

# POWER SYSTEM FACTORS

## 1. Connected Load

Sum of continuous rating of all equipment connected to supply system.

maximum power that a load draws from power system on continuous basis, without Heating



100 W



60 W



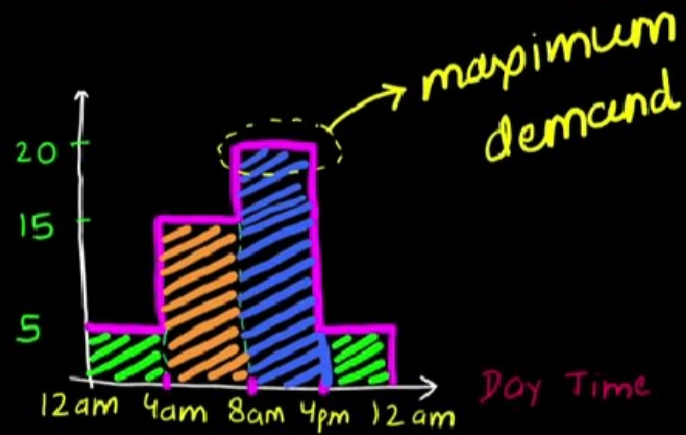
500 W [Power Point]

$$\begin{aligned} \star \text{Connected Load} &= 1 \times 100 + 60 \times 1 + 500 \times 1 \\ &= 660 \text{ W} \end{aligned}$$

It doesn't matter, loads are running or NOT

## 2. Maximum demand

"Greatest demand of connected load, during a given period of time"



5 Bulb  
3 Fan  
2 TV



10 Bulb  
2 Fan  
2 TV  
1 LAPTOP



2 Bulb  
1 Fan  
1 TV

Max<sup>m</sup>  
Demand

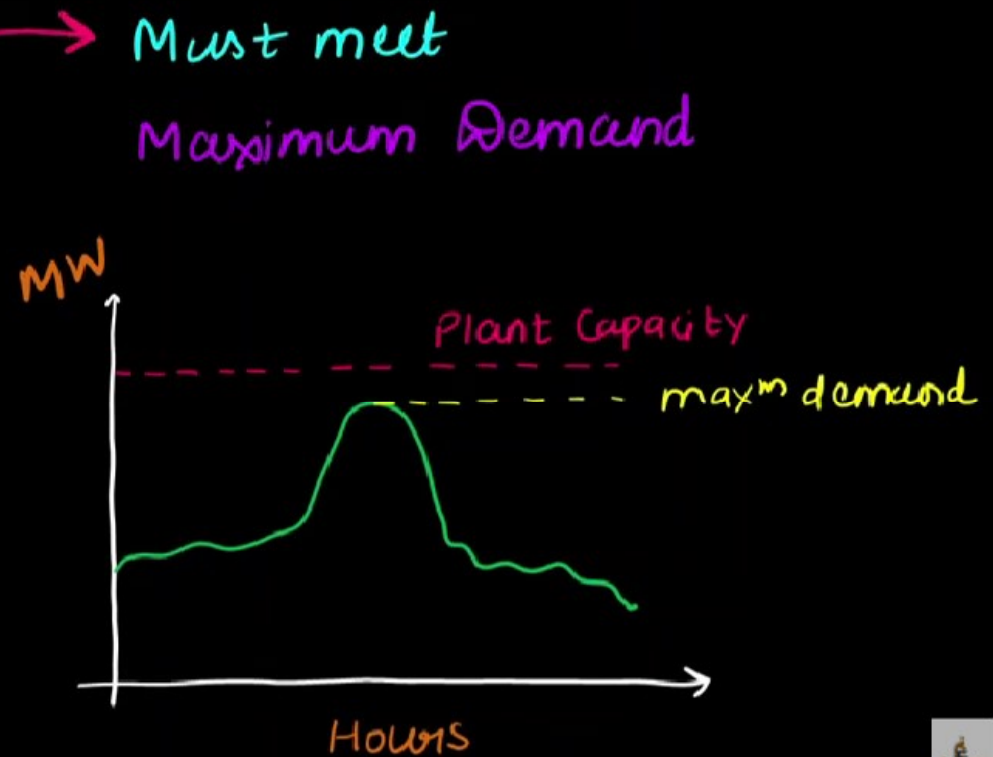
<

Connected  
Load

All consumer don't switch  
ON all Loads at same time

## # Importance of max<sup>m</sup> Demand

"Help in determining size and capacity of power station"



### 3. Demand Factor

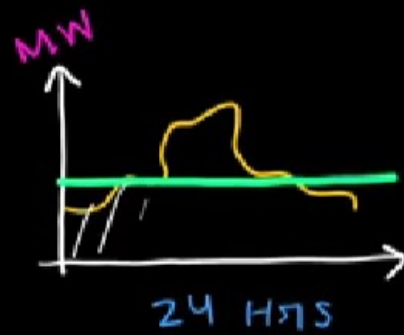
$$\text{Demand Factor} = \frac{\text{Maximum Demand}}{\text{Connected Load}} < 1$$

\* eg  $\rightarrow$  Max<sup>m</sup> demand = 80 MW  
connected Load = 100 MW  
$$DF = \frac{80}{100} = 0.8$$

\* Importance  $\rightarrow$  Demand Factor helps in determining the Capacity of plant equipment.

#### 4. Average Load

“Average load demand on power station in a given period”  
↓  
daily, weekly, Annually



Average load

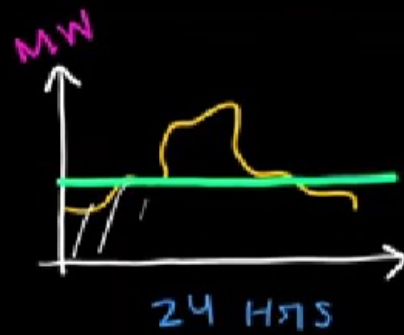
Monday unit Hr.

Daily average load =  $\frac{\text{No. of units (in kWH) demanded in a day}}{24 \text{ Hrs}}$

Monthly average load =  $\frac{\text{No. of units demanded in a month}}{24 \times \text{Days in months } (24 \times 31)}$

## 4. Average Load

“Average load demand on power station in a given period”  
 ↓  
 daily, weekly, Annually



Monday unit Hr.  
units / Hr

Daily average load = No. of units (in kWh) demanded in a day

50 MW/Hr

Dec.

52 MW/Hr

24 Hrs

Monthly average load = No. of units demanded in a month

24 x Days in months 24 x 31

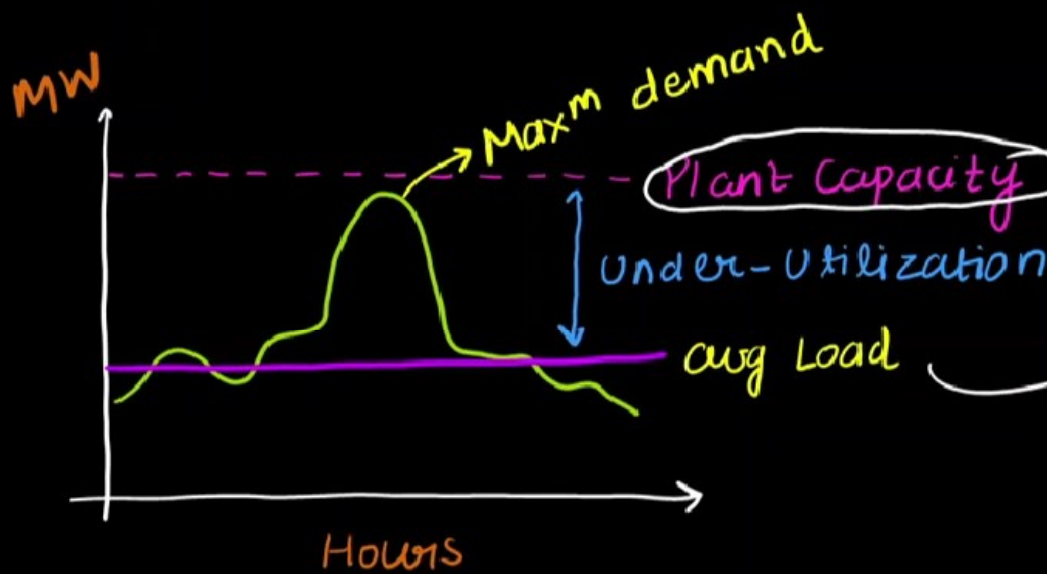
Annually average load = No. of units demanded in a Year

24 x 365 Hrs

## 5. Load Factor

$$\text{Load Factor} = \frac{\text{Average Load}}{\text{Maximum Demand}}$$

How efficiently the electric power being utilized.



50 MW ← under loaded

28 MW

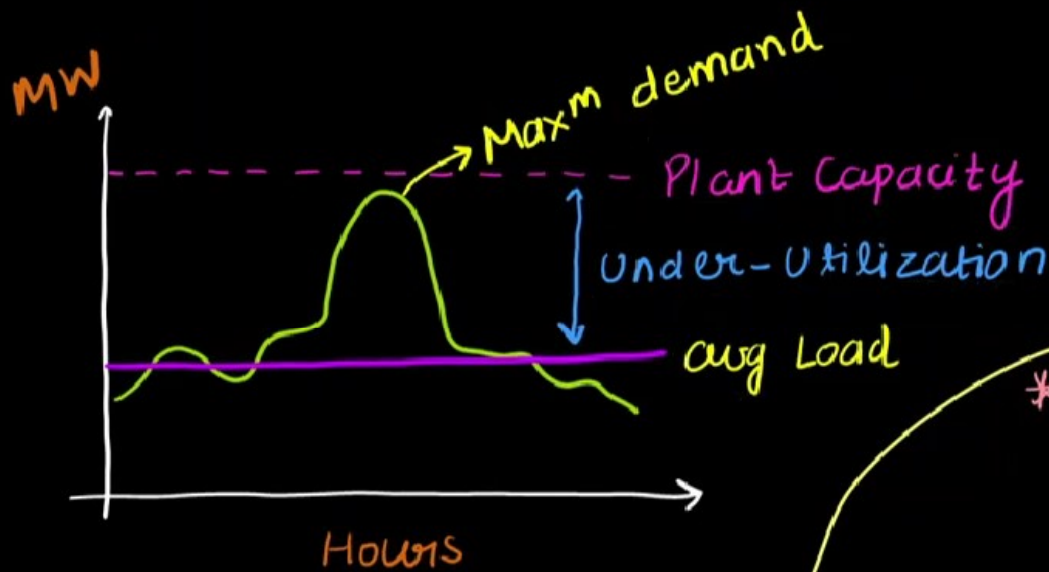
$$28 = P_{\text{gen}} = P_{\text{dem}} = 28$$

## 5. Load Factor

$$\text{Load Factor} = \frac{\text{Average Load}}{\text{Maximum Demand}}$$

How efficiently the electric power being utilized.

Represent utilization of Power Plant



\* Larger the difference b/w Avg Load and max<sup>m</sup> demand, Lower the utilization of Plant, Poor the Load Factor



## # Ideal Load Factor

load will remain constant all the time



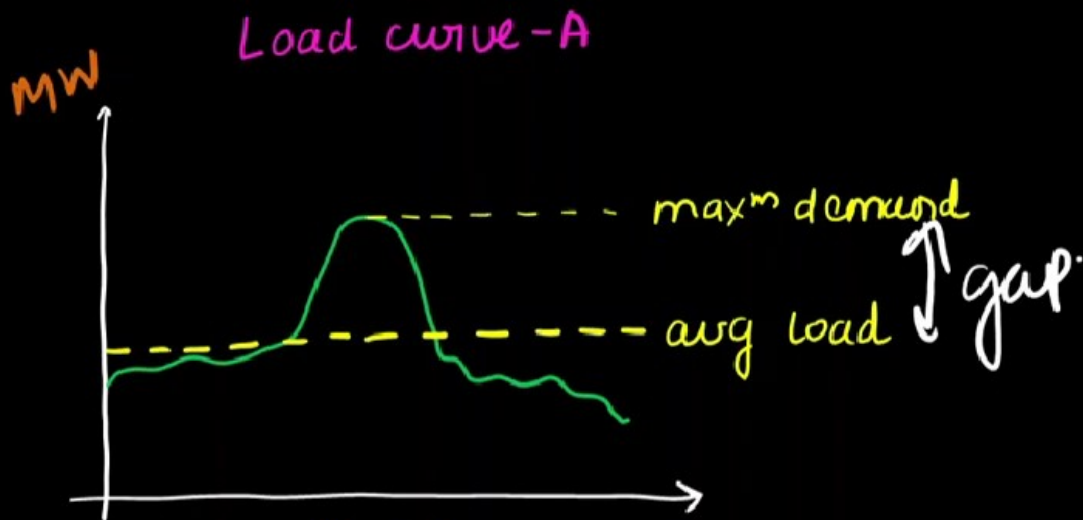
$$\text{Load Factor} = \frac{\text{Avg. demand}}{\text{Max}^m \text{ demand}}$$

\* Practical Desire  $\rightarrow$  LF should be close to 1

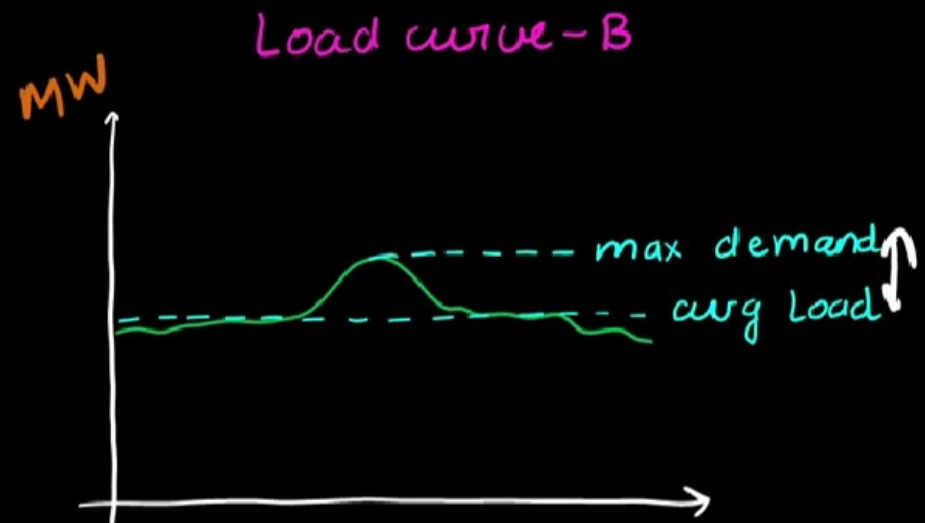
$$\boxed{\text{LF} = 1}$$

$\rightarrow$  minimum difference b/w avg and max<sup>m</sup> demand.

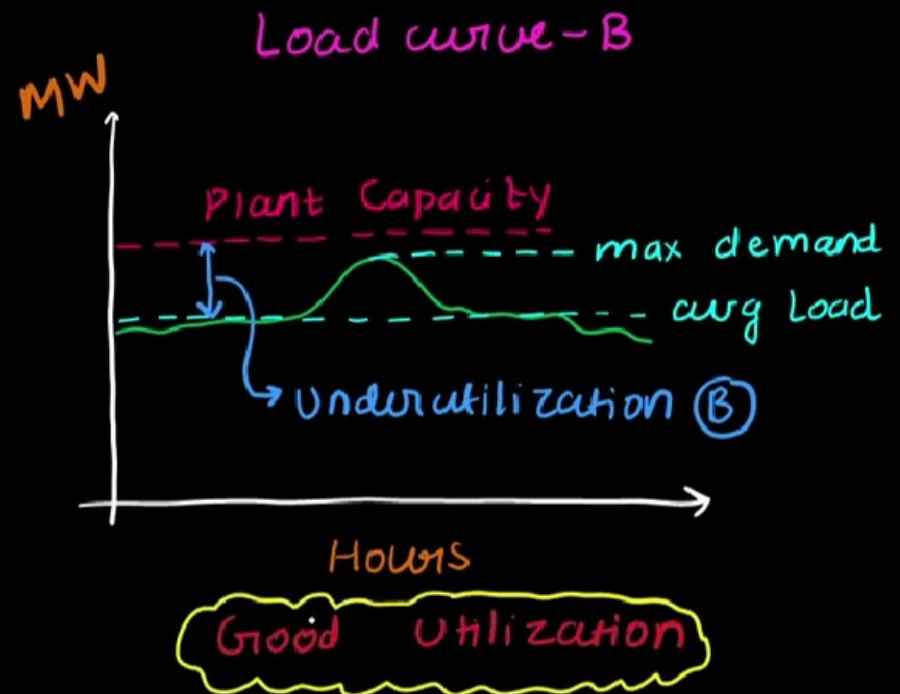
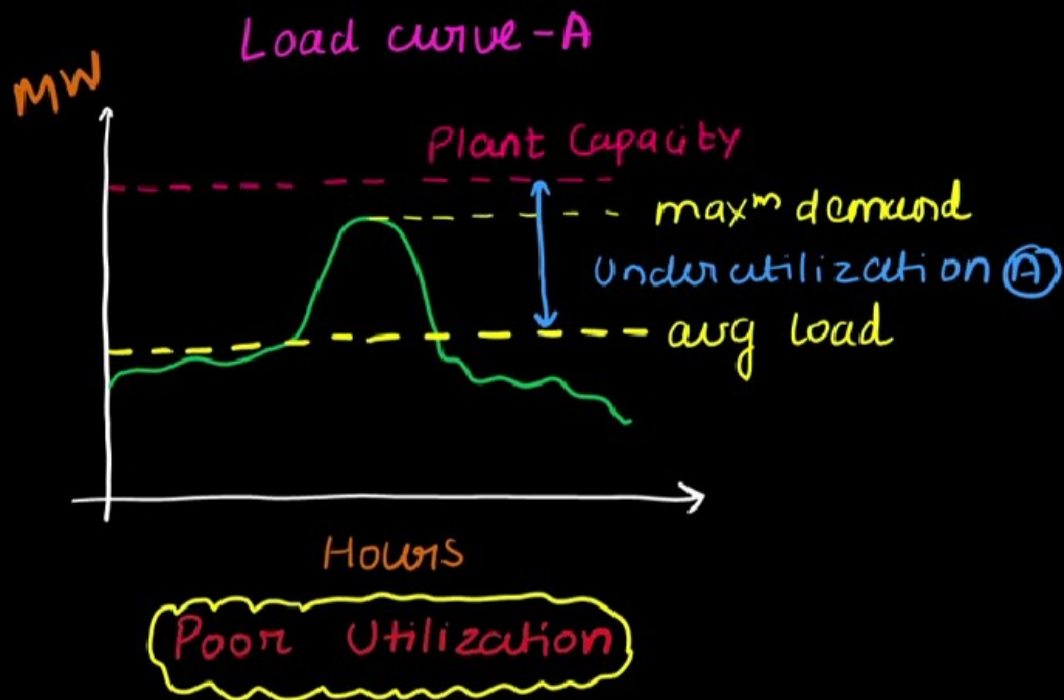




- ④ unavail ↑
- ① LF poor
- ② LF ~~close~~ far from 1
- ③ ~~effective~~ poor



- ④ unavail ↓
- ① LF good
- ② LF close to 1
- ③ effective gener



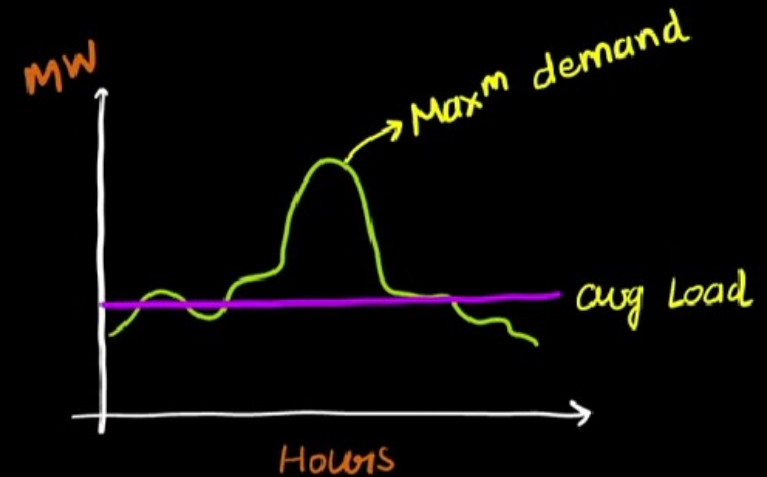
$$(\text{Max}^m \text{ demand} - \text{Avg. Load})_A > (\text{Max}^m \text{ demand} - \text{Avg Load})_B$$

$$\text{Underutilization (A)} > \text{Underutilization (B)}$$

$$\text{Load Factor (A)} < \text{Load Factor (B)}$$

## # Important Feature of Load Factor

1. Load Factor =  $\frac{\text{Avg. Load}}{\text{max demand}} < 1$

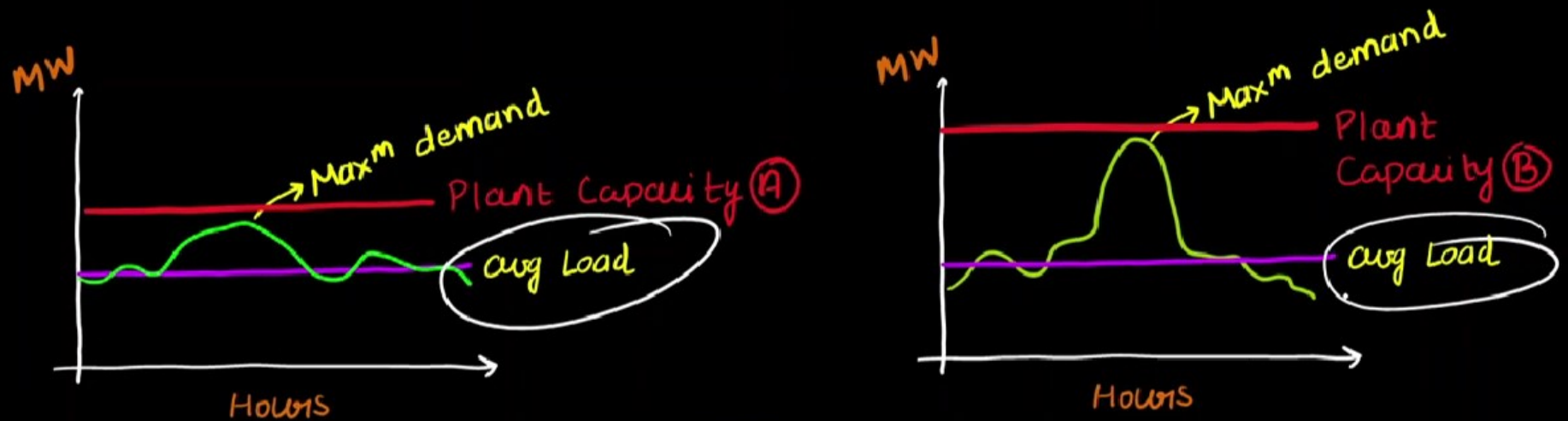


2. Load Factor can be daily, monthly, annually.

3. LF plays key role in determining overall cost of per unit generated.

Load Factor  $\uparrow \rightarrow$  cost per unit generation  $\downarrow$

Load Factor  $\uparrow$   $\rightarrow$  cost per unit generation  $\downarrow$



"Plant - A"  $\rightarrow$  Same Average Load  $\leftarrow$  "Plant - B"

Plant Capacity A  $<$  Plant capacity B

① Cost of 1 unit generation  $<$  cost of 1 unit generation ②

## 6. Diversity Factor

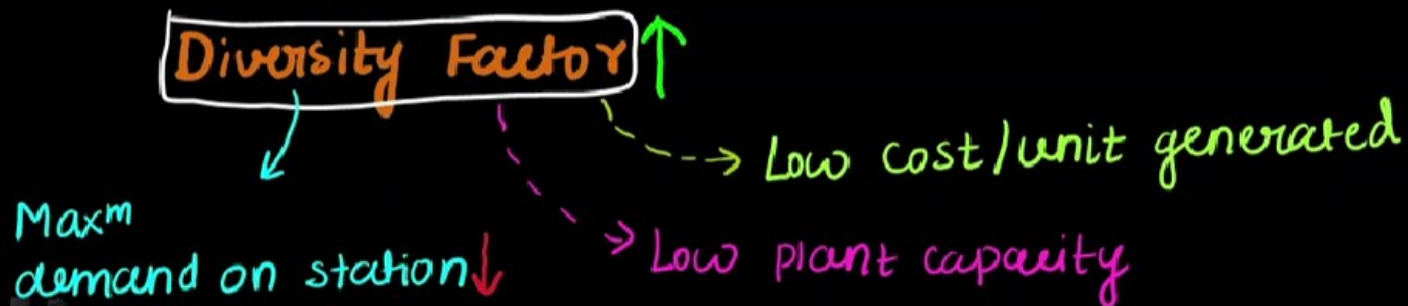
$$\text{Diversity Factor} = \frac{\text{Sum of Individual max}^m \text{ demand}}{\text{Max}^m \text{ demand on Power station}} > 1$$

Signify the diversification of Load's max<sup>m</sup> demand

cost/unit generated

Helps in determining plant's capacity

\* Relation



# # Calculation of Diversity Factor

Max<sup>m</sup> Load



4 kW [6am - 6pm]



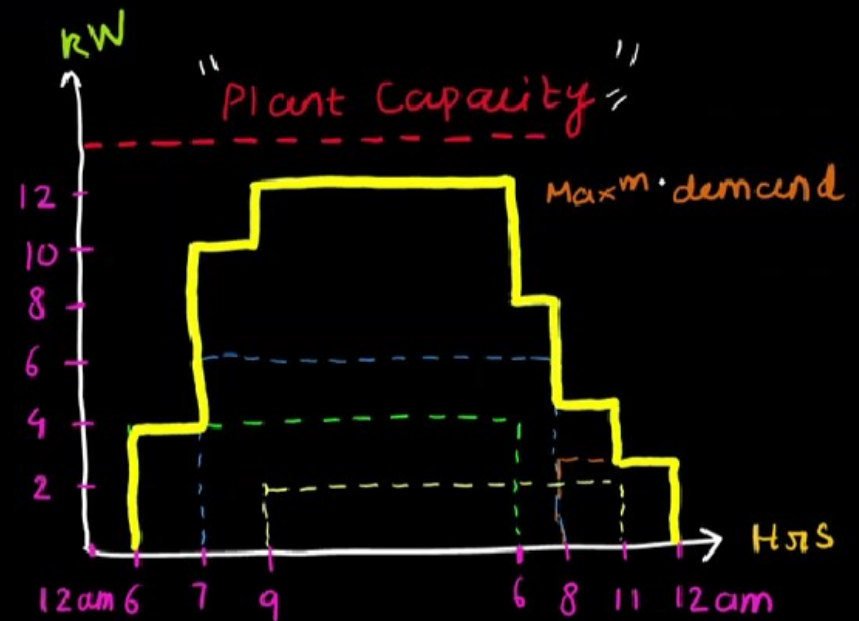
6 kW [7am - 8pm]



2 kW [9am - 11pm]



3 kW [8pm - 12am]



$$DF = \frac{4 + 6 + 2 + 3}{12} = 1.25$$



# # Effect of Diversity Factor

Max<sup>m</sup> Load



4 kW [12am - 3am]



6 kW [3am - 9am]

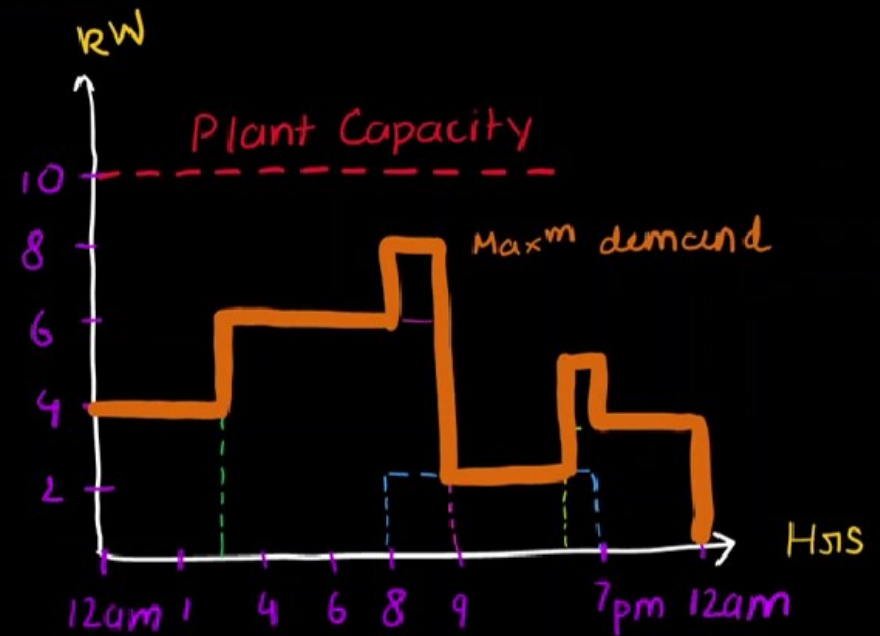


2 kW [8am - 7pm]



3 kW [6pm - 12am]

Plant Capacity = 10 kW



$$\text{Diversity Factor} = \frac{4 + 6 + 2 + 3}{8}$$

4 kW

$$= 1.87$$



### Case-1



$$DF = 1.25$$

Plant capacity  $\approx 14$  kW

Less diversify Load  
or

Concentrated Load

Maximum load are at its peak, at same time

Higher the Diversity Factor

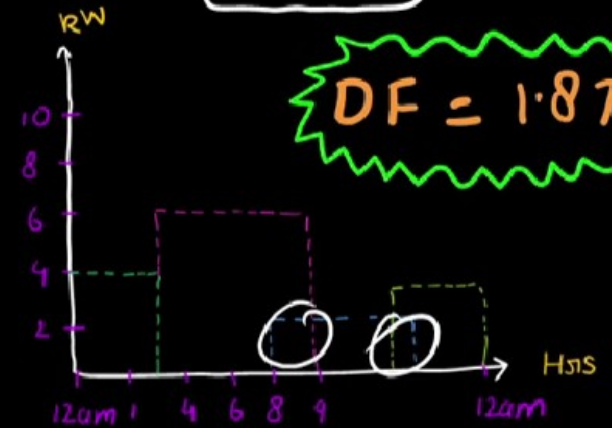
Diluted the Load

Lower the Max<sup>m</sup> Demand

Smaller the Plant capacity

Lower the cost per unit generation

### Case-2



$$DF = 1.87$$

Plant Capacity = 10 kW

More diversify load  
or  
Diluted Load

Loads are at its peak, at different time

Activate Windows  
Go to Settings to activate Windows.



# What if Diversity Factor = 1



4 kW



6 kW



2 kW



3 kW

Max<sup>m</sup> Load

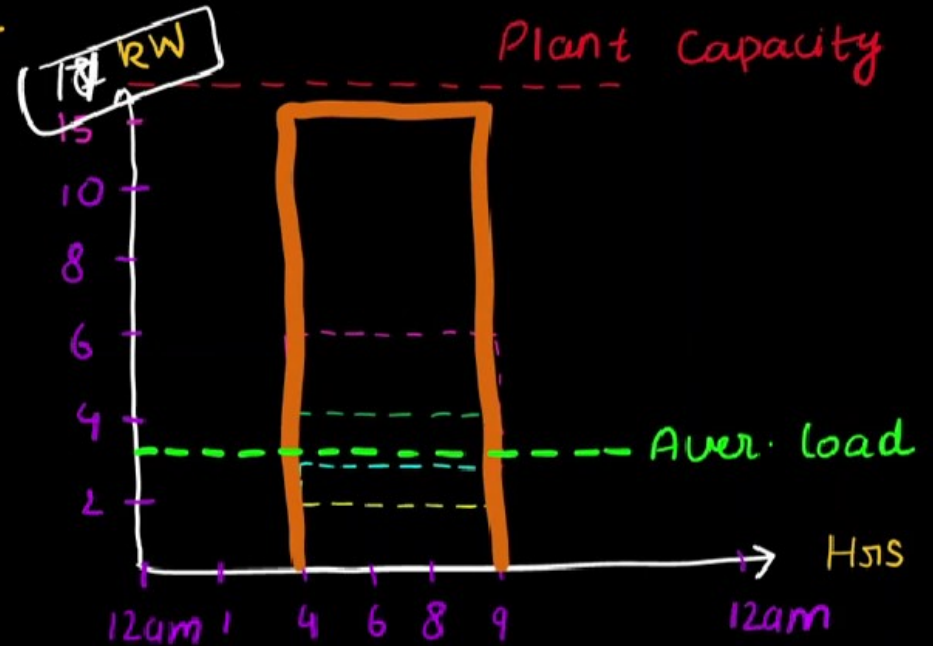
D

14 kW  
10 kW

4am - 9am

Peak = 1

17 kW



$$\text{Div. Fact} = \frac{4 + 6 + 2 + 3}{15} = 1$$

\* All loads are at their peak during same time.

Activate Windows  
Go to Settings to activate Windows.



## 7. Plant Capacity Factor

$$PCF = \frac{\text{Actual Energy Produced}}{\text{Max}^m \text{ energy that can be Produced}} < 1$$

$$= \frac{\text{Average Demand} \times T}{\text{Plant Capacity} \times T}$$

PCF  
∴ Capacity Factor

$$PCF = \frac{\text{Average Demand}}{\text{Plant capacity}}$$

$$(\text{Plant Capacity Factor})_{\text{annual}} = \frac{\text{Units generated in a year}}{\text{Plant capacity} \times \text{Hours in a year}}$$

Activate Windows  
Go to Settings to activate Windows.

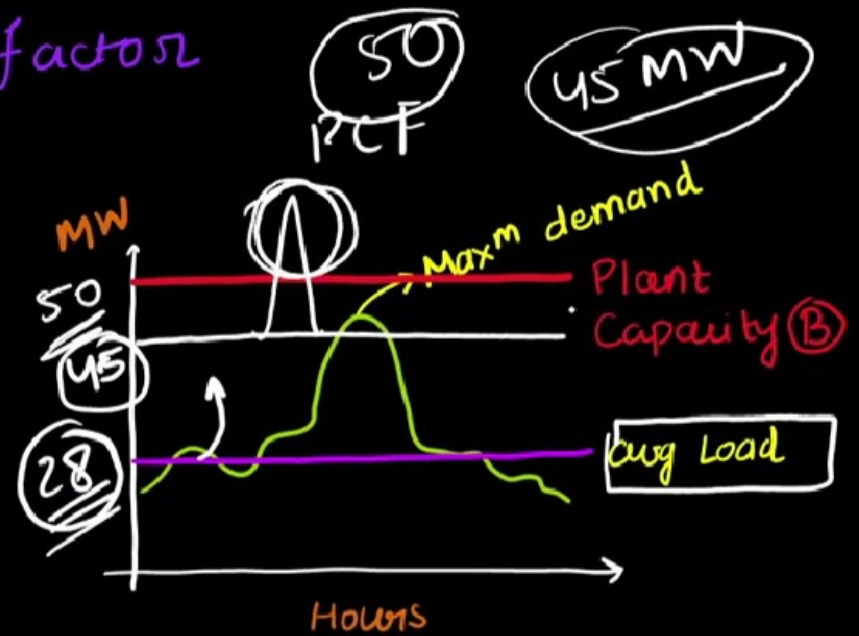
## # Understanding Plant Capacity factor

$$\uparrow PCF = \frac{\text{Average Demand}}{\text{Plant capacity}} \uparrow$$

\* PCF indicates reserve capacity of Power Plant

\* Higher values of PCF  $\rightarrow$  Average load on plant is close to its peak capacity

Small Reserve  $\leftarrow$  Plant generally operates near its peak capacity



\* PCF  $\rightarrow$  Measure how often a plant is running at its peak capacity.

\* PCF = 1  
 $\downarrow$

Avg demand = Plant capacity

Load Factor

$\rightarrow$  Plant operate at its peak, all the time

$$* \text{ PCF} = \frac{\text{Avg. demand}}{\text{Plant capacity}} = \frac{\text{Load Factor} \times \text{Maximum Demand}}{\text{Plant capacity}}$$



# # Reserve Capacity

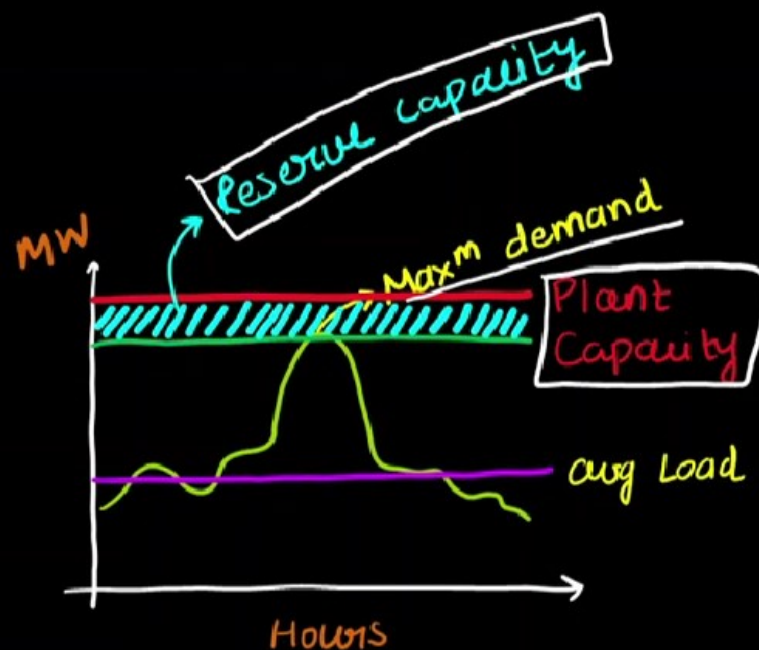


Design

Plant has  
some reserve  
capacity

To meet increased  
load demand in  
Future

Installed  
capacity > Max<sup>m</sup>  
demand



$$* \text{ Reserve capacity} = \text{Plant Capacity} - \text{Max}^m \text{ demand}$$

Activate Windows  
Go to Settings to activate Windows.



$$* PCF = \frac{\text{Load Factor} \times \text{Maximum Demand}}{\text{Plant Capacity}}$$

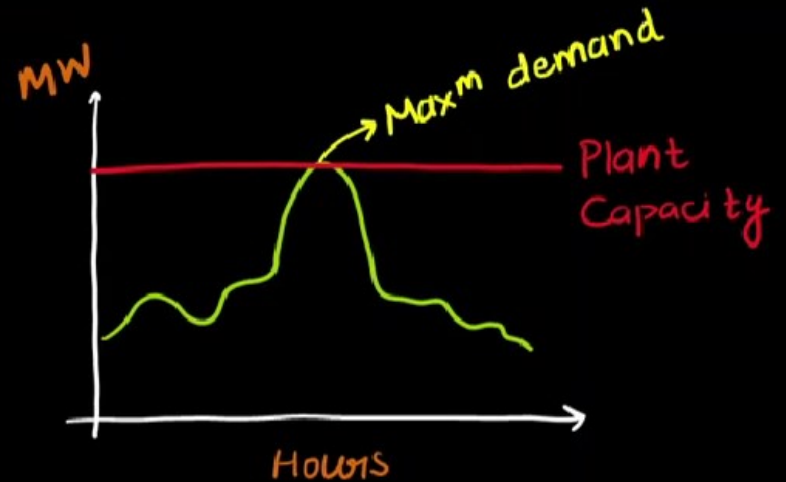
If,

$$\text{Plant Capacity} = \text{Max}^m \text{ Demand}$$

$$PCF = \text{Load Factor}$$

$$\text{Reserve capacity} = 0$$

→ Power plant has  
Zero tolerance for  
Load fluctuations



## 8. Plant use Factor

PCF

$$\text{PUF} = \frac{\text{Station o/p in kWh}}{\text{Plant Capacity} \times \text{Hours}}$$

Plant Util

$$= \frac{\text{Max}^m \text{ Demand}}{\text{Plant Capacity}}$$

$$* \text{ Plant Capacity Factor} = \frac{\text{Avg. demand}}{\text{Plant capacity}}$$

$$* \text{ Plant use Factor} = \frac{\text{Max}^m \text{ demand}}{\text{Plant capacity}}$$

