

# ISO 50001 Energy Management System Case Study

2021

INDIA

## NTPC RAMAGUNDAM

A Govt. of India Public Sector Enterprise that focuses on Efficient, Economical & Environment friendly (EEE) power generation through Implementation of EnMS with ISO 50001:2018 certification

**“Winner of USA Times Magazine top power plant recognition in 2015”**



### Organizational Profile & Business Case

NTPC Ramagundam is third in the series of Super Thermal Power Stations set up by NTPC Ltd, India’s largest energy conglomerate. The project was launched on November 14, 1978 by the then Prime Minister of India. The installed capacity of 2600 MW contributes about **6.9%** to the total electricity requirement of Southern part of India. Station took a giant step, in line with NTPC’s long-term commitment to produce sustainable energy and green power, by installing 10 MW solar PV plant near the existing plant premises for harnessing solar energy. Also one of its kinds in India, **100 MW** floating solar PV plant on its water reservoir is under implementation out of which 17.5 MW is commissioned. This foray will play a major role in lowering its carbon footprint by reducing GHG emissions. On Implementation of various Energy Efficiency initiatives, loading compensated Net Station Heat Rate (NSHR) has shown improvement trend from **2482 kcal/kWh in the year 2017-18 to 2448 kcal/kWh in FY 2020-21 (Fig. 1)** thus plant has become a preferred choice in generator segments for beneficiaries.

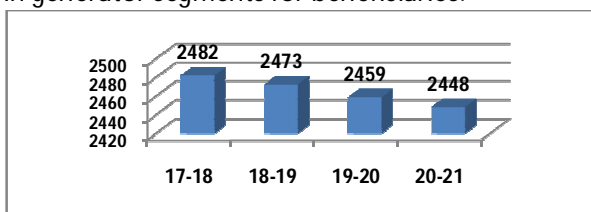


Fig. 1 NSHR improvement trends over years

**“Our mission is to reduce emission through ISO 50001 EnMS implementation which strives to save every possible quantum of energy to create environmental synergy and become the most energy efficient unit in power industry.”**

- Sunil Kumar, Head of Project

### Case Study Snapshot

Industry	Power Generation
Product/Service	Thermal Power
Location	Telangana, India
Energy Management System	ISO 50001:2018
Energy Performance Improvement Period	04 years (considering ISO implementation period)
Energy Performance Improvement (%) over last 4 year	1.36% every year
Total energy cost savings	3.3 million USD
Cost to implement	6.68 million USD
Payback period (years) On EnMS implementation	2 years
Total Energy Savings over last 4 years	0.37 million GJ
Total CO <sub>2</sub> -e emission reduction over last 15 year	5.95 million metric tons

### Our Motivation & Drivers for energy and climate sustainability efforts, and goals:

- **Achieving our MISSION target:** To provide Cheaper, Efficient & Environment friendly power
- **Meeting Statutory requirements** Perform Achieve & trade (PAT) & emission target
- **Competitive Power Market:** To remain competitive by keeping generation cost less through efficient energy performance
- **Building the confidence of all stakeholders:** through improved Environment Social Governance (ESG) score

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- Natural Resources conservation like coal & oil for future generation
- Improved customer satisfaction Index and social responsibility index

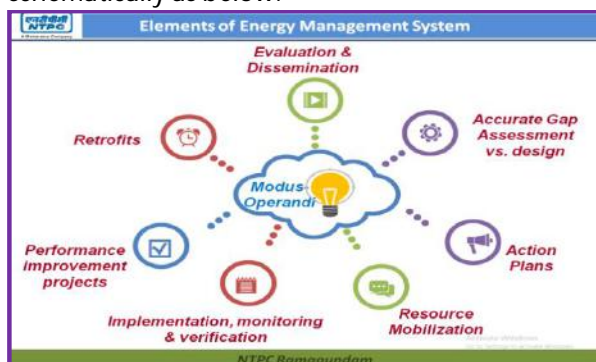
Station is committed for conservation of every form of energy like reduction in Auxiliary power consumption (APC) by augmentation of efficient drives, Heat rate improvements through process improvements and system modifications and water consumption reduction through sustainable actions. Keeping the consideration of sustainability, we have the Brighter Plan 2032 (Fig. 2) which also works as drivers for efforts.



Fig. 2: NTPC Brighter Plan 2032

## Role of Energy Management in the organization's larger business strategy

In its management system, we have always been adhered to the energy conservation approach. Every planning has always done with a feasibility study of operations, financial, and risk including energy reduction that will be pursued. With such a management pattern and implementation of desired action plan the implementation of ISO 50001 has become easier. The elements of Energy consumption reduction approach is depicted schematically as below:



- Assessment and review to mitigate the challenges ahead and Involvement of employees & interested parties
- Formulation of Baseline performance data of Energy performance indicators (EnPI) like Heat Rate, Auxiliary Power, Oil consumption.
- Assessment of Operating Heat Rate and APC Gap vis-à-vis design and fixing of SMART (Specific, Measurable, Achievable, Realistic and Time bound) target thereon accordingly
- Setting the Energy consumption saving target based on the base line data and magnitude of deviations from design
- Formulation of Action Plan for achieving the set targets of EnPI
- Intermittent review of Management at different forum and feedback
- Monitoring and verification at the end of year

## Business Benefits

Implementation of EnMS since long and ISO 50001 certification propel us for continual improvement in Energy Efficiency resulting into substantial reduction in generation cost, reduction in GHG emission, reduction in water consumption and reduction in pollutants disposal like ash. This all above creates a great satisfaction to management and increases the stakeholder confidence.

### (i) Energy performance improvement & cost saving:

Since 2017-18 we saves energy up to **0.37 million GJ which is equivalent to 102 GWh or 3.33 million USD with only capital investment for about 6.68 Million USD.**

### (ii) Environmental benefits: Reduction in emission & water consumption with NHR improvement

On Implementation of EnMS since last 15 years, greatest impact towards greenhouse gas emissions (CO<sub>2</sub>) reduction has been achieved. Around 5.95 million Metric Tons of CO<sub>2</sub> have been avoided from emission in last 15 years on improvement in energy efficiency. The trend of CO<sub>2</sub> emission avoided in last 15 years is shown in

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the bar chart at Fig. 3.

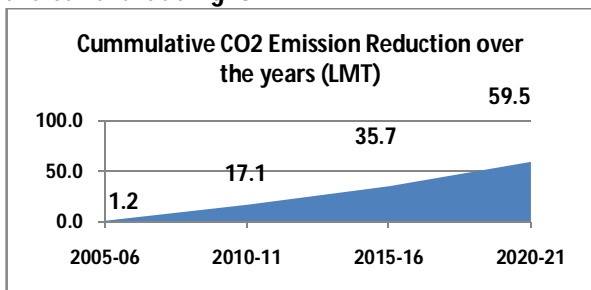


Fig. 3. Year on Year CO2 emission reduction

Water is the limited natural resources. Our EnMS has the wide coverage and guidance on water conservation. Govt. of India has tightened the norms of Specific water consumption (SpWc) to 3.5 litre/kwhr for our plant. Through operational optimization, augmentation of additional ash water return & implementation of Zero Liquid Discharge (ZLD) our SpWc reduced to 3.27 lit/kwhr in FY 2020-21 (Fig. 4).

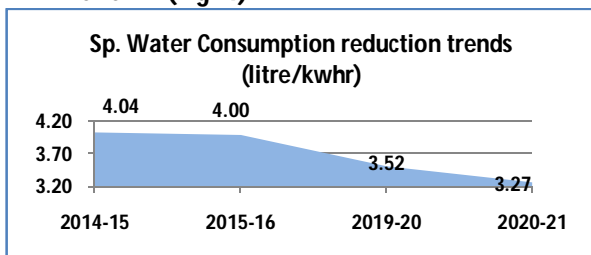


Fig. 4. Specific water reduction trend

### (iii) Benefit on Statutory compliance

Performa Achieve & Trade (PAT) 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) are set which has to be achieved during Assessment Year (AY). Due to implementation of EnMS, our station has surpassed the given target of both PAT cycle (Cycle I AY 2014-15 & Cycle II AY 2018-19) in terms of Oil equivalent savings and awarded the E certificates of 72422. One E certificate is equivalent to 1 MTOE (Heat value of one metric ton of oil with GCV 10000 kcal/kg). The E certificate thus achieved is being traded in National Power exchange. **The monetary value of E certificate are 0.47 million USD.**

### (iv) Non Energy & other associated benefits

EnMS also indirectly suggests improving the environment by total ash utilizations and creating the green belt in vicinity area for carbon sequestration. Station has **utilized more than 100% Ash generated in last 4 years** by evacuating & selling the inventory ash to cement industries & **development of geo-polymer road/coarse aggregates using 90% fly ash (Fig. 5)** which helped in reducing the pollution caused by ash.



Fig. 5. Geo-polymer Road and value added products

### (v) Improved thrust on solar power integration to reduce Emission:

Our EnMS also guide us to utilize renewable energy in place of thermal power for drives which in turn reduce GHG equivalent emission. Station has taken initiatives toward scaling up its renewable capacity to 110.135 MW (Fig.6)

- 100 MW Floating solar on reservoir
- 10 MW solar PV plant
- EV use & charging
- Solar car parking of 100 KW
- Solar light pipes in offices & stores

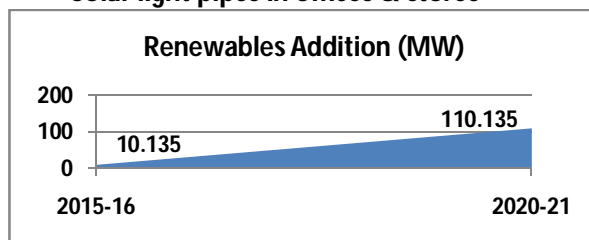


Fig. 6. Increase in renewable capacity



RE Power set up at NTPC Ramagundam

The greatest benefit with the existence of Energy Management System is creating awareness at the company and its employees towards the

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importance of energy efficiency in life. Energy savings and emission reductions are always made to improve the electricity production process. Without a continuous improvement, the goal of the energy management system will never be achieved.

## (vi) Recognition & Brand building

1. Station has received the **State level National Energy Conservation Award 2020** from the Govt of Telangana, India
2. Received "**National Energy Leader Award 2020 for Excellence in Energy Efficiency**" from the Confederation of Indian Industry (CII), India
3. **Station received coveted Golden Peacock Award 2020** from Institute of Directors, New Delhi in Energy Management System.



4. Bureau of Energy Efficiency, Ministry of Power, Govt of India has published the video for the power industry having best Energy Efficiency practices covering NTPC Ramagundam as main. The same can be accessed using the following link [https://beeindia.gov.in/sites/default/files/video\\_upload/Thermal%20Power.mp4](https://beeindia.gov.in/sites/default/files/video_upload/Thermal%20Power.mp4).

These recognitions indicate station's compliance towards EnMS & Environment regulations.

## PLAN-DO-CHECK-ACT (PDCA) APPROACH PLAN

### Top Management Commitment towards EnMS:

Energy Performance through EnMS is the journey of passion and with firm belief our team is committed for its continual improvement. For sustainable business operation, we believe that Energy Efficiency is the key factor which enhance operational profit margin with regulatory compliances. For achieving the Energy efficiency target set for every year management provides ample Budget allocations needed for identified new project implementation or through retrofitting & renovations.

Management also provides budgets for procuring

the new technology instruments for energy efficiency testing by EnMS team and for different Energy audits (Preliminary & detailed audits) and service alike, As per ISO 5001 guidelines, management approves the Energy Policy for the station and form the EnMS team led by Certified Energy Auditor & Energy Managers with a coordinating members of other departments.

### 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 the energy consumption mainly involve:

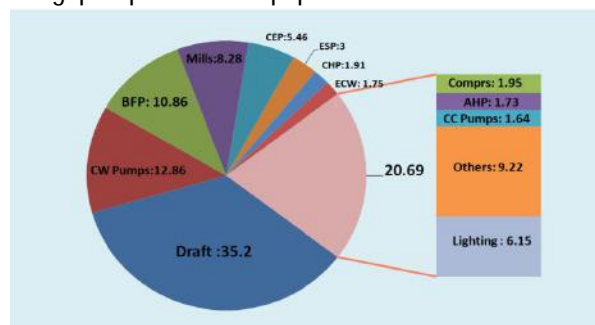
#### Finding the attributes of Turbine Heat rate loss:

Turbine Heat Rate Use in excess of design					
Parameter	Unit	Design Value	Average Value	Deviation	GRH Effect Kcal/kwhr
Load	MW	500	508.0	8.0	-3.34
Main steam Press before ESV	kg/cm <sup>2</sup>	170	171.1	1.1	-2.80
Main steam Temp before ESV	° C	537	536.8	-0.2	0.16
Hot Reheat Temp before IV	° C	537	540.3	3.3	-2.06
Superheat Attemperation	t/hr	0	44.3	44.3	1.87
Reheat Attemperation	t/hr	0	5.2	5.2	1.85
HPT Efficiency	%	93.18	90.00	3.2	13.85
IPT Efficiency %	%	93.9	90.00	3.9	16.98

#### Finding the attributes of Boiler Efficiency Loss:

Boiler Efficiency loss attributes			
Parameters		DESIGN	TEST
DRY FLUE GAS LOSS	%	4.45	6.38
MOISTURE & HYDROGEN LOSS	%	5.13	5.46
MOISTURE IN AIR LOSS	%	0.11	0.18
RADIATION LOSS	%	0.20	0.20
UNBURNT CARBON LOSS	%	1.50	0.42
UNACCOUNTED LOSS & MANU. MARGIN	%	1.50	1.50
TOTAL LOSSES	%	12.89	14.13
BOILER EFFICIENCY	%	87.11	85.87

Segmentation of electric power use system-wise and then equipment wise in the system to identify the gap in particular equipment.



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This is being done on real time basis from remote.  
**Offline monthly field tests of major equipments by EnMS team for finding energy use gap**

### Ensuring the EnMS Support in Strategy & Target:

By virtue of approved Energy policy EnMS team assess the energy use and gap vis-à-vis expected values & Baseline data and after review put up the observations and recommendations with the target improvements to the top management for approval. EnMS team is always a part of monthly strategic review meeting of top management.

### 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 and comparison with baseline performance
- Comparison with similar equipment performance
- Identification of improvement potential & fixing the improvement target
- Energy performance review as below:

Energy Efficiency Performance Monitoring System			
Meetings	Frequency	Headed By	Corrective actions generated from monitoring & review meetings implemented in Operational and Maintenance Practices
Planning Meeting	Daily	O&M Head	
Operational Review Team Meeting	Monthly	Plant Head	
Regional Operational	Half Yearly	Director	

- Preparation of action plan with responsibility for implementation
- Prioritization and recourse allocation are done from O&M and Energy conservation budget

### DO-CHECK-ACT

#### Implementation Process & Involvement:

After fixing the action plan implementations are being done by responsible department within target date. The implementation of the identified projects is being taken up either in routine maintenance, short term planning, during Overhaul or renovations & retrofitting (Fig. 7).

Energy Performance significant issues	Area of	Involvement as per EnMS
Boiler Efficiency Heat Loss Issues		Additional General Manager (AGM)-Boiler Maintenance
Air Pre Heater Exit Temp High Seal Issues		AGM- Rotary Machine
Turbine Heat rate Gap/Pump Efficiency Gaps		AGM- Turbine Maintenance
Use of IE4 motors/VFD as drive		AGM-Electrical
Air compressors and Cooling Tower performance		AGM-Offsite Maintenance
Monitoring of Maintenance activities		AGM-Maintenance Planning
Monitoring of Energy Conservation activities		AGM-Energy Conservation

Fig. 7. Involvement Matrix

### Motivation & Support-Top Management

The Top management of our Station is committed to the implementation of the EnMS and continually improves its effectiveness by

- Communicating to employees the importance of effective energy management.
- Establishing the EMS policy based on the guidelines of EnMS standards.
- Ensuring that the energy policy objectives and energy targets are established in line with the strategic direction of the organization.
- Ensuring the formation of Energy Management Team.
- Required Budget allocations
- Conducting regular management reviews
- Ensuring that the EnPI(s) appropriately represent(s) energy performance
- Ensuring the compliance of EMS Standards

### Activities Identified and Implemented:

Energy Efficiency Program details	Investment	Savings/yr	Payback
	in million USD	in million USD	Yrs
Energy Efficient Motors in Cooling Tower Fans	0.09	0.02	4.51
Conversion of conventional Lighting to LEDs	1.14	0.43	2.67
U4 (500 MW unit) APH Basket replacement	0.07	0.04	1.61
28% Eco Coil Addition In three 500 MW unit	4.29	0.84	5.05
Stage II units (1500 MW) Cooling Tower renovations	0.43	1.04	0.41
A/C using VAM operated by Waste heat of flue gas	1.42	0.47	3.02
<b>Total Savings</b>	<b>7.4</b>	<b>2.84</b>	

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The Target set by the team as per gap analysis and base line performance data were achieved. In financial Year Loading compensated Net Heat Rate achieved was 2448 kcal/kwhr against the target of 2459 kcal/kwhr

**Energy Performance Improvement Validation:**  
ISO 5001 gives a recognized framework for **energy performance improvement validation through Internal & external Audits.**

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

**Our Baseline and Reporting Period:**

The baseline period & reporting period are fixed as per Govt. of India Gazette Notifications and covered under Perform Achieve & Trade (PAT) Cycle.

The first PAT Cycle was 2012-13, 2013-14 & 2014-15 having the baseline period of 2012-13 based on past three years data. The target assessment period was FY 2014-15. The baseline data for second cycle was the achieved value of first cycle. The second cycle assessment period was 2018-19. Now the 3<sup>rd</sup> cycle is 2020-21, 2021-22 & 2022-23 and the target year is 2022-23 for monitoring & verification audit.

Normalization of data is being done on variable basis like reasons out of control in terms of demand PLF, poor coal quality.

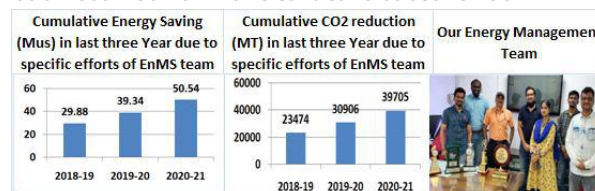
**Transparency:**

- Publication of integrated annual sustainability report as per GRI by NTPC Ltd
- On line Environment Management monitoring screen to local State Government
- Submission of audit reports to Government

**What We Would Have Done Differently**

1. Display of management instructions regarding EnMS in strategic locations
2. Display of financial impacts on parametric variations affecting the EnPI
3. Minimum Man-days training on EnMS processes & its benefits to all employees in advance
4. Advance Budget allocation for EnMS speedy implementation
5. Development of professional expertise through advance training on EnMS

**“ISO 5001 Implementation is only way to business nourishment & future sustenance”**



**our motto is to “ CONSERVE ”**

- C**: commitment to energy conservation for sustainable growth.
- O**: optimize the process of generation
- N**: nurture the nature and protecting the environment
- S**: satisfying the legal, statutory and procurement requirements
- E**: effective and efficient implementation of EnMS for continual improvement.
- R**: resources deployment to promote design improvement in processes
- V**: validating the results of efforts towards conservation
- E**: establishing energy stewards, educating employees and increasing awareness to promote energy conservation

The Energy Management Leadership Awards is an international competition that recognizes leading organizations for sharing high-quality, replicable descriptions of their ISO 50001 implementation and certification experiences. The Clean Energy Ministerial (CEM) began offering these Awards in 2016. For more information, please visit [www.cleanenergyministerial.org/EMAWards](http://www.cleanenergyministerial.org/EMAWards).

