IDENTIFICATION OF FACTORS FOR SITE SELECTION OF THERMAL POWER PLANT (TPPS)

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ABSTRACT

A power plant affects the environment surroundings during its construction and operation. These effects are of temporary and permanent nature. A power plant take up space on the ground and in the air, use water resources, and, in most cases, emit pollutants into the air. The plant's footprint on the ground eliminates second opportunity in some cases. It can also affect the existing or future uses of adjoining and nearby land also. Therefore, it is required to analyze any location before the installation of power plant. The analysis should take care of all the factors and sub-factors that affect power plant site selection. The main objective of this paper is to identify the critical factors help in Selecting the location of Thermal Power plant (TPPs).

Keywords*: *Factors, Identification, Location, Selection, Thermal Power Plant

I. INTRODUCTİON

Energy planning aim involves finding a set of sources and conversion devices so as to meet the energy requirements/demands of all the tasks in an optimal manner [1].Making an energy planning decision involves a process of balancing ecological, social, technical, and economic aspects over space and time. This balance is important to the survival of nature and to the prosperity of energy dependent nations [2].

Selecting a proper site for a thermal power plant is important for its long term efficiency and a lot many factors come into play when deciding where to install the plant. Of course it may not possible to get everything which is desirable at a single place but still the location should contain an optimum mix of the requirements for the settings to be feasible for long term economic justification of the plant.

II. GUIDELINES FOR SITE SELECTION OF THERMAL POWER PLANTS

Guidelines of Ministry of Environment and Forests (MoEF), Government of India, for location selection of Thermal Power plants (TPPs) [3].

1. Locations of TPPs are avoided within 25 km of the outer periphery of the following:

1.1 Metropolitan cities,

1.2 National park and wildlife sanctuaries, and

1.3 Ecologically sensitive areas like tropical forest, biosphere reserve, important lake and coastal areas rich in coral formation.

2. The sites should be chosen in such a way that chimneys of the power plants do not fall within the approach funnel of the runway of the nearest airport;

3. Those sites should be chosen which are at least 500 m away from the flood plain of river system.
4. Location of the sites are avoided in the vicinity(say 10 km) of places of archaeological, historical, Cultural/religious/tourist importance and defense installations.
5. Forest or prime agriculture lands are avoided for setting up of thermal power houses or ash disposal.

Guidelines of Central Electrical Authority (CEA), Government of India, for location selection Thermal Power plants (TPPs) [3].

1. The choice of location is based on factors like availability of land, water, coal, construction material, etc.
2. Land requirement for TPP is 0.2 km2 per 100 MW.
3. The land for housing is taken as 0.4 km2 per project.
4. Land requirement for ash pond is about 0.2 km2 per 100 MW.
5. Water requirement is about 40 cusecs per 1000 MW.
6. Location of thermal power station is avoided in the coal-bearing area.
7. Coal transportation is preferred by dedicated marry-go-round rail system.

III. FACTOR AFFECTING SELECTION OF LOCATION OF THERMAL POWER PLANT

Table 1The Factors and Sub-Factors for Selection of Location of Power Plant [2, 4, 5, 6]

Factors	Sub-Factors
Availability of resources	Land availability Water availability Fuel availability Skilled manpower availability
Economical impact	Land acquisition cost Investment cost Operation and maintenance cost Payback period Future development limitations Possibility of Site expansion
Environment concern	Degradation of local air quality Land Use Impacts Dust Noise Effect on water bodies
Social concern	Job creation Public acceptance Number of relocation Distance from public area
Accessibility	Road/Rail/Airport accessibility Transmission grid accessibility Electricity consumption point Urban area accessibility

IV. AVAILABILITY OF RESOURCES

4.1 Land Availability

Power plant needs a wide range of land requirements. For example, coal plants tend to need larger areas to support rail lines, coal piles, and landfills. Natural gas-fired power plants may only need area for the generation facilities and support equipment. Needed information includes the site size (acres), and the portion of the site (acres) that would be occupied by plant buildings and systems. Generally, sites with ample space may be preferred. Land requirement for thermal power projects depends on many factors viz. unit size and number of units; type of coal (indigenous or imported); location (pit-head or coastal) etc. whereas Nuclear power plants require far less land area. For a 1000-MW plant, site requirements are estimated as follows: nuclear, 1- 4 km^2 (247- 988 acres), solar or photovoltaic park, 20-50 km^2; a wind field, 50-150 km^2; and biomass, 4,000-6,000 km^2 [7]

4.2 Water Availability

Many power plant technologies use water from lakes, rivers, municipal water utilities, or groundwater. Surface water is used for plant cooling and groundwater is used for plant processes. Generally, the presence of adequate and usable water resources at or near a site is preferred over sites with remote, inadequate, or low-quality water resources. Sites with nocompeting water uses are generally preferred to sites with many uses. For a typical 2x500 MW plant the plant requirement is 4000m^3/h[7].

4.3 Fuel Availability

Fuel availability influences choices positively; its marginal utility is diminishing with supply.
Without a higher level of availability, alternative fuels are unlikely to be adopted[8].

4.4 Skilled Manpower Availability

A power plant requires labor for construction and operation. Local communities can benefit from these employment opportunities. Generally, sites that can make use of local labor are more desirable. These sites would have a larger skilled work force within a short distance from the plant site.

V. ECONOMICAL IMPACT

5.1 Land Acquisition Cost

Each site will have unique land acquisition requirements and effects. Generally, sites that have lower land acquisition costs and require shorter acquisition times are more desirable.

5.2 Future Development Limitations

The construction of a plant at a particular site may create limitations on future development in the local area through its effect on land use or through its consumption of local PSD air increments, water resources, or water discharge capacity. Generally, sites that impose fewer limitations on future development may be more desirable.

5.3 Possibility of Site Expansion

A site might be able to support more generating capacity than proposed. It's usually more economical and environmentally acceptable to add generating capacity at an existing site than to build at a new site.. Often, an expandable site may be more desirable. But, a potential concern of local property owners is the effect of plant

siting on nearby property values. Generally, sites that enhance property values or minimize the decrease in property values may be more desirable.

5.4 Payback Period

The return on the investment are essential factors in determining whether a particular installation is worthwhile or not. Payback period is the time in which the initial cash outflow of an investment is expected to be recovered from the cash inflows generated by the investment.

Formula of payback period:

$$\text{Payback period} = \frac{\text{Investment required for a project}}{\text{Net annual cash inflow}}$$

5.5 Operation and Maintenance Cost

\The expenditure incurred on operation and maintenance of the project includes the expenditure on manpower, repairs, spares, consumables, insurance and overheads.

The CERC (Central Electricity Regulatory Commission) has specified O&M Costs for thermal power stations on the normative parameters (Rs. lakh/MW), depending on the class of the machine installed by the power station. The normative O&M expenses allowed are:

Table2. Electric act 2003

Rs Lakh/MW	200/210/250 MW	300/330/350 MW	500 MW	600 MW and Above
2009-10	18.20	16.00	13.00	11.70
`2010-11	19.24	16.92	13.75	12.37
2011-12	20.34	17.88	14.53	13.08
2012-13	21.51	18.91	15.36	13.82
2013-14	22.74	19.99	16.24	14.62

5.6 Investment Cost

The expenditure incurred with expectation of capital appreciation, Profit, rents or some combination of these returns. Generally, sites that require less investment are more desirable.

VI. ENVIRONMENT CONCERN

6.1 Degradation of Local Air Quality

Operating power plants that burn coal, oil, or natural gas emits air pollutants into the atmosphere requiring the plant be fitted with pollution control equipment to reduce emissions. Many of these Power plant air pollutants have been identified and are regulated by CENTRAL POLLUTION CONTROL BOARD(CPCB). Public exposure to air emissions (air pollution) is regulated by the CPCB through the National Ambient Air Quality Standards(NAAQS) for major air pollutants, including sulfur dioxide (SO_2), nitrogen oxides (NOx), carbon monoxide (CO), ozone (O_3), particulate matter ($PM_{2.5}$ or PM_{10}), and lead (Pb). The CPCB is charged with enforcing the NAAQS.SO_2 has been a cause of acid precipitation, commonly known as “acid rain,” which can damage vegetation and acidify lakes. Species vulnerable to acidic conditions have trouble reproducing and, in some cases, die. NO_x and volatile organic compounds (VOCs) are components of ozone formation. Ozone is a

principal component of smog and can result in respiratory health and other environmental effects. A more significant concern is the NO_X and So_2 emission from power plants that burn coal or natural gas. These compounds are part of a complex chemical reaction in the atmosphere that creates nitrate-based and sulfate-based fine particulates. Mercury (Hg) is naturally present in small quantities in the environment. Human activities have greatly increased the concentration of this pollutant in the air and water. Coal-fired power plants are the biggest category of mercury emitters. Mercury is very volatile and can travel around the world in the atmosphere, repeatedly being deposited and re-emitted into the atmosphere. Mercury is deposited in lakes and rivers by rain, snow and surface runoff once deposited in waterways, bacteria can convert mercury into methyl mercury that can be easily absorbed by fish and other organisms. Eating contaminated fish is the primary pathway for human exposure to mercury. Ingested mercury can damage the nervous system, especially in children and fetuses.

Table3.National Ambient Air Quality Standards (NAAQS) [9]

S. no.	Pollutant	Time Weighted average	Concentration in Ambient Air		
			Industrial, Residential, Rural& Other Areas	Ecologically Sensitive Area	Methods of Measurement
1	SO2, µg/m3	Annual 24 hours	50 80	20 80	Improved west and gaeke Ultraviolet fluorescence
2	NO2, µg/m3	Annual 24 hours	40 80	30 80	Modified Jacob &Hochheiser Chemiluminescence
3	PM10 or less than 10 µg/m3	Annual 24 hours	60 100	60 100	Gravimetric Beta attenuation
4	PM2.5 or less than 2.5 µg/m3	Annual 24 hours	40 60	40 60	Gravimetric Beta attenuation
5	Ozone µg/m3	8 hours 1 hours	100 180	100 180	UV photometric Chemical Method
6	Lead(Pb) µg/m3	Annual 24 hours	.50 1.0	.05 1.0	ED-XRF Using Teflon filter
7	Carbon Monoxide (CO) µg/m3	8 hours 1 hours	02 04	02 04	Non Dispersive Infrared spectroscopy
8	Ammonia (NH3) µg/m3	Annual 24 hours	100 400	100 400	Chemiluminescence Indophenol blue method

6.2 Land Use Impacts

Industrial forests are a valuable commodity. Site evaluation should address the forest resources of the site and nearby lands, and the effects of plant construction and operation on these resources. Generally, more desirable sites have fewer impacts on these resources.Typically, active or vacant industrial lands may be more compatible and urban residential lands may be less compatible with power plants. Generally, sites that are more compatible with present and planned land uses are more desirable.

6.3 Dust

The “nuisance” impacts of fugitive dust are of particular concern to nearby residents. “Fugitive" dust is PM (Particulate Matter)suspended in the air by wind action and human activities. It has not come out of a vent or a stack, and is usually not a by-product of burning. Fugitive dust particles are composed mainly of soil minerals (e.g. oxides of silicon, aluminum,calcium, and iron), but can also contain sea salt, pollen, spores, tire particles, etc. About half of fugitive dust particles (by weight) are big particles, larger than 10 microns in diameter (the average human hair is 70 microns in diameter).These larger particles settle out more quickly, on the ground.However, the other half are particles 10 microns or smaller, or PM10. Due totheir very small size and weight, PM10 particles can remain airborne for weeks. When inhaled, PM10 particles can travel easily to the deep parts of the lungs and may remain there, causing respiratory illness, lung damage, and even premature death in sensitive individuals. Generally, more desirable sites are those with fewer sources of fugitive dust and greater distances to adjacent residences and sensitive locations.

6.4 Noise

Noise is of particular concern to nearby residents. Information of interest includes noise caused by plant construction and operations, distance of noise sources from sensitive locations such as parks and residences, and applicability of local noise ordinances or other thresholds. Generally, more desirable sites maximize the distance between the noise source and the public, have landscape features that would absorb noise between the plant and the public, and have no receptors within any areas where noise guidelines or ordinances are exceeded. Sounds that are 85 dBA (decibels) or above can permanently damage your ears. The distance from the source to the boundary of the power plant property can dissipate some of this noise. Noises can be blocked or muffled by intervening landscape features like trees.

6.5 Effect on Water Bodies

There are potential operational impacts on wildlife and wildlife habitat besides effects from air and water quality changes due to the combustion process. They include impacts related to fuel such as coal dust runoff, impacts related to cooling such as fish caught in cooling water systems or the discharge of heated cooling water into streams or lakes, or other impacts such as bird mortality from striking structures or new power lines. Generally, sites that minimize negative impacts on wildlife from power plant operations are preferred.

VII. SOCIAL CONCERN

7.1 Job Creation

The economic impact of a plant includes the jobs and purchases associated with the construction and operation of a plant. A cogeneration project may also help to keep existing industry jobs in the community. Generally, sites that generate or preserve more jobs in the local area may be more desirable.

7.2 Public Acceptance

The location of a power plant has many effects that are of interest to the local community. There are both advantages and disadvantages to be considered. Measures of local interest and concern include the current attitudes of local citizens and officials regarding a potential power plant in the local community, the local questions raised, the public input received, and public support or opposition to a particular site. Generally, a site where the public attitude is positive or supportive may be preferred.

7.3 Number of Relocation

The property owner impacts of a potential plant site are of significant concern for local communities. One concern is how many homeowners and businesses are located at the proposed site and would have to be moved if the plant were built. Generally, sites needing less relocation are more desirable.

7.4 Distance from Public Area

The intent of buffering is to minimize the visual and noise effects of the plant by increasing the distance to neighbors through use of surrounding land that provides visual and sound barriers. "Buffer area" refers to land between the plant facilities and adjacent property owners, especially residential property owners. Generally, sites with more or better buffer areas may be more desirable.

VIII. ACCESSIBILITY

8.1 Road/Rail/Airport Accessibility

Power plant construction and operation can require road, rail, or barge access to the site. The number and location of site entrances and the distances to and quality of nearby roads and rail lines are important. Sites with access solely from heavily traveled roads are less desirable than sites on less heavily traveled routes. However, closeness to major highways is desirable. The objective is to allow easy access to the site without causing traffic congestion or safety problems.

The roads in a power station can be divided into the following types:-

5.1.1 All main plant roads shall be 10 meter wide.

5.1.2 All secondary plant roads shall be 5 meter wide provided with 1.5 meter wide hard shoulders on either Side and shall be for access to plant auxiliary areas and buildings.

5.1.3 Peripheral roads along the boundary wall shall have adequate nos. of watch towers as per requirement.

Table4. Land Required for Roads Area in acres [7]

Description	2x500 MW	3x660 MW	5x660 MW	6x660 MW	4x800 MW	5x800 MW
Land for Roads	20	25	25	25	25	25

8.2 Transmission Grid Accessibility

An electrical grid is an interconnected network for delivering electricity from suppliers to consumers. It consists of generating stations that produce electrical power, high-voltage transmission lines that carry power from distant sources to demand centers, and distribution lines that connect individual customers.

8.3 Electricity Consumption Point

A power plant must be located near the load to which it is supplying the power. However a plant a plant cannot be located near all loads. As such C.G of the load is determined with reference to two arbitrarily axis[10].

IX. CONCLUSION

Site selection is a vital issue that must be analyzed deeply in order to have efficient power Generation from technical and economic point of view without damaging environment and Society. Selection of unsuitable location for power plant will lead to increased costs, waste of energy and resources, and increased environmental pollution, which has a tremendous negative impact on society. Therefore, it is required to analyze any location before the installation of power plant. So, this paper tries highlighting the main factors which helps in the Selecting the location of Thermal Power Plant.

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