CAPITAL UNIVERSITY - KODERMA

POWER SYSTEM -2 ASSIGNMENT

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1.Explain Least Cost Planning

Ans: Least-cost planning is a process by which electric utilities evaluate the costs, benefits, and risks of different resources for meeting electric power demand (including traditional power plants and energy efficiency) in an effort to arrive at the mix of resources that will meet future demand at the lowest cost while still providing reliable electric services.

3.Describe the two techniques of load forecasting in power system

Ans: Generally, load-forecasting methods can be classified into two broad categories: parametric methods and artificial intelligence–based methods. The artificial intelligence methods are further classified into neural network–based methods and fuzzy logic–based methods. The parametric methods are based on relating load demand to its affecting factors by a mathematical model. The model parameters are estimated using statistical techniques on historical data of load and its affecting factors. Parametric load-forecasting methods generally can be categorized under three approaches: regression methods, time-series prediction methods, and gray dynamic methods.

4.Write a note on distribution planning

Ans: Distribution system planning is the process electric utilities use to determine appropriate investments in the infrastructure that delivers power to individual homes and businesses. As the energy industry changes, distribution system planning must modernize, as well.Distribution system planning is the process electric utilities use to determine appropriate investments in the infrastructure that delivers power to individual homes and businesses. As the energy industry changes, distribution system planning must modernize, as well.

To ensure reliable service for customers, utilities regularly assess their distribution systems and determine whether any modifications, upgrades, or additions are necessary. As part of this distribution system planning process, the utilities create forecasts to understand and assess new demands and stresses on the distribution system. If electricity demand is expected to increase in a particular area, a utility may determine that existing infrastructure is inadequate to serve the new load. Traditionally, utilities would then add or upgrade infrastructure—such as a new substation or more transformers to accommodate the growing demand for power ensure reliable service for customers, utilities regularly assess their distribution systems and determine whether any modifications, upgrades, or additions are necessary. As part of this distribution system planning process, the utilities create forecasts to understand and assess new demands and stresses on the distribution system. If electricity demand is expected to increase in a particular area, a utility may determine that existing infrastructure is inadequate to serve the new load. Traditionally, utilities would then add or upgrade infrastructure—such as a new substation or more transformers—to accommodate the growing demand for power.

6.What is the need for private participation in generation planning? How can it improve the power Situation in India?

Ans: India suffers from widespread shortages of electricity supply. These shortages, among others, are detrimental to the economic growth. The prospects for the next decade do not seem to be much brighter. Efforts in expanding generation capacity by the state-owned electric utilities are hampered by severe resource constraints. Against this backdrop, to mobilize additional resources to help bridge the gap in demand and supply, the Government of India formulated a policy in 1991 with the objective to encourage greater investment by private enterprises in the electricity sector. To study the implications of such an initiative on various stakeholders, viz., public utilities, consumers and private sector, the present paper tries to analyse issues like planned rationing, guarantees to private sector, backing down of existing capacity. Using the state of Karnataka (in Southern India) as a case study, the paper develops multiple scenarios using an integrated mixed integer-programming model. The results show the advantage of marginal non-supply (rationing) of electricity in terms of achieving overall effective supply demand matching as well as providing economic benefits to the state that could be generated through cost savings. The results also show the negative impacts of high guarantees offered to the private sector in terms of the opportunity costs of reduced utilization of both the existing and the new public capacity. The estimated generation losses and the associated economic impacts of backing down of existing and new public capacity on account of guarantees are found to be significantly high. For 2011–12, depending on the type of scenarios, the estimated generation and economic losses are likely to be in the range of 3200–10,000 GWh and Rs. 4200–13,600 million respectively. The impact of these losses on the consumers could be in terms of significant increase in energy bills (in the range of 19–40% for different scenarios) due to rise in tariffs.

7. Discuss wheeling in power system and list the typical objectives in wheeling?

Ans: In electric power transmission, wheeling is the transportation of electric energy (megawatt-hours) from within an electrical grid to an electrical load outside the grid boundaries. Two types of wheeling are 1) a wheel-through, where the electrical power generation and the load are both outside the boundaries of the transmission system and 2) a wheel-out, where the generation resource is inside the boundaries of the transmission system but the load is outside. Wheeling often refers to the scheduling of the energy transfer from one Balancing Authority (Balancing Authority, Tie Facility and Interconnection) to another. Since the wheeling of electric energy requires use of a transmission system, there is often an associated fee which goes to the transmission owners. In a simpler sense, it refers to the process of transmission of electricity through the transmission lines.

Despite its advantages, the implementation of power wheeling faces both technical and economic challenges. The first technical challenge is the congestion of the network. Heavily loaded transmission network restricts additional generators to be integrated into the system. The safe operation of the network is constrained by the network's thermal capacity and voltage. Additional integrated generators cause power flow changes in the network which may overload constrained lines in the network. Furthermore, operation voltage constraint may also be exceeded if the network is heavily loaded. Another issue is network line losses which are proportional to the square of line current. The implementation of power wheeling can increase the transmission line current which substantially causes significant line losses. Hence, power flow analysis is strongly required prior to the integration of generators to the network by power wheeling.

8.Explain the effect of power generation on environment.

Ans: During the generation of electricity, and in their decommissioning and disposal. These impacts can be split into operational impacts (fuel sourcing, global atmospheric and localized pollution) and construction impacts (manufacturing, installation, decommissioning, and disposal). The United States Environmental Protection Agency clearly states that all forms of electricity generation have some form of environmental impact. The European Environment Agency view is the same. This page looks exclusively at the operational environmental impact of electricity generation. The page is organized by energy source and includes impacts such as water usage, emissions, local pollution, and wildlife displacement.

Electric power systems consist of generation plants of different energy sources, transmission networks, and distribution lines. Each of these components can have environmental impacts at multiple stages of their development and use including in their construction.

Water usage is one of the main environmental impacts of electricity generation. All thermal cycles (coal, natural gas, nuclear, geothermal, and biomass) use water as a cooling fluid to drive the thermodynamic cycles that allow electricity to be extracted from heat energy. Other energy sources such as wind and solar use water for cleaning equipment, while hydroelectricity has water usage from evaporation from the reservoirs. The amount of water usage is often of great concern for electricity generating systems as populations increase and droughts become a concern. In addition, changes in water resources may impact the reliability of electricity generation.

Most electricity today is generated by burning fossil fuels and producing steam which is then used to drive a steam turbine that, in turn, drives an electrical generator.

More serious are concerns about the emissions that result from fossil fuel burning. Fossil fuels constitute a significant repository of carbon buried deep underground. Burning them results in the conversion of this carbon to carbon dioxide, which is then released into the atmosphere. The estimated CO_2 emission from the world's electrical power industry is 10 billion tonnes yearly. This results in an increase in the Earth's levels of atmospheric carbon dioxide, which enhances the greenhouse effect and contributes to global warming.

Depending on the particular fossil fuel and the method of burning, other emissions may be produced as well. Ozone, sulfur dioxide, NO_2 and other gases are often released, as well as particulate matter. Sulfur and nitrogen oxides contribute to smog and acid rain. In the past, plant owners addressed this problem by building very tall flue-gas stacks, so that the pollutants would be diluted in the atmosphere. While this helps reduce local contamination, it does not help at all with global issues.

Fossil fuels, particularly coal, also contain dilute radioactive material, and burning them in very large quantities releases this material into the environment, leading to low levels of local and global radioactive contamination, the levels of which are, ironically, higher than a nuclear power station as their radioactive contaminants are controlled and stored.

Coal also contains traces of toxic heavy elements such as mercury, arsenic and others. Mercury vaporized in a power plant's boiler may stay suspended in the atmosphere and circulate around the world.

10.Explain reactive power balance in power system

Ans: The voltage along an alternating current (AC) transmission line depends on both the capacitive charging and the loading of the line. The former is due to the capacitance between the line's conductors and Earth and depends on the line geometry. The capacitance generates so-called reactive power in the line. The reactive power balance determines the voltage stability of a transmission line, no matter whether it is an overhead or cable line.

If there is an excessive amount of reactive power, the voltage will increase in the system. If there is a lack of reactive power, the voltage will decrease. Therefore, the reactive power must be controlled in order to maintain voltage stability.

11.Explain computerized management of power system?

Ans: Computer Control of Power System

Operation in plants with automated computer control of power system work mainly in a central control room. In olden plants, the controls for the equipment are not centralized and the switchboard operators control the flow of electricity from a central point, whereas, auxiliary equipment operation work throughout the plant, operating and monitoring valves, switches and gauges.

Electric power systems have grown in size and complexity. Their power generation, transmission and distribution methods and equipment have constantly improved in performance and reliability. The power industry in nuclear plant was among the first to use analog controls for turbine generators and introduced the use of on-line digital control computers. These advances were often needed because of the enormous growth in megawatt requirements of the power systems.

ENERGY MANAGEMENT SYSTEM (EMS)

Energy management is the process of monitoring, coordinating and controlling the generation, transmission and distribution of electrical energy] It is performed at centres called 'system control centres', by a computer system called Energy Management System (EMS). Data acquisition and remote control is performed by the computer system called SCADA, which forms the front end of EMS. The EMS communicates with generating, transmission and distribution systems through SCADA systems.

Automatic generation control and economic dispatch minimize the production cost and transmission cost. Commit the number of units to be operated to minimize the cost and schedule hydro-thermal plants properly have come under energy management.

Energy management system consists of energy management, AGC, security control, SCADA, load management.

The functions of energy management systems are:

- System load forecasting – Hourly energy, 1 to 7 days.
- Unit commitment – 1 to 7 days.
- Fuel scheduling to plants.
- Hydro-thermal scheduling – upto 7 days.
- Interchange evaluation – with neighbouring system.
- Transmission loss minimization.
- Security constrained dispatch.
- Maintenance scheduling.
- Production cost calculation.

14. Write all steps required to design a transmission line.

Ans: During design of transmission tower the following points to be considered in mind,

- The minimum ground clearance of the lowest conductor point above the ground level.
- The length of the insulator string.
- The minimum clearance to be maintained between conductors and between conductor and tower.
- The location of a ground wire with respect to outermost conductors.
- The midspan clearance required from considerations of the dynamic behaviour of the conductor and lightning protection of the power line.

To determine the actual transmission tower height by considering the above points, we have divided the total height of the tower into four parts:

- Minimum permissible ground clearance (H1)
- Maximum sag of the overhead conductor (H2)
- Vertical spacing between the top and bottom conductors (H3)
- Vertical clearance between the ground wire and top conductor (H4)

16. State the factors to be considered in the selection of a voltage suitable for transmitting a certain Amount of power over a given distance.

Ans: Ability to save conductor size (usually steel and aluminum conductors not copper) which in turn saves money by ability to save conductor size (usually steel and aluminum conductors not copper) which in turn saves money by less material lower cost and construction efforts

Smaller wire size give double advantage by decreasing the weight and reducing strength requirements which makes them lighter still smaller wires gives less wind "catch" and reduces tower loads.

Less strong towers due to doubly reduced weight and lower wind "catch" saves costs as towers farther apart due to lower weight (sag) and stress.

Energy loss due to I^2*R loss can be made smaller if you give up the double advantage mentioned above, e.g. add back wire size to reduce losses instead of losing weight related advantages. Weight savings are a one time savings but energy efficiency keeps paying back with dividends over time.

However the following technical issues drives the voltage downwards:

Increases complexity for higher voltages larger conductor separation to prevent arcing makes bigger more expensive towers closer spaced towers adds to cost, they have to be closer to prevent arcing as longer lines can sway more in winds moving them too close if the towers are far apart

Bigger insulators, more special breakers and switch gear result in steeply increasing costs when the voltage is too high probably higher maintenance costs due to HV breakdown issues and ageing.

The most economic transmission scheme balances the advantages of high voltage with the disadvantages of higher voltages. I'm sure they must do massive spreadsheet calculations to see what the relative costs are.

But it seems most transmission systems top out at about 500 KV, so I'm guessing that's close to the most economical point.

17. Explain station earthing system with earthing grid.

Ans: The primary requirements of a good earthing system in a substation are: It stabilizes circuit potentials with respect to ground and limits the overall potential rise. It protects life and property from over voltage.

The substation earthing system comprises of a grid (earth mat) formed by a horizontal buried conductors.

The grounding system in substation is very important. The functions of grounding systems or earth mat in include:

- Ensure safety to personnel in substations against electrical shocks.
- Provide the ground connection for connecting the neutrals of stat connected transformer winding to earth (neutral earthing).
- Discharge the overvoltages from overhead ground wires or the lightning masts to earth. To provide ground path for surge arresters.
- Provide a path for discharging the charge between phase and ground by means of earthing switches.
- To provide earth connections to structures and other non-current carrying metallic objects in the sub-station (equipment earthing).

In addition to such a grid below ground level, earthing spikes (electrodes) are driven into the ground. They are connected electrically to the earth grid, equipment bodies, structures, neutrals, etc. All these are connected to the station earthing system by earthing strips.

If the switchyards have a soil of low resistivity, earth resistance of the earthing system would be low. If the soil resistivity is high, the mesh rods are laid at closer spacing. More electrodes are inserted in the ground.

The fence, equipment body, tanks, support, structures, towers, structural steelworks, water pipes, etc. should be earthed.

Earth Resistance Value

The value of earth resistance of the ground system determines the voltage rise of the various earthed points during the earth fault.

If earth fault current is I, earth resistance is R, the voltage rise under short circuit condition would be V= IR.

The permissible potential rise and the maximum possible earth fault current set a limit on the maximum value of earth resistance.

To achieve earth resistance within specified limits, enough number of earth spikes and sufficient surface area of the earth grid and closer ground mesh rods are necessary.

The touch potential and earth potential in the switchyard under any earth fault condition should be within safe limits.

18.Write short note on Power system over voltages.

Ans: Transient over voltages can be generated at high frequency (load switching and lightning), medium frequency (capacitor energizing), or low frequency. Over voltage due to external causes:

This cause of over voltage in power system Overvoltage faults may occur between a phase and the ground or between phase conductors. It is the caused primarily by thunderstorm activity, specifically by lightning strokes in the cloud discharges. Overvoltages, due to atmospheric discharges, manifest themselves most on overhead lines and in sections of unshielded cables.

19. Explain how voltage regulation and losses in a power system is determined?

Ans: In electrical engineering, particularly power engineering, voltage regulation is a measure of change in the voltage magnitude between the sending and receiving end of a component, such as a transmission or distribution line. Voltage regulation describes the ability of a system to provide near constant voltage over a wide range of load conditions. The term may refer to a passive property that results in more or less voltage drop under various load conditions, or to the active intervention with devices for the specific purpose of adjusting voltage.

Voltage regulation in transmission lines occurs due to the impedance of the line between its sending and receiving ends. Transmission lines intrinsically have some amount of resistance, inductance, and capacitance that all change the voltage continuously along the line. Both the magnitude and phase angle of voltage change along a real transmission line. The effects of line impedance can be modeled with simplified circuits such as the short line approximation (least accurate), the medium line approximation (more accurate), and the long line approximation (most accurate).

$\%$ Voltage Regulation$=((V_{nl})-(V_{fl}))/(V_{fl}) \times 100$

Where Vnl is voltage at no load and Vfl is voltage at full load. The percent voltage regulation of an ideal transmission line, as defined by a transmission line with zero resistance and reactance, would equal zero due to Vnl equaling Vfl as a result of there being no voltage drop along the line. This is why a smaller value of Voltage Regulation is usually beneficial, indicating that the line is closer to ideal.

Distribution feeder regulation

Electric utilities aim to provide service to customers at a specific voltage level, for example, 220 V or 240 V. However, due to Kirchhoff's Laws, the voltage magnitude and thus the service voltage to customers will in fact vary along the length of a conductor such as a distribution feeder (see Electric power distribution). Depending on law and local practice, actual service voltage within a tolerance band such as ±5% or ±10% may be considered acceptable. In order to maintain voltage within tolerance under changing load conditions, various types of devices are traditionally employed:

A load tap changer (LTC) at the substation transformer, which changes the turns ratio in response to load current and thereby adjusts the voltage supplied at the sending end of the feeder;

Voltage regulators, which are essentially transformers with tap changers to adjust the voltage along the feeder, so as to compensate for the voltage drop over distance; and

Capacitors, which reduce the voltage drop along the feeder by reducing current flow to loads consuming reactive power.

A new generation of devices for voltage regulation based on solid-state technology are in the early commercialization stages.

Distribution regulation involves a "regulation point": the point at which the equipment tries to maintain constant voltage. Customers further than this point observe an expected effect: higher voltage at light load, and lower voltage at high load. Customers closer than this point experience the opposite effect: higher voltage at high load, and lower voltage at light load.