'**SPARK**', the IUCEE-RVCE Student Chapter aims at holistic development and practical oriented learning. In view of this a 2-day educational tour was organised to Yeramarus Thermal Power Plant and Raichur thermal Power Plant.

Yeramarus Thermal Power Station : India's First Super-Critical Power Plant

The SPARK team arrived to Yeramarus Thermal Power Station at around 11.30am and were excited for the learnings and industry expert lectures. We were escorted to the board room for a basic briefing about the power station by **Mr. Channappa Munolli** sir, **The Executive Engineer of YTPS.**

All the students were welcomed and taken to the board room for the briefing session in the presence of **Mr. H R Ramesh, I/c.Chief Engineer (O&M) & Project Head of YTPS.** The session was a good start for all of us to understand the working of thermal power plant and was well explained by the engineers.

Yermarus Thermal Power Station is a coal-based thermal power plant located in Yermarus village in Raichur district, Karnataka. The power plant is owned by the Karnataka Power Corporation. This is India's first 800MW super critical thermal power plant and Bharat Heavy Electricals is the EPC contractor for this power project.

We initially learned about KPCL [Karnataka Power Corporation Limited] and the projects under it:

Installed Capacity

The power generation capacity in the region consists of various sources, contributing to a diverse energy mix.
Hydel power holds a significant portion, with a capacity of 3666.6 MW, harnessing the energy from water resources. This renewable source plays a crucial role in providing clean and sustainable electricity to meet the region's needs. Additionally, mini hydel projects contribute to 13.15 MW to the overall hydel capacity, further enhancing the renewable energy generation capacity.
Thermal power plants also make a substantial contribution to the region's energy generation. The Raichur Thermal Power Station (RTPS) has a capacity of 1720 MW, while the Bellary Thermal Power Station (BTPS) generates 1700 MW. Another significant thermal power station, the Yelluru Thermal Power Station (YTPS), adds 1600 MW to the total thermal capacity. These power plants utilize fossil fuel resources to generate electricity efficiently.

In addition to hydel and thermal power, other sources also contribute to the overall energy mix. Diesel power generation plays a role with a capacity of 108 MW, providing a backup and supporting the grid during peak demand periods. Solar power installations contribute to 34 MW of clean and renewable energy, utilizing the abundant sunlight in the region. Furthermore, wind

power generation adds 4.555 MW to the energy mix, harnessing the power of wind to produce electricity.
Combining all these sources, the total power generation capacity in the region amounts to an impressive 8846.305 MW. This diverse energy mix ensures a reliable and sustainable supply of electricity to meet the growing demands of the region, while also incorporating renewable and environmentally friendly sources of energy. The combined efforts of these power generation facilities play a vital role in powering homes, businesses, and industries, ensuring a stable and efficient energy supply.

Ongoing Projects

Yelahanka GAS=370MW

New Projects

To install capacity of 6450 MW

Yeramarus Thermal Power Station (YTPS) is a power plant located in Karnataka, India. It operates under the Karnataka Power Corporation Limited (KPCL), which is responsible for power production and distribution in the region. The plant has a total power generation capacity of 8,846.305 megawatts per day. Additionally, there are ongoing projects, such as the Yelahanka gas project with an estimated capacity of 370 megawatts, and several proposed projects totalling 6,450 megawatts. YTPS spans over an area of 1,139 acres and employs 1,446 workers. The plant requires a daily water usage of 120,000 cubic units, sourced from the The Singareni Collieries Company Limited.

The coal used in the plant is graded based on its gross calorific value (GCV), with the boilers at YTPS using coal with a GCV of 4200. The boilers at YTPS include subcritical boilers operating at 221 kilograms per centimeter square (kg/cm^2), supercritical boilers operating above 221 kg/cm^2, and gives information on ultra-critical boilers operating over 270 kg/cm^2. The coal is pulverized and fed into the boilers through compartments. Steam generated in the boilers is first directed to high-pressure turbines and then to low-pressure turbines, working in conjunction with generators. This process results in temperature elevation.

YTPS has a five-year agreement with Singareni Collieries Coal Limited (SCL) and achieves a maximum monthly generation of 718.85 million units, recorded in December 2021. The plant boasts an efficiency rate of 45%. It has two handling plants: a coal handling plant and an ash handling plant.

Water supply is secured through an annual agreement of 1.5 lakh cubic units from the Krishna River. Electricity is consumed by the induced cooling tower, which operates using auxiliary power since it is not a natural cooling tower. YTPS sells coal at ₹240 per ton and purchases it for ₹6500 per ton. The transportation cost of coal is approximately ₹1 per ton.

Challenges faced by the coal plant include coal quality, boiler management, and temperature-related issues. General maintenance is carried out six to seven times per year, with a continuous 24-hour monitoring of boiler parameters and heating systems. Negative pressure caused by the induced cooling towers can sometimes prevent the flame in the boiler from igniting properly.

The dimensions of the boiler are 21 meters in length, 19 meters in width, and 85 meters in height. It operates at temperatures ranging from 1500 to 1900 degrees Celsius, using 3800 cubic units of demineralized water. YTPS utilizes spiral tube boilers due to their advantages over straight tube boilers, with the tubing made of T12 tubes.

The nearby Krishna River, located 14 kilometers away from the plant, provides water for the boilers, which contains alumina and silica. These substances can be used for agricultural purposes. The plant utilizes halogen lighting for illumination purposes, which offers advantages not provided by other lighting methods.



Yeramarus Thermal Power Station (YTPS) boasts several salient features that contribute to its efficient and reliable operation. Spanning across a vast area of 1139 acres, the power station is equipped with various key elements. The workforce at YTPS comprises 162 employees working within the power station, accompanied by 1178 individuals from PMPL (Preserved Monument Protection Limited), 61 from the security team, and 45 from the fire department, summing up to a total of 1446 dedicated personnel.

One of the critical resources for YTPS is the water source, which is supplied from the Krishna River, located approximately 14 kilometers away from the plant. The power station receives an impressive daily water supply of 120,000 cubic meters, ensuring an abundant and reliable source for its operations. The plant relies on Singareni Collieries Company Limited (SCCL) for the procurement of coal, securing a consistent and steady supply.

The boiler system employed at YTPS is a super-critical design with a once-through configuration. It utilizes radiant reheat, dry bottom, balanced draft, outdoor construction, and operates on a pulverized fuel and tangentially fired setup. The steam turbine consists of high-pressure (HP), intermediate-pressure (IP), and two low-pressure (LP) cylinders, forming a tandem

compound configuration. This setup facilitates efficient energy conversion within the power station.

With a generator capacity of 800 MW, YTPS ensures stable and reliable power generation. The generators operate at 941 MVA, 27 kV, with a permanent magnet generator (PMG), maintaining a rotational speed of 3000 RPM, and operating on a three-phase system at a frequency of 50 Hz.
YTPS houses eight HP1103 bowl mills per unit as part of its pulverizing system. These mills play a crucial role in grinding the coal into a fine powder, facilitating efficient combustion and energy release during the power generation process.
The project cost of YTPS amounts to a total of 13742.89 crores, inclusive of the installation of the Flue Gas Desulfurization (FGD) system. This system is employed to minimize the emission of sulphur dioxide, thereby contributing to the station's environmental sustainability efforts.

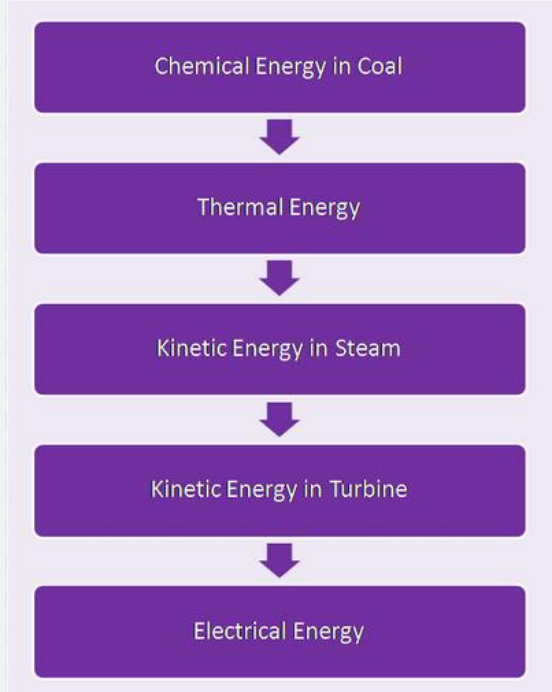
With a total capacity of 1600 MW, YTPS holds a significant position in the power generation sector. The power plant boasts a plant efficiency rate of 45%, signifying its effectiveness in converting fuel into electricity.
The super-heated steam within YTPS reaches a temperature of 568 degrees Celsius, operating at a pressure of 285 kg/cm3. This high-temperature, high-pressure steam is utilized for efficient power generation within the plant.

YTPS incorporates modern technology in the form of electrostatic precipitation, a process that efficiently removes particulate matter and ensures cleaner emissions, aligning with environmental regulations and sustainability practices.



The comprehensive set of features and advanced technologies implemented at YTPS highlight its commitment to efficient, reliable, and environmentally conscious power generation. The power station stands as a remarkable testament to the advancements in the thermal power sector, contributing significantly to meeting the region's energy demands.

We were then informed about the energy conversion in thermal power plants and 3 main components of the plant i.e., Boilers, Turbines and Generators.



We were given more information about the overview and working of the plant and also about the boilers and turbines.

They took us for a walkaround tour where we went to a height of 181 feet above and had an on-spot explanations of the working of the boilers and how the coal is transported, how the grade checking of the coal happens, how the cooling takes place, what are the machineries adopted for cooling and so on. They also explained that even though the temperature of the boiler is about 1500°C the fire doesn't come out due to the negative pressure inside the boiler, which was the highlighting part of our visit. A unique and well-organized system has been made for the transport of coal from the tippling point to the boiler point which was appreciable. We had a very enriching session with the engineers there and also took us to the control room and explained the protocols taken for the working, environment conditions, external factors, the output units and so on. Later we were also taken to the coal tippling point where we saw practically how the coal is unloaded from the train and then sent to the boiler units. We were taken to the workshop where they explained us the different machineries used. It was an eye opening for all of us to keep a gage on how far the instruments can be used.

YTPS operates with impressive steam parameters that ensure efficient power generation. The main steam flow, which amounts to 2592 tons per hour, carries tremendous energy to drive the turbines and generate electricity. The superheated steam within the system is maintained at a high pressure of 255 kg/cm2 and reaches a scorching temperature of 568 degrees Celsius. These extreme conditions enable optimal energy transfer and maximize the power output of the plant.

To maintain the steam cycle's efficiency, proper control over the feedwater temperature is essential. YTPS carefully manages the feedwater temperature at 294 degrees Celsius, ensuring optimal conditions for heat transfer and steam generation. The feedwater, which is heated through various processes, enters the boiler at this temperature, contributing to the overall energy conversion process.

After passing through the high-pressure section of the turbine, the steam undergoes expansion and reheating before entering the low-pressure section. The reheated (RH) steam flow at YTPS measures 2069 tons per hour. The RH steam operates at a reduced pressure of 60.8 kg/cm2 but attains a temperature of 596 degrees Celsius. This reheating process enhances the

steam's energy content and improves the overall cycle efficiency of the power plant.
These specific steam parameters are meticulously controlled and monitored at YTPS to ensure optimal power generation and efficiency. By maintaining precise control over steam flow, pressure, and temperature, YTPS maximizes energy conversion while ensuring safe and reliable operation of the plant. These parameters play a crucial role in achieving high thermal efficiency and generating electricity to meet the region's energy needs.

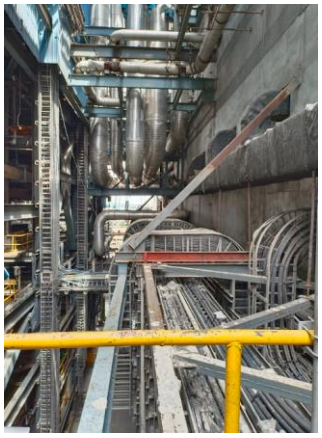
BOILER CLASSIFICATION

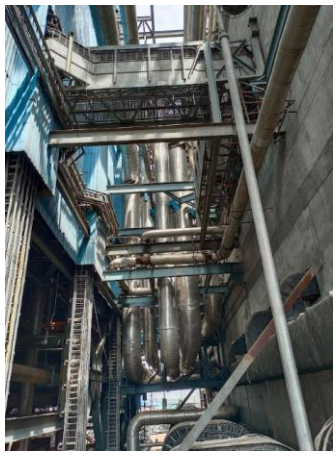
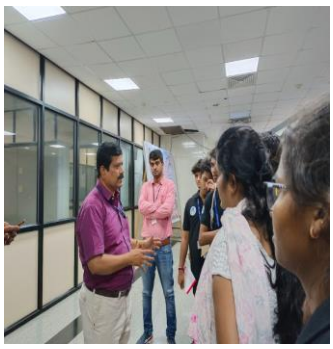
Boiler technology plays a crucial role in the efficiency and performance of power plants. Different boiler classifications are based on the steam pressure they can generate.

Subcritical boilers, operating at pressures below 221 kg/cm2, form the foundation of conventional power generation. These boilers produce steam at lower pressures, which undergoes expansion in the turbine to generate electricity. Although subcritical boilers are widely used and offer reliable power generation, they have relatively lower thermal efficiencies compared to higher pressure systems.

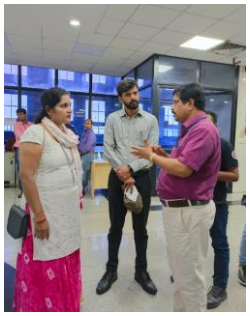
Supercritical boilers, on the other hand, are designed to operate at pressures above 221 kg/cm2. These boilers utilize higher steam pressures and temperatures to achieve improved thermal efficiency. The supercritical technology allows the water to reach a state where there is no clear distinction between liquid and steam phases. By operating at higher pressures, supercritical boilers enhance heat transfer and improve energy conversion, resulting in higher overall plant efficiencies. Advancing further, ultra-supercritical boilers are engineered to operate at pressures exceeding 270 kg/cm2. These boilers push the boundaries of steam pressure and temperature, enabling even greater thermal efficiencies. The ultra-

supercritical technology maximizes heat transfer and energy conversion, leading to significantly higher plant efficiencies and reduced emissions.



The choice of boiler technology depends on various factors, including the desired plant efficiency, operational requirements, and environmental considerations. While subcritical boilers are widely used and have served the power industry effectively, the development of supercritical and ultra-supercritical boilers represents significant advancements in power generation technology, allowing for more efficient and sustainable electricity production.


BEST PERFORMANCE OF YTPS UNITS

Glad to see the power station achieved remarkable milestones in terms of electricity generation, showcasing its operational efficiency and reliability. In December 2021, the highest monthly generation reached an impressive 718.085 million units (MU), with a Plant Load Factor (PLF) of 60.32%. This accomplishment highlights the power station's ability to meet the region's energy demands effectively.

Unit #1 set a record for the highest generation in a single day, producing 19.331 MU on 10th April 2021, resulting in a remarkable Gross PLF of 100.68% and a PLF of 101.68%. Similarly, Unit #2 achieved a significant milestone on 4th December 2020, generating 15.599 MU, with a Gross PLF of

81.24% and a PLF of 79.58%. These exceptional single-day performances demonstrate the power station's operational excellence and capacity to deliver substantial electricity output.

Furthermore, on 10th April 2021, the power station achieved a notable feat by generating 32.031 MU, accounting for an impressive PLF of 83.41%. Similarly, on 23rd August 2021, the station achieved its highest generation of 32.031 MU, resulting in a PLF of 83.41%. These accomplishments reflect the power station's ability to consistently deliver substantial electricity output on specific days.

Unit #1 achieved its highest monthly generation in April 2021, generating an impressive 522.403 MU, with a PLF of 90.69%. Similarly, Unit #2 set its highest monthly generation record in January 2022, producing 389.998 MU, with a PLF of 65.52%. These notable monthly achievements demonstrate the power station's capability to sustain high levels of electricity generation consistently.

Unit #1 and Unit #2 exhibited impressive continuous running periods, with Unit #1 operating for 51 consecutive days in March 2022 and Unit #2 running for 69 consecutive days in February 2023. These extended operational durations signify the power station's robustness and reliability in meeting continuous power demands.

Additionally, since August 2022, the power station has successfully achieved coal rakes unloading without incurring any demurrage charges. This accomplishment demonstrates effective management and coordination in ensuring smooth coal supply, minimizing operational disruptions, and optimizing efficiency.

Overall, these achievements showcase the power station's commitment to efficient and reliable electricity generation, setting benchmarks in monthly and daily generation records, continuous operation, and effective coal management practices. Glances of these enriched our knowledge and inspired us to work for these thermal units which has wide scope and getting to know the challenges faced and how they are dealt were mind-blowing.

One of the crucial components of the plant is the induced cooling tower. Unlike natural cooling towers, it requires auxiliary power to function. The blades of the tower have a four-degree incline, re lightweight, and resistant to corrosion due to the use of FRP (Fiber Reinforced Plastic) material. The blades rotate at a speed of 120 RPM, which is then transferred to a shaft rotating at 1500 RPM. Around 30% of the vapor is vaporized and subsequently compensated through nearby reservoirs.

The whole of the visit took place till 6p.m. in the evening with lunch break in the middle and we headed back to our accommodation place with bundles of knowledge and learning.

Raichur Thermal Power Station : Karnataka's First Thermal Power Plant

Day 02- 1st July, 2023

The second day of the educational trip was to visit Raichur Thermal Power Station. After a tiresome yet knowledgable first day, we woke up, got ready, had breakfast and started our journey to RTPS.

After a thorough checking at the entrance, we headed to the seminar hall and had a briefing session about the history of KPCL - that how it started as hydel power plant and then continued to become thermal power station along with an informative video and also an overview of RTPS.

The History:

The Raichur Thermal Power Station project was finalized in the year 1978 upon a MOU agreement signed between Karnataka State Electricity Board and Karnataka Power Corporation Limited. The Krishna River banks close to Raichur was chosen for the establishment of the project. The foundation for RTPS was laid by the then President of India Shri. N. Sanjiva Reddy in 1980 January 18th.

Initially the RTPS project had two stages for installing four units of thermal power plants (2 units each under both stages) for which 300 hectares of plot was chosen. Unit 1 was completed in 1985 March 29th, Unit II was completed in 1986 March 2nd, Unit III was completed in 1991 March 30th and Unit IV was completed in 1994 September 29th. Each of the four units has a capacity to generate 210 MW electric power.

In 1996 further expansion of RTPS was proposed and Unit 5 to 8 was established in between 1999 to 2010. Unit 5 and Unit 6 was completed in the year 1999 January 31st and 1999 July 22nd with 210 MW capacity each, Unit 7 was completed in the year 2002 December 10th with 210 MW capacity and Unit 8 was completed in the year 2010 April 9th with 250 MW capacity.

Power Generation in RTPS :

Coal is used as raw material for power generation in Raichur Thermal Power Station. Coal to RTPS is provided by Western Coalfields Limited and Mahanadi Coalfield Limited. The coal brought to RTPS undergoes serious quality check using computerized testing and laboratory testing before being used for RTPS power units. Recently washed coal with low ash content is also used by RTPS for power generation. Coal is brought to RTPS through rail wagons to the site directly.

To cool the power plants water is used from the River Krishna. The quality checked coal is crushed and sent to furnaces that convert water to stream. The stream thus generated is passed through the turbines to generate electric power. The 8 unit in RTPS generate 35 MU of electric power per day.

The Ash wastage from the power plants is removed by Slurry pumps and Pump pneumatic system. The removed ash is disposed in 193 hectares of land in the north end of the RTPS which is specially allotted for ash disposal.

Salient Features of RTPS :

- Raichur Thermal Power Station (RTPS) is a 1720MW coal-fired electric power station located at Shaktinagar in the Raichur district of the state of Karnataka, India. It is operated by the Karnataka Power Corporation Limited (KPCL) and was the first thermal power plant to be set up in the state. The power station was commissioned during various periods from 1985.
- RTPS has a total of 8 units out of which 7 units has a capacity to generate 210 MW power each and one unit has a capacity to generate 250 MW power so totally the Raichur Thermal Power Station generates 1720 MW electric power. The Raichur Thermal Power Station generates 40 % of the total electric power generated in Karnataka.

- It is a Steam Turbine power plant. The power plant run on dual-fuel. The primary fuel being used to power the plant is coal. In case of shortage of coal the plant can also run on Light Diesel Oil. The fuel is procured from Singareni Coal Fields, Western Coal Fields, Talcher Coal Fields.
- Raichur Thermal Power Station is equipped with steam turbines from Bharat Heavy Electricals Limited i.e., 7 units of 210MW capacity and 1 unit of 250MW capacity. BHEL also supplied electric generator for the 250MW unit.
- Steam Boilers for all the eight units of RTPS are also supplied from Bharat Heavy Electricals Limited.

Coal-Handling Plant:

We were taken in batches into the control unit for viewing the tippling of coal, how its been recorded the amount or weight of the coal and the it was very thought provoking for all of us. The huge amount of coal is usually supplied through railways. A railway siding line is taken into the power station and the coal is delivered in the storage yard. The coal is unloaded from the point of delivery by means of wagon tippler. It is rack and pinion type. The coal is taken from the unloading site to dead storage by belt conveyors. The belt delivers the coal to 0m level to the penthouse and further moves to transfer point.

Coal from the coal wagons is unloaded in the coal handling plant. This unloading is done by the “Tipplers”. This coal is transported up to the raw coal bunkers with the help of conveyor belts. After hand picking foreign material, coal is transported to the Crush house by conveyor belts where it is crushed to small pieces of about 20 mm diameter. The crushed coal is then transported to the store yard. Coal is transported to bowl mills by coal feeders. The coal is pulverized in the bowl mill, where it is grounded to a powder form. The mill consists of a round metallic table on which coal particles fall.



This table is rotated with the help of a motor. There are three large steel rollers, which are spaced 120" apart. When there is no coal, these rollers do not rotate but when the coal is fed to the table it packs up between rollers and the table and this forces the rollers to rotate.

This crushed coal is taken away to the furnace through coal pipes with the help of hot and cold air mixture from P.A Fan. P.A Fan takes atmospheric air, a part of which is sent to Air pre-heaters for heating while a part goes directly to the mill for temperature control.

Boilers used in the power plant is suspended type. This prevents it from getting deformed, when a subjected to very high temperatures.

Water is partly converted to steam as it rises up in the furnace. This steam and water mixture is again taken to the boiler drum where the steam is sent to super heaters for superheating.

The super heaters are located inside the furnace and the steam is superheated (540°C) and finally it goes to turbine. Flue gasses from the furnace are extracted by induced draft fan, which maintains balance draft in the furnaces with forced draft fan. These flue gasses emit their heat energy to various super heaters in the pant house and finally pass through air pre-heaters and goes to electrostatic precipitator where the ash particles are extracted. Electrostatic precipitator consists of metal plates, which are electrically charged.

Cooling Tower of RTPS:

Cooling Tower was scenic beauty and worth the wait to watch on the 2nd day. As soon as we entered into the cooling tower it felt that we were dipped into the steam and the hot humid weather was a joyful experience. There the experts gave an overview of how exactly cooling take place and it was an amazing experience as soon as we came out of the cooling tower, the cool chill breeze experience made us spellbound.

RTPS has Natural Draft Cooling Towers[NDCT] which use very large concrete chimneys to introduce air through the media. Due to the large size of these towers, they are generally used for water flow rates above 45,000 m3/hr. The cooling tower[CT] reduces the hotness of water stream through expelling high temperature from water and transmitting it to the air.

The principle behind it is simply evaporation as the water falls down the column, due to temperature difference between water and air, the water droplets lose the heat as latent heat of vaporization, thus decreasing the temperature of the water.

Key Takeaways*:*

The plant visit to Raichur Thermal Power Station and Yeramarus Thermal Power Station provided us with several key takeaways, including:

- **In-depth Understanding of Power Generation**: We gained a comprehensive understanding of the power generation process in thermal power plants. We learned about the various components,

systems, and technologies involved in converting coal into electrical energy.

- **Operational Excellence and Safety**: Through the visit, we developed an appreciation for operational excellence and safety considerations in power plants. We witnessed the stringent safety protocols followed at both RTPS and YTPS understanding the importance of efficient and safe operations.
- **Environmental Sustainability**: We were exposed to the environmental control measures implemented at both power stations. We learned about the efforts made to mitigate the impact of power generation on the environment and promote sustainable practices.

Conclusion:

The industrial visit to **Raichur Thermal Power Station** and **Yeramarus Thermal Power Station** proved to be an enriching and informative experience for the students of IUCEE-RVCE Student Chapter, SPARK. The visit provided us with practical exposure to the operations and functioning of thermal power plants. The insights gained during the visit will undoubtedly enhance our understanding of power generation, transmission and distribution and promote our awareness of environmental sustainability in the power sector. The knowledge acquired from this visit will prove valuable in our academic and professional pursuits in the field of engineering.