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Internal Assesment Test –I

Sub:	Power System Planning							Code:	18EE824
Date:	14/05/22	Duration:	90 mins	Max Marks:	50	Sem:	8th	Branch:	EEE

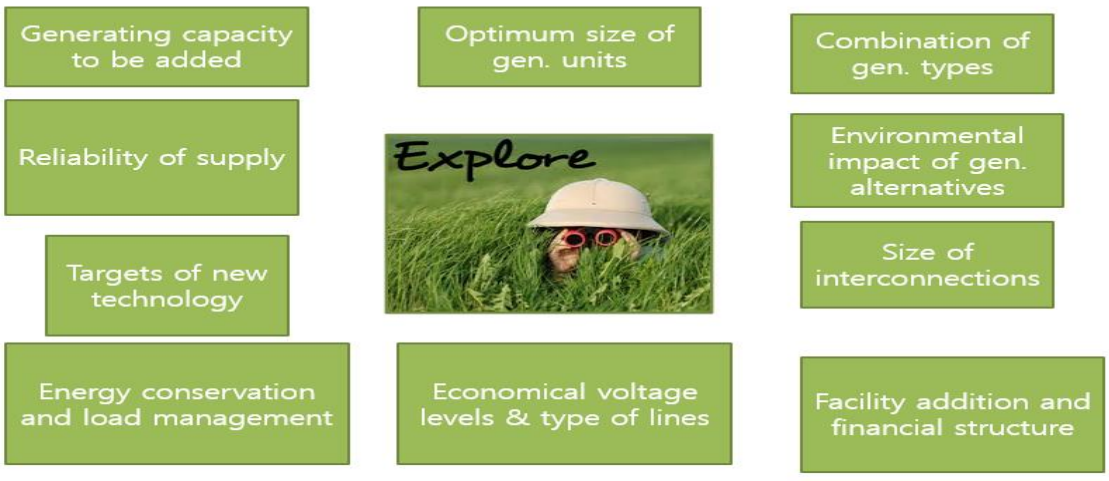
Answer Any FIVE FULL Questions

		Marks	OBE CO	OBE RBT
1	a) Explain the planning principles. b) Explain planning process.	[5] [5]	CO1	L2
2	Explain structure of power system and types power transmission and distribution network.	[10]	CO1	L2
3	Explain functions of planning organization and different types of organization models.	[10]	CO1	L2
4	Explain forecasting techniques	[10]	CO1	L2
5	Explain different factors affecting for the forecasting.	[10]	CO2	L2
6	Explain Peak-Load Forecast and Reactive Load Forecast.	[10]	CO2	L2
7	Explain the things to study under private participation in detail.	[10]	CO2	L2

1a.

1.2 Planning Principles

Points to be explored :



Explain each point in detail

1b.

1.3 Planning process

- Process of taking **careful decision**.
- Process of **selecting** **vision**, values, **mission** and objectives, decide plan to achieve them.
- Input for planning is **quality** of systematic **thought** that goes into **decision**.
- Process of establishing power industry is **time** consuming and **capital** intensive.
- Planning saves **project time** and utilizes **resource economically**
- Planning should consider
  1. uncertinity about future
  2. alternative action choices
  3. goals and constraints

1.3 Planning process

It consists of **three** cyclical components

1. **Learning** about the environment related issues and possible future scenarios to identify :
   a. Strategically goals
   b. Decision criteria and constraints
   c. Technological needs and opportunities.
2. **Thinking** about existing plans, associated costs and risks.
This involves
   a. Investment of resources
   b. Unforeseen factors
   c. Reliability of outcome
3. **Preferred plans** based on support analysis

1.3 Planning process

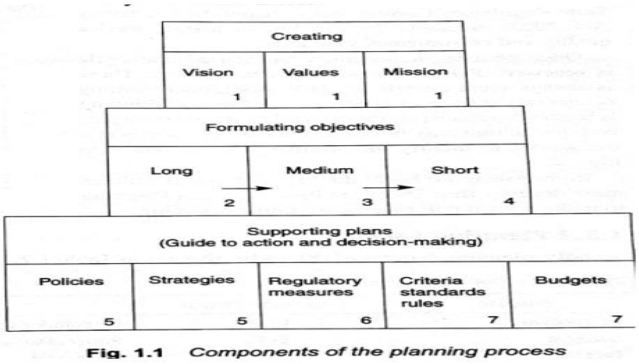


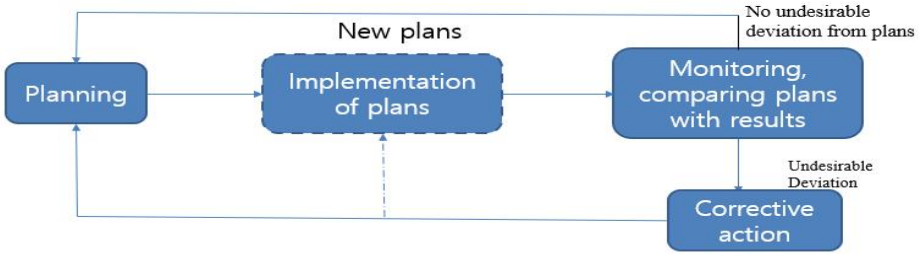
Fig. 1.1 *Components of the planning process*

1.3 Planning process

Characteristics of power system that makes planning challenging

1. **High capital** intensive
2. Plan implemented in **advanced** countries cannot be implemented in **developing countries**
3. Planning **diverges** a **lot** before it **actually converges**.(Eg: Environmental effects)

Planning Actions



2

1.9 Structure of a Power System

The basic system consists of **energy resources** such as **hydro, coal**, **gas** etc., a **prime mover, a generator and a load**.
Some sort of **control system** is required for supervising it.

The **prime mover may** be a **steam driven turbine, a hydraulic turbine or an internal combustion** engine.
prime movers :**energy in the form of heat, falling water or fuel**

↓

into **rotation of the shaft**

↓

drives the **generator.**

1.9 Structure of a Power System

generator may be **alternator or a d.c. machine**.

Electrical **load** on the generator may be **lights, motors, heat or other devices**

The **control system** functions: a) to keep the **speed of the machine constant**

b) the **voltage** within prescribed **limits**

c)**excitation** within **the generator capability**.

The **active power** (MW) is regulated by frequency (speed) control

The **reactive power** (MVAr) and voltage is regulated by excitation control.

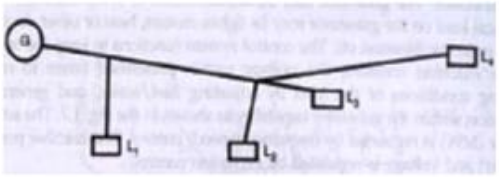
1.9 Structure of a Power System

The power **transmission and distribution network** may be of the following types

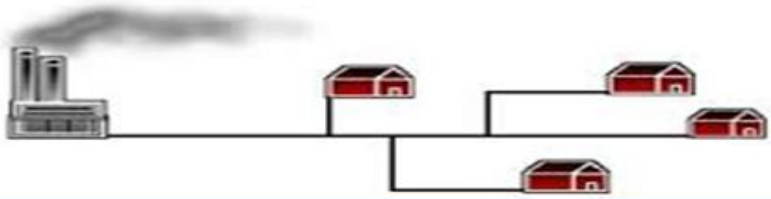
1. **radial system** :

lines form a **'tree' spreading out** from the generator.

Opening any line results in **interruption of power to one or more** of the loads.



Radial System



1.9 Structure of a Power System

2. loop system :

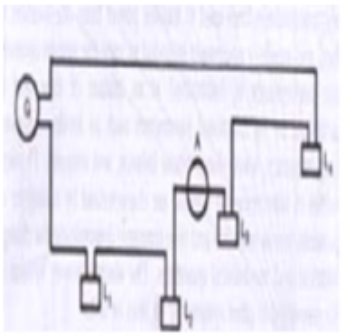
all loads will continue to be served even if one line section' is put out of service.

In normal operation the loop may be open at some point at **A** as shown in the figure.

In case a line section is to be taken out, the loop is first closed at **A**

the line section is put on shut down.

In this way **no service interruption occurs.**



Loop System

1.9 Structure of a Power System

3. Network of line

the **same loads being served by a network**.

arrangement has a **higher reliability** as each load has **two or more circuits** of supply

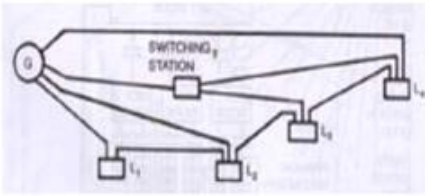
The **sub transmission and distribution circuits** are commonly designed as radial or loop circuits.

The **high voltage transmission lines** are generally laid as interconnected or networks.

Transmission and distribution are distinguished by their voltage levels.

general, transmission systems have **bulk power handling capability,** and relatively **long lines .**

connecting **generating stations** to **load centers** of the utilities.



Network of Lines

3. Explain functions of planning organization and different types of organization models.

1.12 Power Planning Organization

Functions of planning organization

1. **Vision mission and value** statement
2. **Practical** proposal **set up** to implement these
3. Decide the preferred **mode of development**
4. **Communicate the decisions** to design, construction and finance department , ensure developments are executed as per the plan.
5. Demand forecasts, generating plant , transmission and distribution requirements should be mentioned in **guides and manuals**

1.12 Power Planning Organization

Organization models

Different functions of electricity supply : G, T , D and C

1.Vertically integrated model : mostly used in India

2. Integrated model : IPP and NUG(Europe)

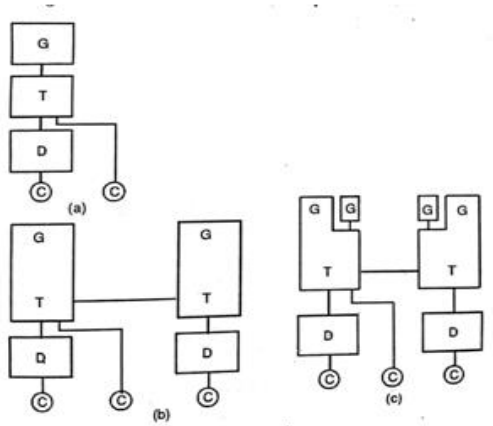
3. Open access model: long term basis, wheeling
(no direct dealings with consumer) (USA)

4. Spot market model : short term (generators and consumers can deal directly with each other) (UK)

5. Decentralized generator model

1.12 Power Planning Organization

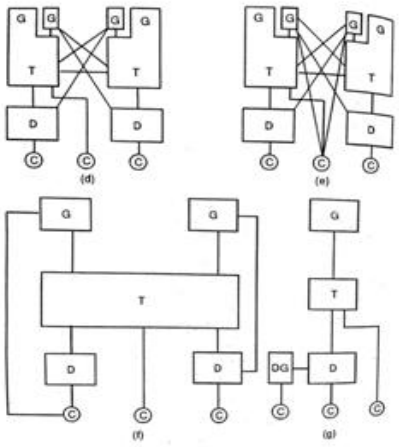
Organization models



a. Vertically Integrate Model
b. Integrated Model
c. Open access model
d. Spot market
e. Decentralized genera

1.12 Power Planning Organization

Organization models

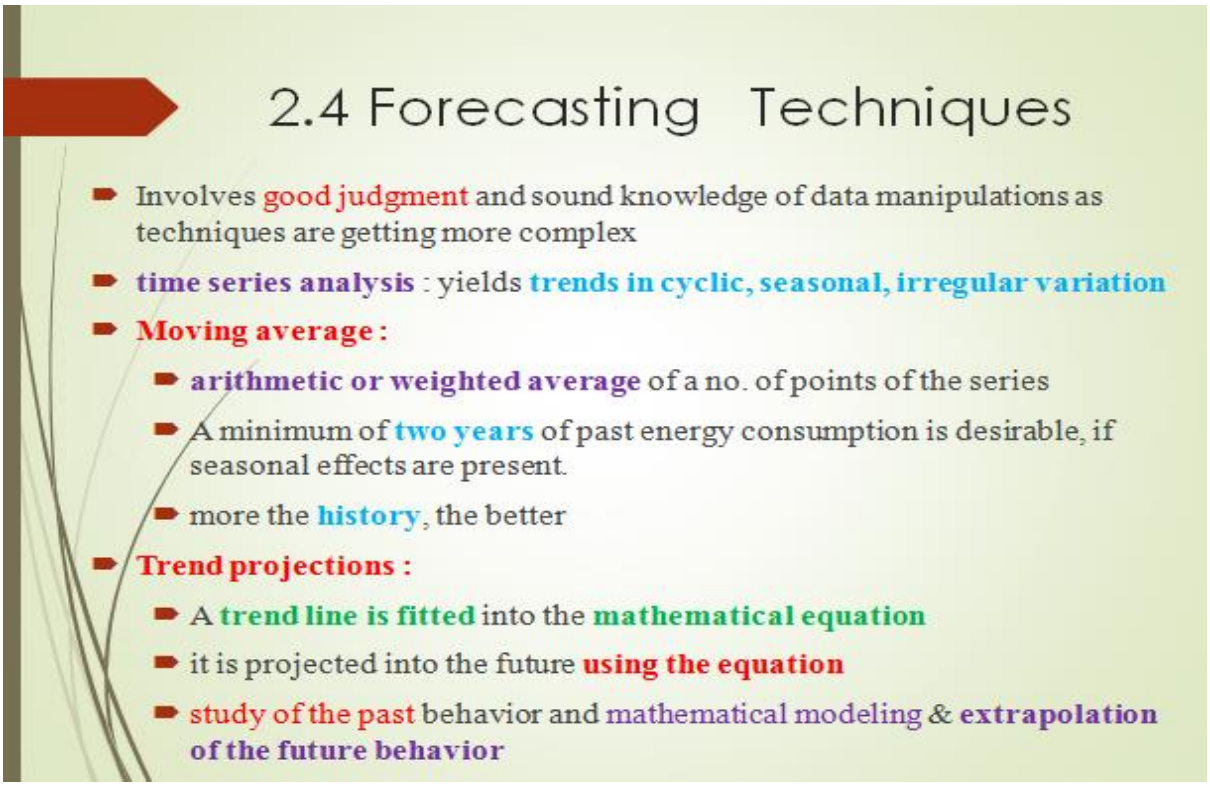


1.12 Power Planning Organization

Reasons to have different models

1. To lower **electricity costs**
2. To guarantee **security and quality** of power supply
3. To seek **private investment**
4. To limit **environmental consequences**
5. To contribute for **social and political objectives**

4. Explain forecasting techniques



2.4 Forecasting Techniques

- **Trend projections : Two general approaches :**

1. Regression analysis :

- **Fitting of continuous math functions** through actual data to achieve least overall error

2.Fitting of a sequence on discontinuous lines / curves

- Prevalent in **short term forecasting**

2.4 Forecasting Techniques

- **Power system load can be broken down :**
  - (i) **Basic trend**
  - (ii) **Seasonal variation**
  - (iii) **Cyclic variation** :longer than the above

causes the load pattern to be repeated (2/3 yrs)

- (iv) **Random variations** :day-to-day changes

time of the week-(weekend, week day)

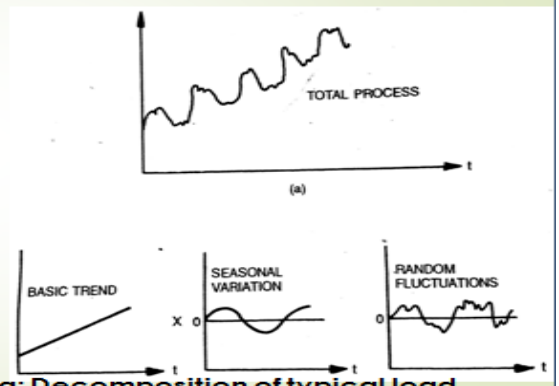
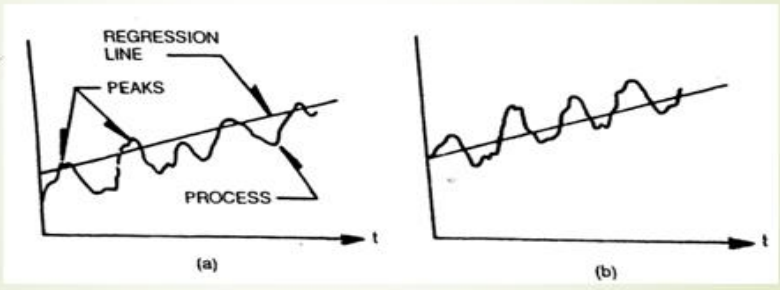


fig: Decomposition of typical load growth curve

2.4 Forecasting Techniques



5. Explain different factors affecting for the forecasting.

2.5 Forecasting Modelling

Factors Affecting the Forecasting :

- **many factors** which influence the prediction of load
- vary from area to area and from country to country
- any factor ➡ properly examined ➡ forecasting model

1.Time dependent factors :

- Power systems exhibit **a time dependent pattern** of electric **load demand**.
- these factors **are regular, irregular or random** in nature.
- Regular pattern is exhibited during the **time of day, day of week and week of the year, and yearly growth**

2.5 Forecasting Modelling

- **Irregular pattern** — **holidays, weekends, special days** etc
- **load requirements** tend to **differ on these days** than on other days.
- load patterns are different **on weekdays and weekends**
- **holidays and special days** on **load demand**
  - extent of public participation
  - impact on **industrial activity**
  - **state-level celebrations** requiring excessive **lighting load**

2.5 Forecasting Modelling

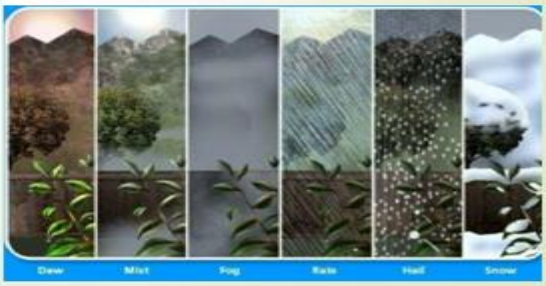
2.Weather Dependent Factors :

- Weather is one of the **principal causes** of load variations
- as it affects domestic load, public lighting, commercial loads etc.
- essential to choose relevant weather variables
- **model their influence** on power consumption

2.5 Forecasting Modelling

2. Weather Dependent Factors :

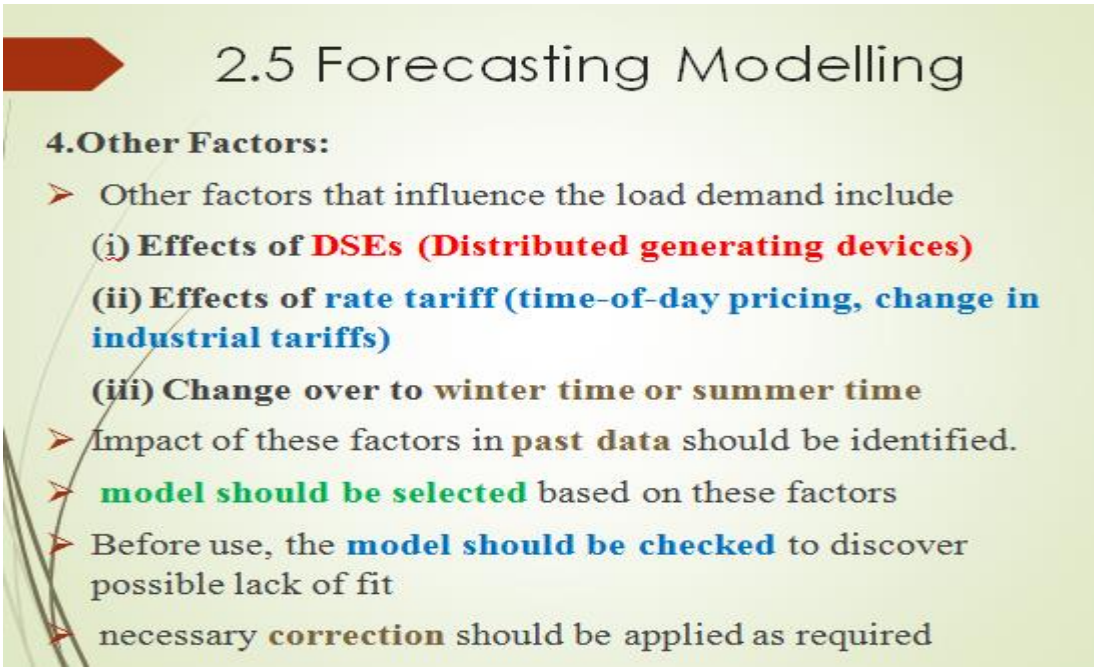
- Principal weather variables **temperature**, **cloud cover**, **visibility** & **precipitation**.
- The first two factors affect the domestic/office (e.g., heating, cooling) loads
- others affect lighting loads as they affect daylight illumination.



2.5 Forecasting Modelling

3. Random Factors:

- **random phenomena** which affect **load consumption** and can cause **large errors** in load forecast.
- It is **difficult to accurately model their actual impact** on **load demand**.
- These include **school holidays, factory strikes**, and influence of popular **TV programmes**.
- Influence of these Phenomena can be studied if **past data** on these occurrences are available.

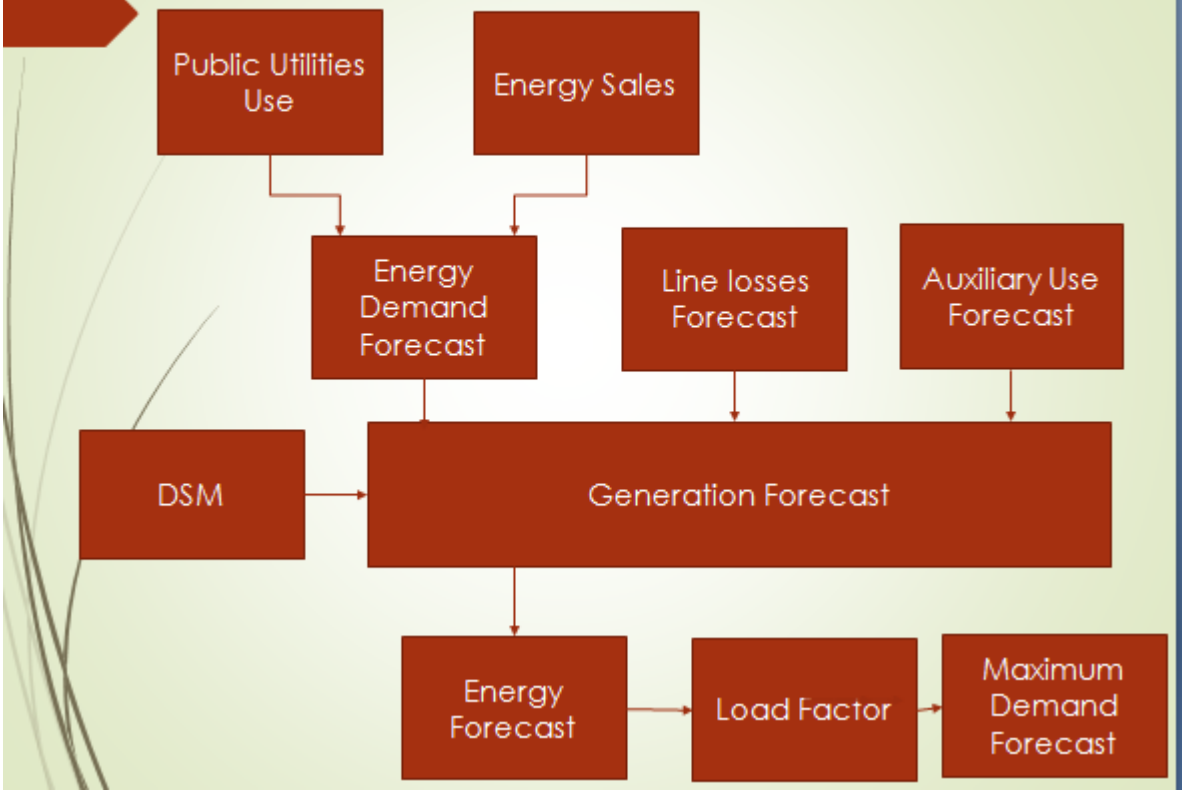


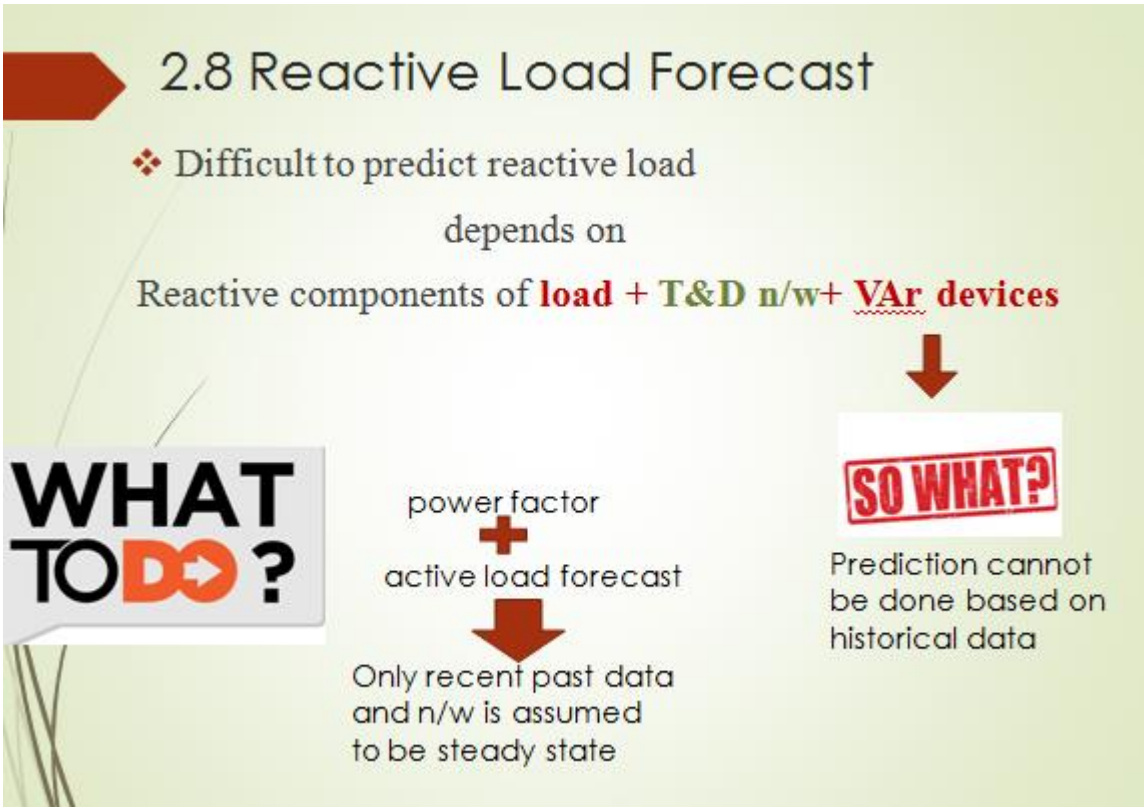
6. Explain Peak-Load Forecast and Reactive Load Forecast.

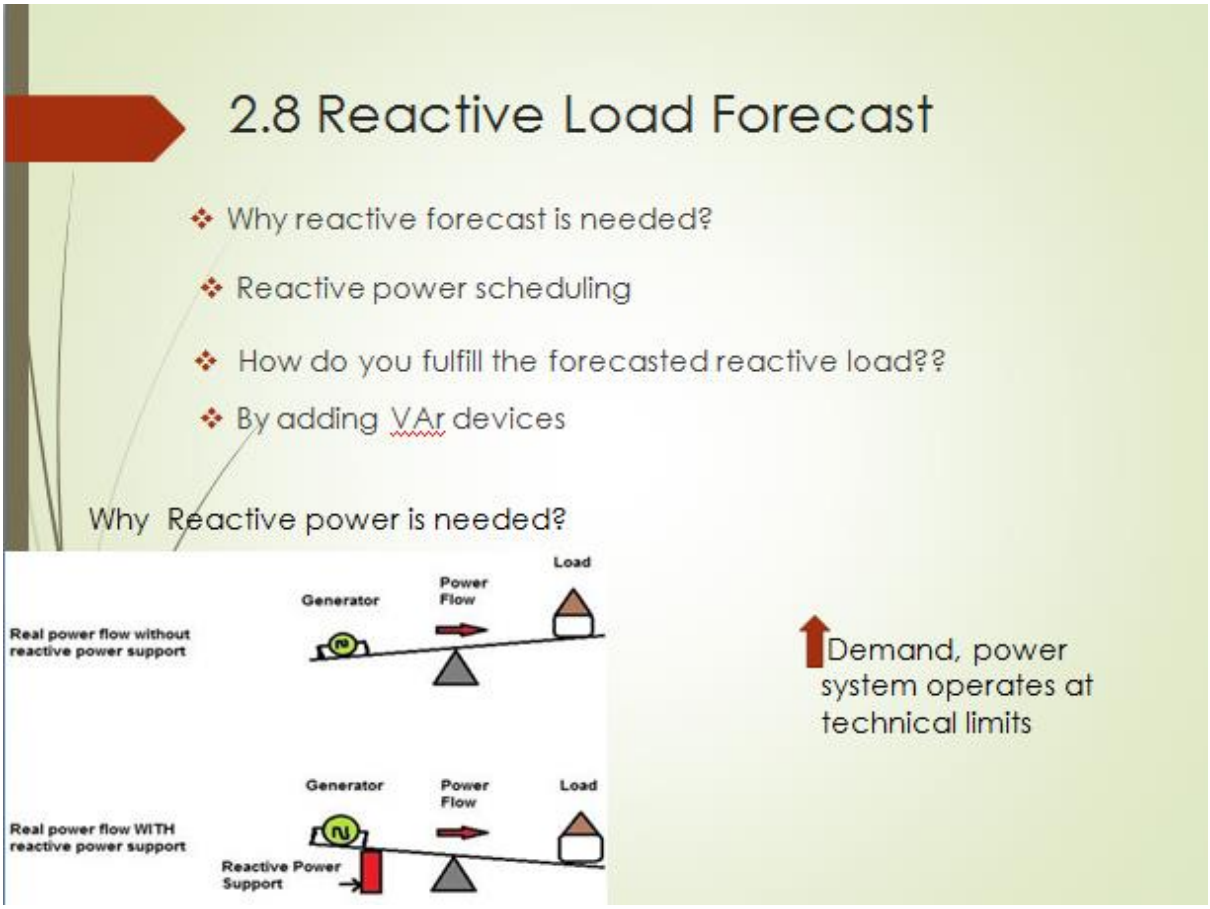
2.7 Peak Load - Forecast

- Total energy includes public lighting, sewage pumping, water works, railway traction , auxiliary consumption of G and losses
- To estimate peak ➡ Load factor to be forecasted
- $\frac{Annual\ Energy\ Forecast}{8760*LF} = Annual\ System\ Peak(P)$

2.7 Peak Load - Forecast







7. Explain the things to study under private participation in detail.

3.4 Private Participation

Things to study under private participation

1. Ownership
2. Debt-equity ratio
3. Modes of participation
4. Bidding for private entrants
5. Power purchase agreement with co-generators

3.4 Private Participation

- Private power projects are important as a part of the **country's investment resources**
- Under the Indian Electricity (Supply) Act, the private sector generating companies, transmission or distribution companies are encouraged **to participate in power sector**.
- Another **advantage** of private' sector participation

  new work and management skills

  timely execution of the project

  quality in work and service

3.4 Private Participation

Table 3.1 *Financial parameters*

S.No.	Item	Unit	Value
1	Debt: % of capital cost	%	70
2	Equity: % of capital cost	%	30
3	Working capital: % of capital cost	%	6
4	Interest on debt	%	11.5
5	Return on equity	%	15.5
6	Interest on working capital	%	12.25
7	Discount rate	%	9.0
8	O&M charges: power plant	%	2.5
9	O&M charges: transmission line	%	1.5
10	Depreciation: power plant	%	5.28 for 12 years

interest(%) during construction is $= \frac{C*R*N}{2*12*100}$

where, C= Cost of project in Rs.
R = Rate of interest
N = Construction and commissioning period in months.

3.4 Private Participation

OWNERSHIP:

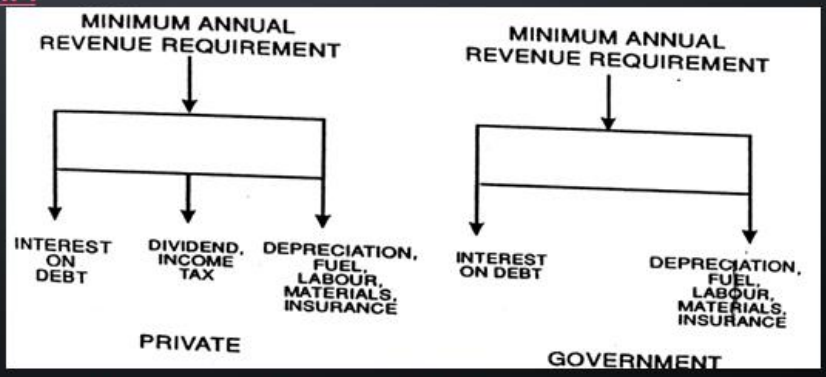
- **Power utilities** have a **natural monopoly**.
- The efforts are to remove this monopoly by creating **supply market** as in **UK** , **USA**, **Argentina**, **Australia.**
- The **consumers** will be **free to choose their suppliers**.
- **Rapid decision**-making, **risk-taking** and **innovation** are needed.
- **these qualities** are usually **lacking in state-owned undertakings.**
- **Privatization** will **restructure** the electricity **supply industry** in the near future.
- It will **break up vertically integrated monopolies** in search **of lower costs** and **higher productivities.**

3.4 Private Participation

- **OWNERSHIP:**
  - The **public sector** and **private sector** power utilities have **different financial structures**
  - Various **private sector options**
  - **turnkey contract**, **BOOT**, **BOO**, BOL, ROL etc.
    - **BOO** (**Build-own-operate**)
    - **BOOT** (**Build-own-operate-transfer**)
    - **ROL** (**Rehabilitate-operate-lease**) are **common for old plants**
  - **BOM** (**Build-own-maintenance**) for **new transmission lines.**

3.4 Private Participation

- **OWNERSHIP:**
-



- Fig: showing the **finance structure of private & public utilities**.

3.4 Private Participation

- **Incentives given by the government to private investment are:**

1. Private sector units **can set up coal/lignite/**oil/gas-based thermal, hydel, wind and solar energy projects of **any size.**

2. a)Private enterprises **can set up units**, either as **licensees**

distributing power in a **licensed area**

own generation or purchased power

b)as **generating companies**, generating **power for supply to the grid**.

3.4 Private Participation

3. **Captive power plants** may be allowed to set up, they can **sell or distribute power** to state power utilities

4 .Both **licensees** and **generating companies** can **enjoy** the following **Benefits**:

(i) Up to **100% foreign equity participation** can be **permitted for projects** set up by **foreign private investors**.

(ii) With the **approval of the government**, import of equipment for power project will be permitted.

(iii) Approved return

3.4 Private Participation

Debt: Equity ratio (4:1) ↑ ratio ↑ risk for lenders

Debt

1. Long term loans
2. Convertible and non-convertible bonds
3. Deferred payments
4. Redeemable preference shares

Equity

1. Ordinary paid-up share capital
2. Irredeemable preference shares
3. Free reserves
4. Central/state subsidy
5. Long term interest-free unsecured loan
6. Non-refundable deposits for cooperatives

3.4 Private Participation

Mode of participation

1. **Purchase or contract**: **IPP** based on PPA
2. **Franchise monopoly** :monopoly rights to supply **specific areas**
3. **By-passing** : Wheeling power (either directly to consumer or T&D n/w)

3.4 Private Participation

Bidding for private entrants

1. Levelized tariff-based bidding :ITPs
2. Cost –Plus approach

a. MoU route
b. Competitive bidding route: RFQ,RFP, submission , signature c & e
c. PPA
d. Fuel supply agreement
e. IA
f. O & M A
g. Financial close

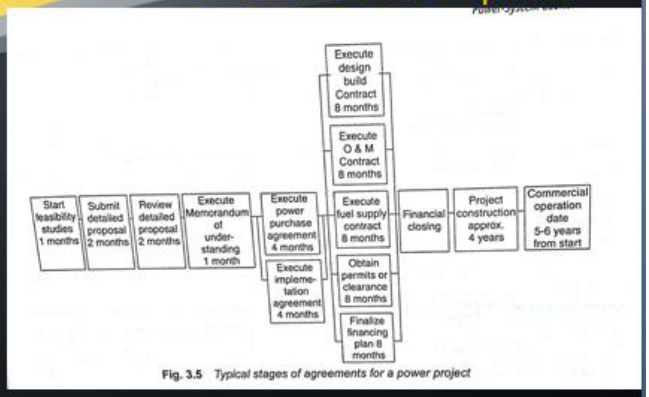


Fig. 3.5 *Typical stages of agreements for a power project*

Explain in details