

BEYOND

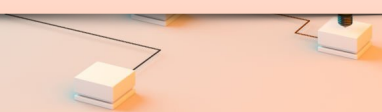
SMART CITIES



ENERGY SAVINGS PERFORMANCE AND  
MEASUREMENT & VERIFICATION  
ONLINE TRAINING COURSE

KRISHNAJI PAWAR, LEED AP BD+C, GSAS CGP, ISO 14001:2015, GCP  
ENERGY SPECIALIST CURRICULUM





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SMART CITIES



BASICS OF ENERGY AND ITS VARIOUS FORMS  
ELECTRICITY TARIFF - ADDITIONAL  
FOR ENERGY PROFESSIONALS

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WHAT SHOULD YOU LEARN





Electricity tariff

Load management and  
Maximum demand control

Power factor



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## ELECTRICITY TARIFF

✓ **Calculation of electric bill for a company :**  
Electrical utility or power supplying companies charge industrial customers not only based on the amount of energy used (kWh) but also on the peak demand (kVA) for each month.

✓ **Contract Demand**  
Contract demand is the amount of electric power that a customer demands from utility in a specified interval. Unit used is kVA or kW. It is the amount of electric power that the consumer agreed upon with the utility. This would mean that utility has to plan for the specified capacity.

✓ **Maximum demand :**  
Maximum demand is the highest average kVA recorded during any one demand interval with- in the month. The demand interval is normally 30 minutes, but may vary from utility to utility from 15 minutes to 60 minutes. The demand is measured using a trivector meter / digital energy meter.

## PREDICTION OF LOAD

While considering the methods of load prediction, some of the terms used in connection with power supply must be appreciated.

✓ **Connected Load** - is the nameplate rating (in kW or kVA) of the apparatus installed on a consumer's premises.

✓ **Demand Factor** - is the ratio of maximum demand to the connected load.

✓ **Load Factor** - The ratio of average load to maximum load.

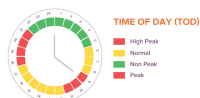
**Load Factor = Average Load / Maximum Load**

The load factor can also be defined as the ratio of the energy consumed during a given period to the energy, which would have been used if the maximum load had been maintained through- out that period. For example, load factor for a day (24 hours) will be given by:  
The load factor can also be defined as the ratio of the energy consumed during a given period to the energy, which would have been used if the maximum load had been maintained through- out that period. For example, load factor for a day (24 hours) will be given by:

**Load Factor = Energy consumed during 24 hours / Maximum load recorded x 24 Hours**

## ELECTRICITY TARIFF +

✓ **PF Measurement** A power analyzer can measure PF directly, or alternately kWh, kVAh or kVAh readings are recorded from the billing meter installed at the incoming point of supply. The relation kWh / kVAh gives the power factor.



| Peak      | Time of day   | Units | Unit Rate<br>p/ unit | Money spent per hr<br>(p/ rupee) |
|-----------|---------------|-------|----------------------|----------------------------------|
| Peak      | 09:00 - 12:00 | 100   | 15.8                 | 1580 ↑ High                      |
| Normal    | 12:00 - 18:00 | 100   | 15                   | 1500 → Normal                    |
| High Peak | 18:00 - 22:00 | 100   | 16.5                 | 1650 ↑ High                      |
| Non Peak  | 22:00 - 06:00 | 100   | 13.5                 | 1350 ↓ Low                       |
| Normal    | 06:00 - 09:00 | 100   | 15                   | 1500 → Normal                    |

✓ **Time of Day (TOD) Tariff**  
Many electrical utilities like to have flat demand curve to achieve high plant efficiency. They encourage user to draw more power during off-peak hours (say during night time) and less power during peak hours. As per their plan, they offer TOD Tariff, which may be incentives or disincentives. Energy meter will record peak and non- peak consumption separately by timer control. TOD tariff gives opportunity for the user to reduce their billing, as off peak hour tariff charged are quite low in comparison to peak hour tariff.

### THREE PHASE AC POWER MEASUREMENT



Most of the motive drives such as pumps, compressors, machines etc. operate with 3 phase AC Induction motor. Power consumption can be determined by using the relation.

$$\text{Power} = \sqrt{3} \times V \times I \times \cos\phi$$

Portable power analysers /instruments are available for measuring all electrical parameters.



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### EXAMPLE



A 3-phase AC induction motor (20 kW capacity) is used for pumping operation. Electrical parameter such as current, volt and power factor were measured with power analyzer. Find energy consumption of motor in one hour?  
(line volts. = 440 V, line current = 25 amps and PF = 0.90).

$$\text{Energy consumption} = \sqrt{3} \times 0.440 \text{ (kV)} \times 25 \text{ (A)} \times 0.90 \text{ (PF)} \times 1 \text{ (hour)} = 17.15 \text{ kWh}$$



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### MOTOR LOADING CALCULATION



The nameplate details of motor, kW or HP indicate the output parameters of the motor at full load. The voltage, amps and PF refer to the rated input parameters at full load.

#### Example:

A three phase, 10 kW motor has the name plate details as 415 V, 18.2 amps and 0.9 PF. Actual input measurement shows 415 V, 12 amps and 0.7 PF which was measured with power analyzer during motor running.



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## MOTOR LOADING CALCULATION

Rated output at full load = 10 kW  
Rated input at full load =  $1.732 \times 0.415 \times 18.2 \times 0.9 = 11.8 \text{ kW}$   
The rated efficiency of motor at full load =  $(10 \times 100) / 11.8 = 85\%$

Measured (Actual) input power =  $1.732 \times 0.415 \times 12 \times 0.7 = 6.0 \text{ kW}$

Motor loading % =  $\frac{\text{Measured kW}}{\text{Rated kW}} \times 100 = \frac{6.0}{11.8} \times 100 = 51.2\%$

## MOTOR LOADING CALCULATION +

Which applications use single-phase power in an industry? Single-phase power is mostly used for lighting, fractional HP motors and electric heater applications.

**Example:**  
A 400 Watt mercury vapor lamp was switched on for 10 hours per day. The supply volt is 230 V. Find the power consumption per day? (Volt = 230 V, Current = 2 amps, PF = 0.8)

Electricity consumption (kWh)  
=  $V \times I \times \text{Cos} \times \text{No of Hours}$   
=  $0.230 \times 2 \times 0.8 \times 10 = 3.7 \text{ kWh or Units?}$

## MOTOR LOADING CALCULATION +

**Example:**  
An electric heater of 230 V, 5 kW rating is used for hot water generation in an industry. Find electricity consumption per hour (a) at the rated voltage (b) at 200 V

A. Electricity consumption (kWh) at rated voltage  
=  $5 \text{ kW} \times 1 \text{ hour}$   
= 5 kWh.

B. Electricity consumption at 200 V (kWh)  
=  $(200 / 230) \times 5 \text{ kW} \times 1 \text{ hour}$   
= 3.78 kWh.





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