ISO 50001 Energy Management System – Case Study

2024 INDIA

NTPC Limited, TALCHER KANIHA

SUSTAINABLE, WATER & ENERGY EFFICIENT Thermal Power Plant of NTPC

Case Study Snapshot	
Industry	Power Generation
Product/Service	ELECTRICITY
Location	Kaniha, Angul District, Odisha, India
Energy performance improvement percentage (over the improvement period)	Average improvement of 0.97 % per year over 5 years
Total energy cost savings (over the improvement period)	USD 35.2 Million
Cost to implement Energy Management System (EnMS)	USD 0.055816 Million
Total energy savings (over the improvement period)	3025165 MWh (10.89 million GJ)
Total CO_2-e emission reduction (over the improvement period)	2.07 million Metric Tons

Organization Profile / Business Case

NTPC TALCHER KANIHA's INSTALLED CAPACITY: 3010MW with COAL BASED CAPACITY of 6X500MW & SOLAR PV CAPACITY of 10MW.

NTPC-Talcher Kaniha is a Coal Pithead Power Station situated in Kaniha Village of Angul district in the state of Orissa. This is the 2nd largest pithead Thermal Power Station in India with an installed capacity of 3010 MW having a uniqueness of supplying power to all corners of India. NTPC Talcher Kaniha pioneers as the most sustainable Power Generation Plant in India which generates power based on the four core principles – Safety, Environment friendly, Energy efficient & Economic affordability.

Uniquely built on NTPC's vision, our sustainability strategy i.e. The Brighter Plan 2032 aims to accelerate NTPC's efforts in leading the energy transition to a decentralized, decarbonized, and digitalized energy future on TBL (Triple Bottom Line) framework and setting new benchmarks in sustainability along the entire energy value chain. The Brighter Plan 2032 is an integral part of NTPC's core business strategy i.e. Corporate Plan 2032 and aligned with the United Nations Sustainable Development Goals and India's INDCs and other commitments for Sustainability. Clubbed with NTPC's Brighter Plan, the adoption of ISO 50001 EnMS has set the framework for NTPC Talcher-Kaniha in delivering Progressive Business, Greener Environment and Enriched Lives by conserving "Water & Energy" to create shared value for all stakeholders.

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Inspired by NTPC's Corporate Brighter Plan 2032, Talcher Kaniha Plant has formulated VISION 2025 for Sustainability of Coal based Power Generation with strong focus on Cleaner Air, Minimizing Carbon Footprint, Maximizing Ash Utilization, lower Specific Water Consumption, and enhancing Operational Reliability. The goals of Minimizing Carbon Footprint, Specific Water Consumption, Forced Outages & partial Losses directly contribute to reduction in CO2 emissions, reduction in Aux. Power Consumption and specific oil consumption. All three factors yield a significant improvement in Net Heat Rate, Energy Conservation and Overall Efficiency, which act as Lead Factors to EnMS ISO 50001. Talcher Kaniha focuses on generating power with the highest efficiency amongst the 500MW units in the country through quality overhauls & periodic Energy audits of the Units. Talcher Kaniha has installed a 400TR Vapor Absorption Chiller System which works by recovering the waste heat from Flue Gas at the outlet of ESP conserving approx. 12264 MWh annually. The wet ash disposal system has been converted into Dry Ash Evacuation & Transportation System conserving both water and electrical energy. Talcher Kaniha has installed 02nos of Waste to Energy Biogas Plants in Township. Talcher Kaniha has forayed into Renewable Energy with an installed capacity of 10MW with an aim to reduce the carbon footprint of power generation. Further, an additional capacity augmentation of 8.5MW Solar PV is planned in FY 2024-25, which, along with the Net Positive Buildings will pave the way to GREEN Township marching towards our goal of NET ZERO.

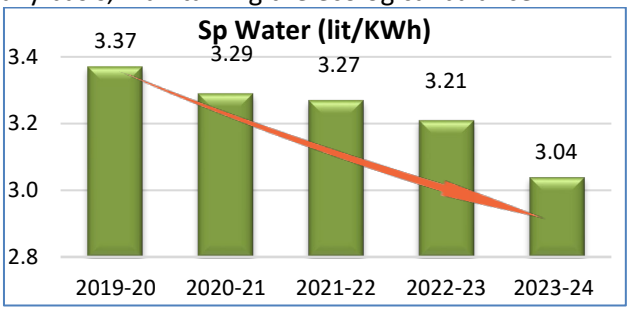
Talcher Kaniha has modified the combustion systems in the Boiler with the latest technology to curtail the NOx emissions. Flue Gas Desulphurization (FGD) plants will be commissioned by March 2025 which will further reduce the SOx emissions from our facility. Fugitive Dust suppression systems have been installed in Coal and Ash handling areas with the motive to keep the ambient air clean. These initiatives along with the modernization of ESP formulate our plan towards cleaner power generation.

NTPC Talcher Kaniha is committed to conserving "Water", the elixir of all lives, through the principle of 5Rs for Water- **Reduce, Re-use, Recycle, Recharge Groundwater, Respect** Innovative ideas.

Water consumption is monitored on a real-time basis through the implementation of a dedicated "WATER DASHBOARD" helping to identify slippages and rectify them on daily basis, maintaining the ecological balance.

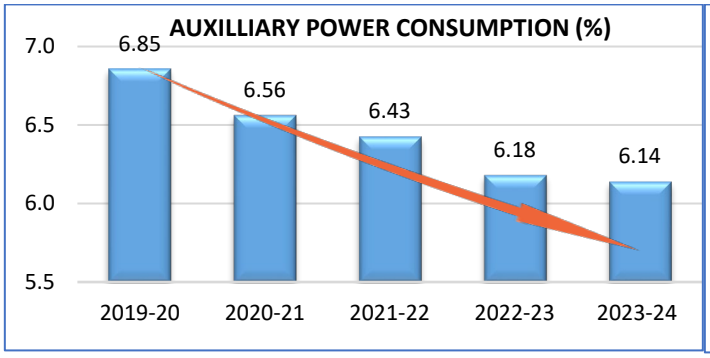
"ISO 50001 has given a formidable impetus to the Energy Conservation & Environment Preservation goals of NTPC Talcher Kaniha with its well defined & structured framework for differentiating our efforts towards Sustainability by minimizing our Carbon Footprint & water consumption and sensitization towards emissions from Thermal Power Plant."

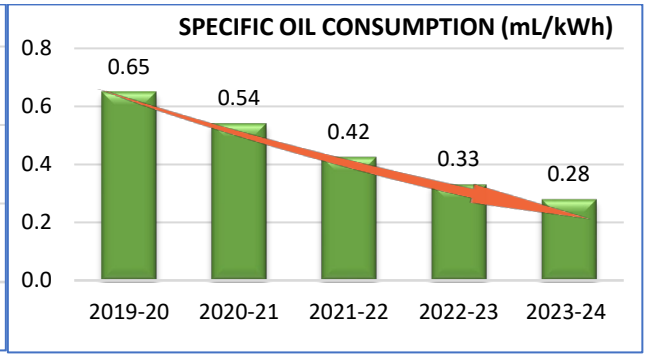
— Ashok Kumar Sehgal, Business Unit Head, NTPC Talcher Kaniha

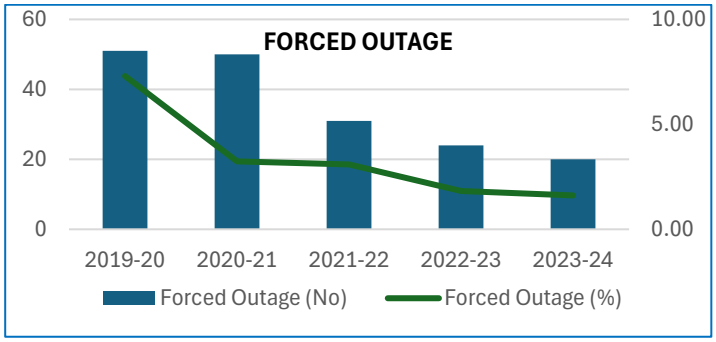


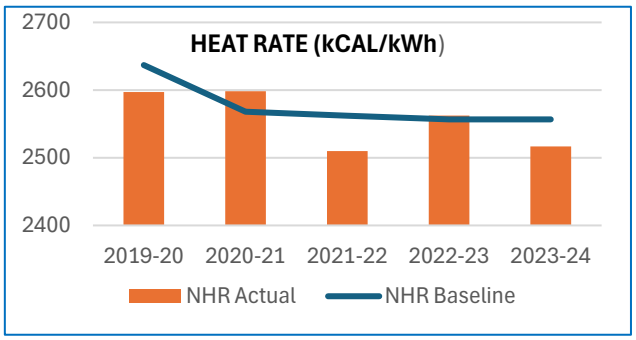
NTPC-Talcher Kaniha's feat of being the highly energy efficient plant has been fostered by a remarkable reduction in the Net Heat Rate over the past years with adoption of EnMS. Other avenues, where principles of ISO 50001 EnMS has yielded results include reduction in Auxiliary Power Consumption (APC) through modernization of drives with IE3 rating & optimizing the auxiliaries used in power generation, reduction in Specific Oil Consumption (SOC) through reliable & safe operations of the Units minimizing the trips/failures. The Generation losses have also been minimized by reducing Forced Outages and Partial Loading through stringent and quality Overhauls. To sustain the operations of the Coal Based power generation, NTPC Talcher-Kaniha has set a Circular Economy Vision for 2025

of Zero Ash Retention at Dykes through maximizing Ash disposal to mine voids coupled Fly Ash Products like Ash Bricks, export of Fine Fly Ash for use in construction aggregates and Road development projects.









By enhancing Operational Reliability, Talcher Kaniha has achieved a significant reduction in the Forced Outages of the Units over the reporting period. The reduction in the number of Forced Outages, i.e., reduction in the number of Start-ups has a direct impact on the reduction in SOC & APC, while reduction in the duration of Outages has directly reduced our APC. NTPC Talcher-Kaniha has implemented the Energy Management System (EnMS) in accordance with ISO 50001. The certification has been done on 11.07.2017. Re-certification was done on 09.07.2023 and valid till 09.07.2026.

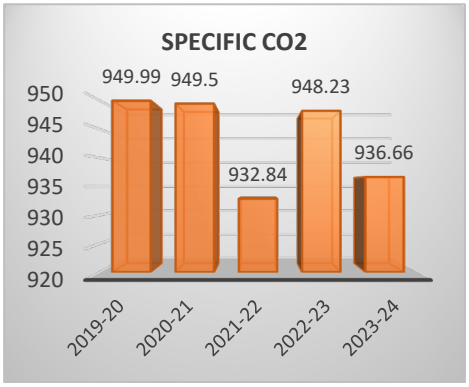
Business Benefits

Implementation of EnMS through ISO 50001 has set the framework and the guidelines for continual improvement in Energy Efficiency and Water Conservation in the process of Power Generation.

- **Sustainable Power Generation**
  The implementation of ISO 50001 has given an impetus to the sustainability goals of NTPC Talcher Kaniha focusing on the inclusive growth of all stakeholders in power generation. This sustainable development has not paid monetary dividends but has also paid dividends in terms of reputation and establishing NTPC Talcher Kaniha as an Ambassador for Sustainable Power Generation. EnMS is in fact a facilitator for a business to help it survive & grow in a long-term time frame meeting its futuristic goals, addressing the efficiency, economy & ecology, and in turn getting evolved as the Sustainable business model.
- **Energy Performance Improvement & Cost Saving:**
  Over the reporting period of FY 2019-20 to FY 2023-24, we have saved 3025165 MWh (10.89 million GJ) which is equivalent to 35.2 million USD.
- **Energy Efficiency Improvement leading to Operational Profit:**
  Real time Energy Monitoring through OLEMS has been crucial to minimize the losses during operation which has led to an increase in efficiency, which in turn has led to Operational Profit. Over the reporting period, we have achieved an operational profit of 33.9 million USD. Year-wise operational profit is shown below.

Operational Profit in Million USD	2019-20	2020-21	2021-22	2022-23	2023-24
	0.49	2.21	13.41	5.24	12.54

- **Environmental Benefits:**
  The key benefits of implementing EnMS have been reduction of carbon footprint and conservation of water. Over the past 5 years, we have achieved a reduction in 2.078391 million tons of CO2 equivalent emissions. Over the reporting period, we have achieved 1.4% reduction in the Specific CO2 emissions. Our efforts in conserving Water have been augmented through the guidelines of ISO 50001 through which we have been continuously reducing our specific water consumption over the past five years well below the normative Sp. Water Consumption of 3.5lit/kWh. With the commissioning of additional recirculation lines from the Mine Voids, we are targeting to achieve Specific Water Consumption of less than 2.5lit/kWh, which will be the best in the industry.
- **Statutory Benefits:**
  The Perform, Achieve and Trade (PAT) Scheme is a statutory instrument to reduce specific energy consumption in energy-intensive industries, with an associated market-based mechanism to enhance the cost-effectiveness through certification of excess energy saving which can be traded. It is the initiative of Ministry of Power, Govt. of India under Enhance Energy Efficiency Mission. Under this scheme the Energy Improvement Target for each PAT cycle (every three years) is set, which must be achieved during Assessment Year (AY). Due to implementation of EnMS, our station has surpassed the given target of PAT-II cycles (AY 2018-19) in terms of Oil equivalent savings and was awarded with 51698 ES Certificates. One ES Certificate is equivalent to 1 MTOE (Heat value of one metric ton of oil with GCV 10000 kcal/kg). The ES Certificate thus achieved is being traded in the National Power exchange. The monetary value of the E certificate is 1.14 million USD.



- **Reduction in Carbon Footprint:**
  Through the guidelines of the EnMS, our plant has achieved a reduction of Carbon Footprint of 28084 MT of CO2 over the reporting period through:
  - 10MW Solar PV Plant which has exported 64765 MWh.
  - 860KW Roof Top Solar which has exported 3741 MWh.

  An additional 8.5MW Solar Capacity is planned to be commissioned which will further yield an additional reduction of carbon footprint equivalent to 4500 tons of CO2 equivalent per year.
- **Employee Participation:**
  The greatest intangible benefit of ISO 50001 is imparting the concept of Energy Conservation into the subconsciousness of all our employees and their family members through continuous and active engagement of them in the energy conservation initiatives. This continuous process will benefit future generations.
- **Recognition & Brand Building**
  NTPC Talcher Kaniha has been rewarded with the following awards for Energy & Water Conservation:
  - Best Water efficient plant award by Mission Energy Foundation – 2022
  - Kalinga Environment Excellence Award 22-23 (5 star)
  - Exceed Platinum Award 2023 for Environment
  - **CII-ITC Sustainability Awards 2022 & 2023**

  The implementation of EnMS ISO 50001 bolstered our focus on two key avenues: **Energy Conservation** & **Efficiency Improvement**, which were the two main criteria of all the above awards achieved by Talcher Kaniha.

- **Non-Energy & other associated benefits**
  EnMS also indirectly suggests improving the environment by total ash utilization, helping reduced ash generation with less fuel consumption, thereby reducing the pollution caused by ash. Presently we have started collecting

Fine Fly Ash from the ESP for export to use in the Construction Industry as Ready-Mix Concrete apart from the conventional use of Ash for Cement Industry, Highways & Land filling. We have an in-house Ash Brick Manufacturing Plant which produces 1Lakh Bricks /day.

- **Benefits to other Stakeholders in the Value Chain:**
  As an innovative measure, our station has engaged the local artisans to make Flower Vases / Table Décor pieces from Fly Ash which will benefit the community around our plant economically and help in brand building.

Plan

Top Management Commitment towards EnMS:

Energy efficiency through EnMS plays a pivotal role for the Sustainability of our business. This continual pursuit towards excellence in Energy Efficiency has enhanced the operational profit margin within the regulatory & statutory compliances apart from the commendable conservation of the important resource "Water". Our pathway for Excellence in Energy Efficiency has been laid by the core initiative of our Top Management with dedicated sections in the corporate structure like CenPEEP (Centre for power efficiency & environment protection) and CEETEM (Centre for Energy Efficiency & total energy management). NTPC Management provides all the technical support through these establishments and the required budget for adoption of new technology, system improvement by implementing new projects or through retrofitting & renovations etc.

Management also provides budget for procuring the advanced instruments for energy efficiency testing by EnMS team and for different Energy audits (Preliminary & detailed audits). As per ISO 50001 guidelines, management approves the Energy Policy for the station and forms the EnMS team led by Certified Energy Auditor & Energy Managers with coordinating members from other departments. Further a separate Energy Conservation-Sustainability Development budget is allotted each year to achieve the planned energy savings.

The top management actively communicate with the middle and lower management about its energy performance through Various forums as mentioned below:

- Station level management Committee meeting,
- Daily planning meeting,
- Monthly operational review meeting

Energy consumption pattern is reviewed thoroughly and Suggestions for improvement are implemented through special performance optimization group (POGs) and Process improvement projects (PIPs). The station has various POGs including Heat Rate & APC reduction, Water consumption optimization, Combustion optimization, ESP performance optimization for emission control etc. for system improvement.

Process of Understanding Energy consumption:

Use of data & developing the appropriate approach: Thermal Power generation mainly uses coal as primary fuel and Electrical power for Auxiliary drives. Our steps for understanding energy consumption mainly involve.

- **Finding the attributes of losses in Turbine Heat rate & Boiler Efficiency:** Talcher-Kaniha has 500MW units. Design Parameter and loss in kcal/kWh for deviation from design parameters is as given below:

Parameter: 500MW	Unit	Design Value	Deviation	Loss in Kcal/kWh
Load	MW	500	1 MW	0.48
Main Steam pressure before ESV	Kg/cm2	170	1 Kg/cm2	1.14
Main steam Temp before ESV	Deg. Celsius	537	1 Deg Celsius	0.68
Hot Reheat Temp before IV	Deg. Celsius	537	1 Deg Celsius	0.57
Superheat Attemperation	Ton/Hr	0	1%	0.68
Reheat Attemperation	Ton/Hr	0	1%	4.54
HP Turbine Efficiency	%	93.1	1%	4.6
IP Turbine Efficiency	%	94.3	1%	4.54

- **Finding the attributes of Boiler Efficiency Loss:**

Parameter: 500MW	Unit	Design Value	Test value
Dry Gas Loss	%	**4.21**	**4.93**
Loss due to Unburnt Carbon	%	**1.5**	**0.34**
Loss due to moisture in fuel	%	**2.45**	**2.47**
Loss due to Hydrogen in Fuel	%	**5.29**	**5.31**
Loss due to Carbon monoxide	%	**0**	**0.00**
Loss due to moisture in air	%	**0.107**	**0.12**
Radiation & unaccounted Loss	%	**0.112**	**0.82**
Other Losses	%	**0.75**	**0.00**
BOILER EFFICIENCY (500 MW)	%	**87.4**	**86.17**

- **Segmentation of electric power use system-wise:** Electric Power consumption is segmented system wise and then equipment wise in the system to identify the gap in particular equipment through **OLEMS** (Online Energy Management System). Offline monthly field tests of major equipment by EnMS team are conducted for finding gap in energy consumption.
- **Ensuring the EnMS Support in Strategy & Target:** By virtue of approved Energy policy and Water Policy, EnMS team, part of the Strategic Review Meeting, assesses the energy use and gap vis-à-vis expected values & Baseline data and after review puts up the observations and recommendations with the target improvements to the top management for approval.
- **Process of Review & Analyzing Energy Use, prioritizing resource & action:**
  - Significant Energy Use data collection, trending of past performance
  - Performance gap analysis vis-à-vis design & peer and comparison with baseline performance
  - Identification of improvement potential & fixing the improvement target
  - Preparation of action plan with responsibility for implementation
  - Prioritization and recourse allocation are done from O&M and Energy conservation budget.
- **Energy Performance Review as below:**

Energy Efficiency Performance Monitoring System			
Meetings	**Frequency**	**Headed By**	Action plan is generated from the Review and Monitoring meetings is implemented in Operation & Maintenance practices
Planning	Daily	O&M Head	
Operation Review	Monthly	Plant Head	
Regional Performance Review	Quarterly Yearly	Director	

"Establishment of EnMS through ISO 50001 has been the key in identifying the major energy eaters and addressing them has delivered turnaround performance in terms of Energy Savings, CO_2 emission reduction and profits."

—C Satyaramakrishna, Head of O&M, NTPC Talcher-Kaniha

Efficiency Parameters in 2023-24	Operational Profit (Million USD)
Heat rate	5.57
Secondary fuel oil	5.48
Auxiliary power	1.49
Total	**12.54**

Operational profit earned through Improved efficiency.

Do, Check, and Act

Implementation Process & Involvement:

Energy Saving = (b) Base line Energy use – (a) Post implementation energy use + (c) Adjustment.

After fixing the action plan, implementations are being done by responsible department either in routine maintenance, short term planning,during Overhaul or renovations & retrofitting within target date.

Areas for Significant Energy Performance improvement	Involvement as per EnMS
Heat loss issues in Boiler	AGM–Boiler Maintenance
Air Preheater Exit Temperature High – Seal Issues	AGM-Boiler Maintenance (Rotary)
Turbine Heat Rate Gap	AGM-Turbine Maintenance
Air Compressor performance & Cooling Tower Performance	DGM-Offsite Maintenance
Monitoring Maintenance & Overhauling activities	AGM-Maintenance Planning
Monitoring Energy Conservation activities	AGM-Energy & Efficiency Management

Major Energy Consumption affecting Variables:

Variable	Effect on Heat Rate	Approx Monetary Loss for 500MW/per day (in USD)
1^0C rise in CW Temp. deteriorates condenser vacuum by 4 mmHg	5.2 Kcal/ Kwhr	663
20^0C rise in Flue Gas exit Temp at APH common outlet deteriorates Boiler efficiency by 1%	20 Kcal/ Kwhr	2650
1 mmHg deterioration of condenser vacuum	1.8 Kcal/ Kwhr	241
1 TPH of Condenser make up water	1.2 Kcal/ kwhr	157

1 kCal loss in heat rate will cost 3.7T coal per hour, which will lead to further higher Aux Power Consumption and loss in overall efficiency.

Activities Identified and Implemented in the improvement period: All figures in Million USD

Activities	Investment (Million USD)	Savings (Million USD)	Remarks
Replacement of conventional motors with energy efficient motors.	0.04	0.09	Energy consumption reduction by 5%
Wet Ash Handling System process optimization by reducing running hours of Pump in Stage-1	0.00	0.08	Additional running hours of pumps stopped
Compressed Air system process optimization	0.00	0.06	Additional running compressors two no's stopped
Stage-1 Mills Liner Replacement & TDBFP Cartridge replacement	0.20	0.56	Mills specific power consumption reduction and TDBFP steam flow reduction by 20TPH
Boiler Draft Power savings after cleaning Air and flue gas ducts, attending leakages	2.65	2.86	Draft power reduction by 2 MW
Replacement of conventional lights with energy efficient LED fitting lights.	0.69	1.90	Energy consumption reduction by 70%

Energy Performance Improvement (EPI) Validation: ISO 50001 gives a recognized framework for EPI validation through Internal & external Audits.

- Ensuring the availability of Data Acquisition System (DAS) for recording the indices under test.
- Data collections like design data, PG test data, efficiency curve and actual performance data,
- Balancing of station Energy flow based on Online Energy Metering System (OLEMS)
- Analysis of data captured and validation of reported data by auditors and reporting.
- Making further improvement action plan

Our Baseline and Reporting Period: Central Electricity Regulatory Commission (CERC), the apex Regulatory Body in the country for Power Generation, has determined the norms for Heat Rate, Aux. Power Consumption & Specific Oil Consumption for the period 2019-24. It is based on past data of the Stations of different Unit Sizes with suitable normalization. Hence, the norms as per the CERC tariff regulations-2019-24, i.e. (1) Heat Rate: 2390 kCal/kWh (2) APC as 7.05% & 6.25% of per unit generation for Stg-I & Stg-II respectively & (3) Specific Oil Consumption of 0.5 ml/kWh are taken as **the base line (EnBs) of our Station for 2019-24 period** without any further normalization.

Bureau of Energy Efficiency (BEE), Govt. of India notified NTPC Talcher Kaniha in PAT (Perform Achieve Trade) cycle-II for the year 2016-19. With the implementation of EnMS in 2017, a percentage improvement of 0.93% with reference to baseline NHR was achieved in PAT-II which was a turnaround performance in comparison to PAT-I Cycle 2012-15. Considering the achieved value of PAT-II cycle, the **base line Net Heat Rate for next cycle (PAT-VII, 2022-2025)** is set by BEE for assessment year 2024-25 as 2481.44Kcal/KWh. This is already normalized & hence no further normalization is required.

PAT-I Cycle: FY 2012-15 (Before EnMS)	***PAT Cycle 2: FY 2016-19 (After EnMS)***
Baseline Net Heat Rate: 2492 kCal/kWh	Baseline Net Heat Rate: 2513 kCal/kWh
Net Heat Rate Target: 2480 kCal/kWh	Net Heat Rate Target: 2492.5 kCal/kWh
Net Heat Rate Achieved: 2500 kCal/kWh.	Net Heat Rate Achieved: 2469.3 kCal/kWh.
Achievement w.r.t baseline: **-0.32 %**	Achievement w.r.t baseline: **1.73%**
Achievement from target: **-0.81 %**	Achievement from target: **0.93 %**

Transparency

- Publication of integrated annual sustainability ESG report by NTPC Ltd
- Online Environment Management monitoring screen provided to State Government Pollution Control Board for real time monitoring.
- Online Water drawl data is provided to Dept. of Water Resources of State Government.
- Submission of audit reports to Government & direct audit by Comptroller and Auditor General of India

What We Can Do Differently

- Dedicated 3-year Plan for Sustainability & Environment Protection.
- Operation of the Units with Zero Start-ups from Overhauling to Overhauling.
- Continuous Renovation & Modernization projects in key Energy conservation areas like Cooling Towers
- Converting all the Buildings/Offices in Plant & Township as Net Positive Buildings, reducing our energy footprint.
- Developing the Culture of Energy Champion in each department of the plant and suitably rewarding the individual / department for the significant & innovative energy conservation efforts.