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Lignite Resources of Rajasthan with Special focus on Bikaner District along with their Application

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ABSTRACT
The state of Rajasthan is endowed with large lignite deposits in the country after Tamilnadu& Gujarat. In the three districts of the state viz. Bikaner, Nagaur and Barmer, geological reserves of more than one billion tonnes have been confirmed so far by exploratory drilling. Beside, deep seated reserves of lignite suitable for underground lignite gasification also exists in the state. The state is also having lignite blocks suitable for development of Coal Bed Methane projects.
The primary energy source and the foundation of Indian industry and the economy is coal. About 99% of the coal in India comes from Gondwana, and the remaining 1% is from the Tertiary period. The majority of India's Gondwana coal reserves are found in the eastern and south-eastern regions, while the Tertiary coals(Lignite)are found in Jammu & Kashmir, Tamil Nadu, Gujarat, Assam, and other north-eastern provinces. The TertiaryJaisalmer, Barmer, and Bikaner-Nagaur basins are lignite-producing basins in Rajasthan. Lignite/Brown coals contain a high moisture level, a very low calorific value, and a high ash content. It is frequently utilised as a fuel for thermal power plants that produce electricity. Coal is burned to create valuable heat energy, but the process pollutes the environment. India's emissions of air particulate matter and other trace gases, especially gases that cause the consequences of global warming, are influenced by the high ash content of its coal and ineffective burning techniques.
Keywords- *Geological reserves, Drilling, Lignite Gasification, Calorific value, Coal, Global warming etc.*

I. INTRODUCTION

The most prevalent fossil fuel in India is coal. It is frequently employed in thermal plants as a source of thermal energy to generate electricity. Due to the demand from households, businesses, and other entities that rely on electricity, power production in India has multiplied in recent decades. Its usage will rise steadily over time.

A dry, ash-free lignite may have a carbon concentration as high as 60–70%. Lignite typically has a carbon content of 25–35%. Additionally, it contains 6 to 19% ash and up to 75% moisture. Lignin has a calorific value of about 17 mega joules per kilogram.

Due to constant exposure to weather changes, some of the water content is even released, which may also cause brown coal to crumble or disintegrate. This thus lowers the value of lignite as a fuel. Additionally, it typically comes from the Tertiary era and is geologically younger than other higher-grade coals. Brown coal often falls between peat and bituminous coal in terms of density, texture, and carbon content. Different types of coal include peat, lignite, bituminous and anthracite,coal.

On a dry, ash-free foundation, lignite is brownish-black in colour and contains 60–70% carbon. Although its inherent moisture content can occasionally reach 75%, and its ash content ranges from 6-19% as opposed to 6-12% for bituminous coal. The measurement of lignite quality is a significant issue in the economic and technical appraisal of lignite reserves. Several factors, including moisture content, ash content, sulphur content, and calorific values, affect the quality of lignite.

In power plants, other sectors, and energy production, factors affecting lignite quality, such as moisture, ash, and sulphur, are crucial. Modelling these characteristics is therefore beneficial for making investment decisions. The majority of the Bikaner lignite deposits with poor calorific value have high levels of ash, moisture, sulphur, and volatile substances. There are a lot of countries in the globe that have lignite coal reserves. According to data from international energy sources, Bikaner produces over 4225 million tonnes of lignite annually and ranks second in India for lignite resources.

In India, there are various geological horizons with Gondwana and Tertiary coal. The tertiary coal in the Gondwana region is lignite, and it ranges from semi-bituminous to bituminous. Gondwana coal may be found in Jharkhand, Orissa, West Bengal, Chhattisgarh, Maharashtra, among other places, while tertiary coal (lignite) can be found in Tamil Nadu, Gujarat, Rajasthan, Assam, Jammu & Kashmir, among other places. In India, there are lignite deposits that date from the Eocene (Jammu & Kashmir), Miocene (Neyveli, Tamil Nadu), and Plio-Pleistocene (Nichahom, Jammu & Kashmir) epochs.TheGondwana and Tertiary coals have a low calorific value and a high ash content, making them of inferior quality. The lowest quality coal is delivered to power plants. Private corporations who own some coal mines do not want to spend money improving the quality. The process of burning coal produces ash and valuable heat energy, but it is also the phase of the process that raises the most environmental and health issues.

The entire coal system, from coal mining to preparation to processing and use, has some sort of environmental issue. In industrial settings, greenhouse gases (GHGs) are mostly produced by the usage of coal. India emits air particulates and other trace gases, including gases that cause the greenhouse effect, due to the high ash content of its coal and ineffective burning techniques. Fly ash is added to the air as a result of India's thermal power plants' current coal consumption, and the remaining coal is deposited on land or in bodies of water. Despite various research findings, a consistent utilisation is not yet apparent, and it is anticipated that fly ash stockpiles will continue to expand as India's number of super thermal power stations rises. This material, which is present in huge amounts, will come into touch with soil and water more frequently.For the purpose of producing electricity, process heat, and residential heat, as well as chemical ingredients, combustion and gasification as well as carbonization are used. The electricity produced by burning coal is by far the biggest consumer of these.

Most airborne inorganic particles, such as fly ash and suspended particulate matter (SPM), as well as carbon dioxide (CO2), sulphur oxides (SOx), nitrogen oxides (NOx), CFCs, and other trace gases are released when coal is burned in thermal power plants. CFCs, NOx, and CO2.

GEOLOGICAL SETTING

The MarwarSupergroup serves as a metaphor for the aranaceous high that divides the Tertiary strata in the Bikaner basin, which are elongate in shape and exist in two clearly distinct sections in the Bikaner districts. Sediments of continental and marine origin were deposited in the Tertiary sequence over the Neoproterozoic rocks of the MarwarSupergroup, or Nagaur Group. The formations of the Palana, Marh, and Jogira, which have conformable contacts, are its representations. It is bounded by E-W trending faults on the north and south, and is distinguished by basement highs in Dulmera, Suratgarh, and other places. At Matasukh and Barsingsar, recent open cast lignite mining in the region revealed new geological sections.

The Bikaner basin, often referred to as the Palana-Ganganagar shelf, is an extended basin with an E-W trend that spans 200 km and has a maximum width of 50 km in a north-south direction. The basin maintains the Palana and Ganganagarembayments and connects to the Indus basin by curving eastward. There is alluvial cover throughout the entire area. The underlying Palana Shale is composed of black shales, lignite, fuller's earth, and fire clay, all of which thin down towards the west.

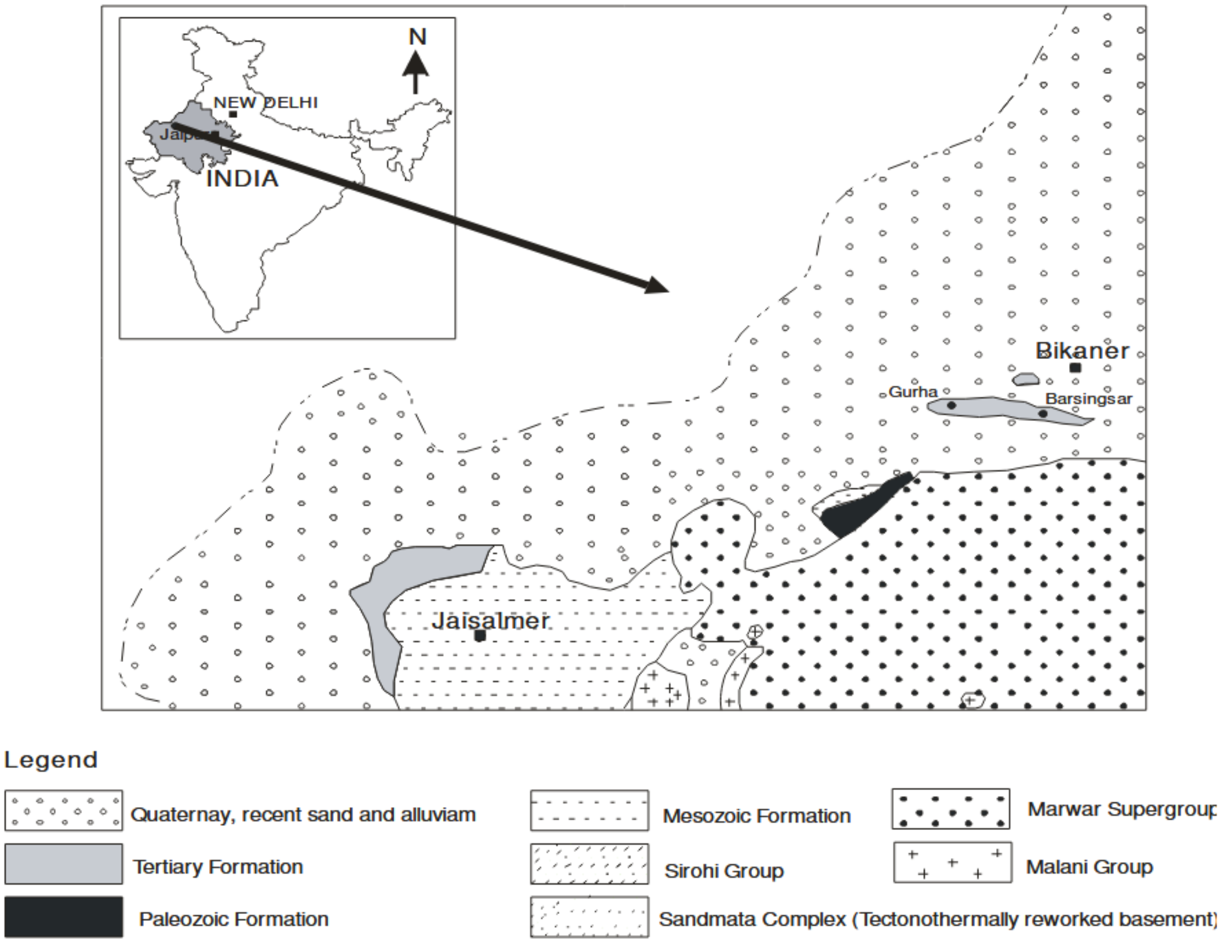

Fig. Geology of Bikaner basin, Rajasthan.

LIGNITE OCCURRENCES IN BIKANER BASIN

In Rajasthan, the Bikaner basin is a significant location for Tertiary coals and is thought to contain sizeable lignitic resources. There are also highly promising but lesser-known lignite resources in the Basin, such as Barsingasar. The lignite deposits in Jammu & Kashmir, Gujarat, and Rajasthan are Eocene, Miocene, and Plio-Pleistocene ages, respectively, as is Neyveli in Tamil Nadu. These lignite mines are also newcomers to the coal mining scene in India. Despite being difficult to predict due to lignite's occurrences as lensoid bodies, the total lignite bearing area is not more than 4,000 square kilometres. For the Palana and Matasukh mines, the coal industry has only produced a small amount of geological and coal characteristic data over time. The information is focused on coal exploration and is mainly limited to the local active mines. Additionally, data generated by the coal and power industries are typically limited to depths of less than 100 metres, leaving a significant portion of the coalfield unexplored in terms of both area and depth. This is primarily due to a lack of demand and demoralising initial exploration results.

The lignite deposits in Rajasthan's Bikaner area are known to exist in a number of locations and date from the Palaeocene to Lower Eocene. All of Rajasthan's lignite outcrops and their accompanying landforms are hidden by the desert sand. The Palana-Barsingsar deposits are the most significant lignite deposits in this region of the Basin since there are operational mines there. Since 1898, lignite has been confirmed and mined in Palana through an underground shaft; however, due to auto-combustion, lignite mining was halted in 1967 and resumed in the early 1990s. Here, a lignite seam with a half-saucer shape is found in association with Nummulitic limestone and Fuller's earth. The lignite body has a 6 to 8 kilometre trend from the northwest to the southeast. While lignite is absent from a sizable portion of the coal-bearing Formations, it does occasionally appear to have been replaced by carbonaceous shales. Palanaand Marh Formation's medium to coarse grained sandstone and clay are overlaid on top of the formation in a gradational pattern. The Marh Formation is entirely buried behind a substantial accumulation of Quaternary sediments, with a layer of desert sand covering the top. The lithological relationship of lignite, fine- to medium-grained sandstone intercalation, and grey to black carbonaceous pyritic shale indicates deposition in decreasing parallic / marshy environment. A total coal thickness of between 30 and 40 m is anticipated in the area's one significant regionally established unit of thick lignite in the Palana Formation.

II. LIGNITE & ITS APPLICATIONS

Lignite, a premature type of coal, is a dark brown to black combustible mineral that has been generated over millions of years as a result of plant material that was partially decomposed under high pressure and temperature in an atmosphere devoid of oxygen. Simply put, lignite is a type of brown coal. Compared to Fixed Carbon, lignite is porous, light in weight, and includes a higher percentage of volatile substances and moisture in its native state. Its long-distance transportation is therefore not profitable. As a result, this fuel is perfectly suited for powering a lignite-based power plant that is near to the pit head.

The Popular Applications of Lignite Include

- Electricity Generation (79%)
- Synthetic Natural Gas Production (13%)
- Production of Fertilizers (7%)
- Home Heating and Oil Well Drilling Mud (1%)

Ultimate and Proximate Analyses Summaries of the outcomes of the ultimate and proximate analyses of lignite samples of the Barsingsar are provided in Tables 1 and 2, respectively, and the same are graphically illustrated in Figure 3. The results from ultimate analysis on dry basis (db) and dry ash-free (daf) along with the H/C and O/C atomic ratios are illustrated in Table 2. The concentrations of sulfur (0.18–0.97%, 0.42%), carbon (22.57–63.52%, 51.38%), nitrogen (0.45–1.27%, 0.93%), hydrogen (2.90–4.66%, 3.88%) and oxygen (17.56–22.19%, 20.03%) were obtained through ultimate analysis. The O/C (0.20–0.56, 0.31%) and H/C (0.75–1.56, 0.95%) ratios were calculated from the ultimate results. The results of proximate analysis on as-received basis, with the db and daf equivalents, are provided in Table 3. The lignites have low moisture content (7.03–13.65%; 9.86%), high volatile matter (32.58–44.22%, 36.70%), high fixed carbon (24.40–45.11%, 34.89) and high ash yield (4.38– 33.58%, 18.56%).

Table 1. Result of ultimate analysis of coals of Bikaner basin (Barsingsar lignite mines)

S. No.	Coalfield	Coal Seam	Band No.	Dry Basis					Dry Ash-Free Basis					Atomic Ratio	
				C%	H%	N%	S%	O%	C%	H%	N%	S%	O%	H/C	O/C
			Bottom												
1	Barsingsar	BS	1	62.18	4.66	0.91	0.97	21.61	69.02	5.11	1.01	1.05	23.75	0.88	0.25
2	Barsingsar	BS	2	62.87	4.49	1.03	0.55	19.98	70.68	5.07	1.17	0.61	22.45	0.86	0.24
3	Barsingsar	BS	3	63.52	4.05	1.09	0.48	17.67	73.11	4.68	1.23	0.57	20.32	0.75	0.20
4	Barsingsar	BS	4	51.90	3.72	0.99	0.34	20.39	67.14	4.79	1.31	0.39	26.34	0.84	0.28
5	Barsingsar	BS	5	59.92	4.05	1.03	0.34	20.31	69.98	4.71	1.19	0.44	23.71	0.82	0.24
6	Barsingsar	BS	6	52.37	4.42	0.83	0.30	21.00	66.38	5.62	1.03	0.41	26.51	1.02	0.30
7	Barsingsar	BS	7	22.52	2.90	0.45	0.18	17.56	51.60	6.61	1.05	0.38	40.23	1.56	0.56
8	Barsingsar	BS	8	37.19	3.56	0.73	0.24	22.19	58.18	5.64	1.11	0.36	34.75	1.16	0.44
9	Barsingsar	BS	9	61.88	3.87	1.09	0.26	19.83	71.17	4.50	1.29	0.31	22.84	0.74	0.26
10	Barsingsar	BS	10	43.32	3.74	0.80	0.28	17.80	65.69	5.63	1.23	0.42	26.88	1.04	0.32
11	Barsingsar	BS	11	46.83	3.24	1.27	0.65	22.06	63.24	4.36	1.69	0.86	29.76	0.82	0.36
			Top Mean	51.32	3.88	0.93	0.42	20.03	66.01	5.15	1.21	0.53	27.04	0.95	0.31

C carbon, H hydrogen, N nitrogen, S sulfur, O oxygen

Table 2. Result of proximate analysis (dry basis) of coals of Bikaner basin (Barsingsar lignite mines)

S. no	*S. no. Coalfield*	*Coal seam*	*Band no*	*Proximate constituents (Ar)*					*Dry basis*			*DAF basis*		
				Moisture	Ash	Volatile matter	Fixed carbon	Total	Ash	Volatile matter	Fixed carbon	Volatile matter	Fixed Carbon	Total
			Bottom											
1	Barsingsar	BS	1	13.51	4.38	41.23	40.88	100.00	5.05	47.67	47.28	50.21	49.79	100.00
2	Barsingsar	BS	2	13.65	11.23	40.45	34.67	100.00	12.97	46.87	40.16	53.90	46.10	100.00
3	Barsingsar	BS	3	11.35	9.84	38.42	40.40	100.00	11.10	43.33	45.57	48.73	51.27	100.00
4	Barsingsar	BS	4	8.98	12.00	34.36	44.66	100.00	13.18	37.75	49.07	43.48	56.52	100.00
5	Barsingsar	BS	5	9.80	20.57	32.58	37.06	100.00	22.77	36.13	41.10	46.78	53.22	100.00
6	Barsingsar	BS	6	10.70	12.78	35.86	40.70	100.00	14.31	40.11	45.58	46.81	53.19	100.00
7	Barsingsar	BS	7	10.87	19.50	36.99	32.65	100.00	21.84	41.49	36.67	53.12	46.88	100.00
8	Barsingsar	BS	8	8.59	18.48	44.22	28.72	100.00	20.17	48.39	31.44	60.70	39.30	100.00
9	Barsingsar	BS	9	7.03	33.58	33.16	26.23	100.00	35.82	35.82	28.37	56.29	43.71	100.00
10	Barsingsar	BS	10	7.92	12.04	34.96	45.11	100.00	13.08	37.93	48.99	43.64	56.36	100.00
11	Barsingsar	BS	11	7.88	28.29	36.54	27.38	100.00	30.69	39.57	29.74	57.10	42.90	100.00
12	Barsingsar	BS	12	7.24	35.45	32.92	24.40	100.00	38.20	35.49	26.31	57.45	42.55	100.00
13	Barsingsar	BS	13	10.65	23.10	35.58	30.67	100.00	25.87	39.82	34.31	53.80	46.20	100.00
			Top mean	9.86	18.56	36.70	34.89	100.00	20.39	40.80	38.81	51.69	48.31	100.00

Ar as-received basis, Drdry basis, DAF dry ash-free basis

THE FUTURE PROSPECTS OF THERMAL POWER PLANTS IN BIKANER

The amount of lignite that is present in the area has a significant impact on Bikaner. Low-grade coal known as lignite is frequently utilised as a fuel in thermal power plants. If there is enough lignite available, it can support the growth of the local economy and open up employment prospects. In addition to these advantages, Bikaner's thermal power plants can assist in supplying a consistent source of electricity to fulfil the expanding energy needs of the area. In rural places with limited access to energy, this is especially crucial. However, a number of other factors, such as the cost of production, the effects of burning fossil fuels on the environment, and the growing emphasis on renewable energy sources, will also have an impact on the prospects of Bikaner's thermal power plants in the future. Thermal power facilities may need to adapt and adopt cleaner technology, including carbon capture and storage, to remain operational in the long run as the worldwide push towards renewable energy sources continues. Overall, a variety of complex elements will influence the possibilities for Bikaner's thermal power plants in the future, and it will be crucial to take a variety of options into account to guarantee that the area can satisfy its energy needs in a sustainable and environmentally responsible manner.

QUALITY ASSESSMENT OF LIGNITE

The 'Gross Calorific Value' (GCV) of coal, also known as the heat value, is the most significant quality measure. The GCV of coal has a substantial impact on how much coal is priced by coal companies and how much energy is priced by producing firms. GCV is influenced by the site where samples are taken as well as the technique employed to measure it.

The ratio of the heat equivalent of the electrical energy produced by a thermal power plant to the heat produced by coal combustion, i.e. The overall efficiency of a thermal power plant in the modern era is roughly 29%.

These lignites have relatively high huminiteand inertinite content with respect to liptinite, along with significant amounts of mineral matter. High concentration of detrohuminite indicates abundance of herbaceous plants, while substantial textiniteconcentration indicates high degree of cell tissue preserved under relatively dry forest condition. The bands of high inertinite concentration indicate periodic dry (oxic) conditions during peat accumulation. GWI and VI indicate that these lignites were formed from a bog forest under ombrotrophic to mesotrophic mire condition. Low sulfur content (0.18–0.97%,<1% S) recorded in theBarsingsar indicates influence of fluvial environment in the region. The low huminite reflectance (%Rom) and Tmax values of Barsingsar lignite indicate their immaturity, which is also reflected in the geochemical data. Lignite contains a mixed kerogen type III/II, which indicates potential for lighter hydrocarbon. The ash of these lignites contains mainly quartz, siderite,coesite, aragonite and rutile. SiO_2 (41.07%) and Al_2O_3 (34.23%) are the predominant oxides, which suggest deposition.

ROADMAP FOR NEXT THERMAL POWER PLANTS

In Rajasthan, India, there is a 2,820-megawatt (MW) coal-fired power plant called Suratgarh Super Thermal Power Station. At the location, a further 1,320 MW of coal capacity was envisaged; it is assumed that this was abandoned.

Gudha West in the Bikaner district has a 10 lakh tonne per year lignite mining capacity. Resources stated that 2.31 lakh agricultural power connections would be released during the first phase in 2022–2023 and 2.58 lakh during the second phase in 2023–2024 at a review meeting of the Energy Department.

In the village of Barsingsar in Bikaner, the Neyveli Lignite Corporation of the Central government is already producing electricity with a 250 MW power plant, while two privately owned plants with 135 MW each are also producing electricity. The capacity of the State's power production and the price of electricity are projected to increase with the combined operations of mining and power generation. An ambitious proposal for lignite mining in Gudha West and the construction of a new lignite-based thermal power plant nearby was created earlier this year. This will guarantee that lignite is used within the State.

Neyveli Lignite Corporation (NLC) runs the 250 MW Barsingar power station, a lignite-based thermal power station. The power plant is situated in the Barsingsarneighbourhood of Rajasthan, India's Bikaner district. In June 2010, the 125 MW first unit was put into service. In January 2011, the 125 MW second unit went into operation.

A lignite-based thermal power station, the VS Lignite Power station is situated in the Rajasthani village of Gurha in the Bikaner district. KSK Energy Ventures is the owner of the power facility. The thermal power plant can produce 135 MW of power when installed.

III. METHODOLOGY USED FOR STUDY

From the Barsingsar lignite mine, 22 pillar coal samples were taken so that the entire thickness of the seam was visible. In order to generate coal powder and identify the ingredients, viz., the coal samples were crushed to -18 and -72 mesh sizes. We traced elements for analysis, maceral analysis, proximal analysis, etc.

IV. RESULTS DISCUSSION AND CONCLUSIONS

We know that environmental worries about the pollutant emissions from coal combustion have grown in recent years. When coal is burned, a variety of pollutants are produced, including gaseous, liquid, and solid pollutants in significant quantities. It has many pollutants. It is becoming more widely acknowledged that these pollutants have a number of negative effects on the environment, which impair public health and lower quality of life.

Moreover, due to the abundance of lignite mine reserves worldwide, lignite is only used as a fuel for the generation of steam-electric power. The only environmentally beneficial uses of brown coal are probably in agriculture and the dispersal of biocontrol bacteria, which are employed to stop harmful insects that transfer disease from injuring plants.

We are aware of lignite as the most hazardous type of coal, which comes with serious health dangers. It is caused by the significant quantities of harmful pollutants from combustion—like NOx, SO2, and dust—that are released into the atmosphere. If we are exposed to lignite-related air pollution, our risk factors for lung cancer, heart disease, and chronic bronchitis may increase.Additionally, because raw lignite contains a lot of moisture, the mine's CO2 emissions might be extremely high. As a result, in order to address the problem of air pollution brought on by the burning of lignite coal, we must adopt more responsible and environmentally friendly actions.

The incomplete oxidation of plant materials at high pressure and temperature in an oxygen-free environment over millions of years produces lignite, a highly flammable mineral that ranges in colour from dark brown to black. To put it another way, lignite is coal. Lignite is commonly accessible and easy to get. Electricity generated from lignite is dependable. It is possible to generate clean lignite power. Using lignite-based electricity is inexpensive. Environmentally friendly power plants use lignite. When coal is burned, sulphur produces SO2 and H2S, which are released into the environment as gases and particles. They will chemically react in the atmosphere with O2 and vapour to produce vitriol-vapor. If the right circumstances are present, acid rain will form, affecting the air and water quality, soil function, normal plant growth, and ultimately the way people live and interact with their surroundings).

AUTHOR'S REMARKS

We have studied in this article about the lignite sites in Bikaner, Western Rajasthan.The lignite mining capacity of 10 lakh tonnes is available in Bikaner district's Gudha West. We saw there is abundance of lignite with fine quality which can be used further for set up of more thermal power plants in this area. SoAuthor wants to seek the attention on this future roadmap of setting up of several more thermal power plants.

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