for the peak infrastructure stress the consumer causes.
- **Disadvantage:** Requires expensive maximum demand meters.
- **Application:** Large commercial and industrial installations where precise demand tracking is critical.



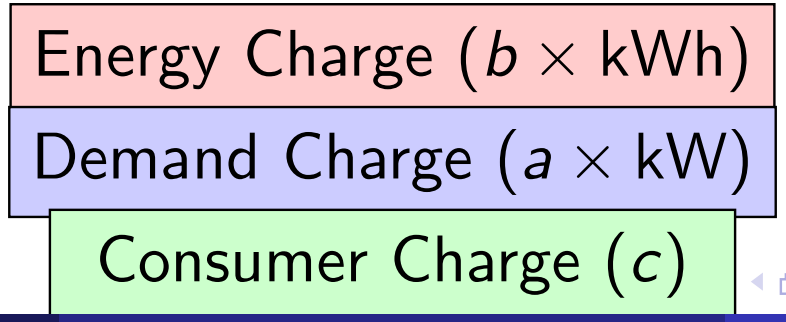
Power Factor Tariff

- **Definition:** Tariffs that explicitly penalize low power factor, as it forces the utility to provide higher reactive power (kVAR) and larger equipment sizing (kVA).
- **kVA Maximum Demand Tariff:** Fixed charges are based on kVA instead of kW. (kVA = kW/Power Factor). Inherently penalizes low PF.
- **Sliding Scale Tariff:** The average power factor is measured. A penalty is applied if PF drops below a reference value (e.g., 0.85 lag), and a bonus is given if it is above.
- **kW and kVAR Tariff:** Both active power (kW) and reactive power (kVAR) are measured and billed separately.
- **Importance:** Encourages consumers to install power factor correction equipment (e.g., capacitor banks).



Three-Part Tariff (Doherty Rate)

- **Definition:** The total bill is split into three parts: a fixed consumer charge, a semi-fixed maximum demand charge, and a running energy charge.
- **Formula:** Total Bill $= c + (a \times \text{kW}) + (b \times \text{kWh})$, where '$c$' is a fixed monthly fee (meter rent, billing costs).
- **Advantages:** Most accurately reflects the utility's cost structure. Recovers administrative costs regardless of consumption or demand.
- **Disadvantages:** Complex billing structure; 'c' charge can be unpopular with small consumers.
- **Application:** Commonly applied to large industrial consumers; variations are increasingly used for modern residential smart-metered homes.



Comparative Analysis of Tariffs

- Tariff selection depends on consumer scale and load characteristics.
- **Simple/Flat:** High cost per unit, low administrative overhead. Poor cost recovery alignment.
- **Block Rate:** Excellent for residential, incentivizes use, easy to implement.
- **Two-Part/Max Demand:** Essential for industrial loads. Aligns capacity costs with the consumer's peak usage.
- **Power Factor:** Critical for large inductive loads (factories). Protects grid stability and efficiency.

Tariff	**Complexity**	**Fairness**	**Target Consumer**
Simple/Flat	Low	Low	Small / Temp
Block Rate	Medium	Medium	Residential
Two-Part	High	High	Industrial
Power Factor	High	High	Large Inductive

Summary

Key Takeaways

- Tariffs are essential for recovering fixed, semi-fixed, and running costs of power generation.
- A good tariff must be fair, simple, and encourage efficient energy use.
- Residential consumers are typically billed using Block Rate tariffs.
- Industrial consumers face Two-Part, Maximum Demand, and Power Factor tariffs to account for capacity and reactive power stresses.
- Power factor correction is incentivized by kVA-based or sliding-scale tariffs.

Next Lecture Preview

Load Forecasting and System Planning

- Understanding how utilities predict future power demand.
- Short-term vs. Long-term forecasting techniques.
- The role of economic growth and weather patterns in capacity planning.