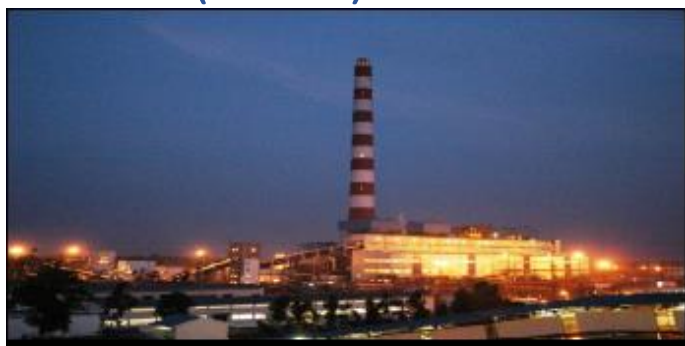


Global Energy Management System Implementation: Case Study

INDIA

BHARAT ALUMINIUM COMPANY LIMITED (BALCO)



Vision-To be a world class integrated Aluminium & Power producer generating sustainable value for all Stakeholders.

“In Vedanta-We empower people to drive excellence & innovation to create values for our stakeholders, we demonstrate world class standard of governance, safety, sustainability & social responsibility”

-ANIL AGARWAL (CHAIRMAN, VEDANTA)

Company profile

- Bharat Aluminum Company (BALCO) has made significant contributions as the, 1st PSU in India’s Aluminum sector Incorporated in 1965, BALCO is India’s first integrated Aluminum business.
- One of the first disinvestments of the Government of India. It now a part of Vedanta Limited, with 51% stake held by Vedanta Limited and 49% held by Government.
- Balco is based in Chhattisgarh State having Captive Bauxite mines in Mainpat and Kawardha, Captive coal mines in Chotia, 2010 MW power generation capacity and 5.7 LTPA Aluminium Smelting capacities at Korba Complex.
- Balco produces Wire rods, ingots, Alloy rods, Alloy ingots and Rolled products. Balco is also selling power.

Case Study Snapshot

Industry	ALUMINIUM
Product/Service	ALUMINIUM, POWER, WIRE ROD, INGOTS & ROLLED PRODUCT
Location	KORBA (C.G) INDIA
Energy Management System	ISO 50001
Energy Performance Improvement Period	3 Years
Energy Performance Improvement (%) over improvement period	EPI Electrical -4.33 EPI Thermal Metal -32.60 EPI Thermal Power plant-6.9
Total energy cost savings over improvement period	7.319 Million \$USD
Cost to implement EnMS	1.74 Million \$USD
Payback period (years) on EnMS implementation	3 Months
Total Energy Savings over improvement period	(483943 GJ)
Total CO ₂ -e emission reduction over improvement period	114264.32(Metric tons)

$$EPI\% = \left(\frac{\text{Baseline Period Energy Consumption} - \text{Reporting Period Energy Consumption}}{\text{Baseline Period Energy Consumption}} \right) \times 100$$

$$EPI \text{ Electrical Energy } \% = \frac{14860 - 14223}{14860} \times 100 = 4.33 \%$$

$$EPI \text{ Thermal Energy } \% = \frac{0.552 - 0.372}{0.552} \times 100 = 32.60 \%$$

$$EPI \text{ Thermal Energy Power plant } \% = \frac{765 - 712}{765} \times 100 = 6.92 \%$$

Business Case for Energy Management

BALCO acknowledge the global concern on climate change & recognizes energy as one of the most important resource being used in the process of generation of power & manufacturing of Aluminum. We are committed to improve our energy performance and reduce negative impacts on the environment through its own Energy & carbon management program that’s forms an integral part of its vision for sustainable development and is consistent with its overall Business Vision & Mission.

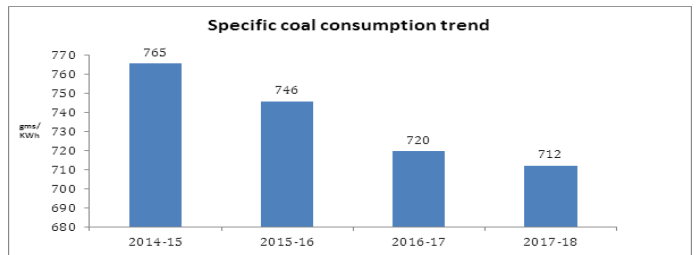
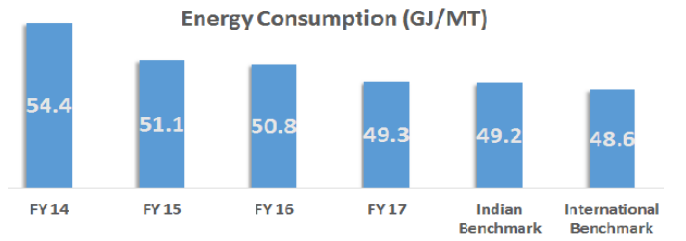
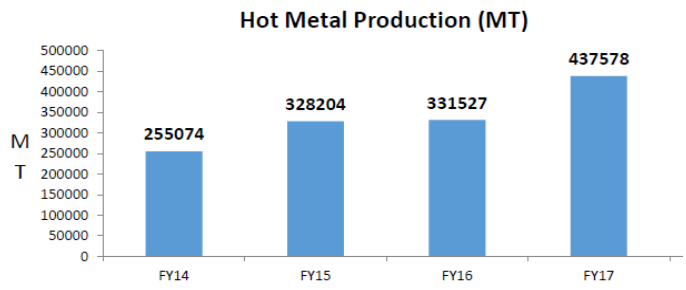
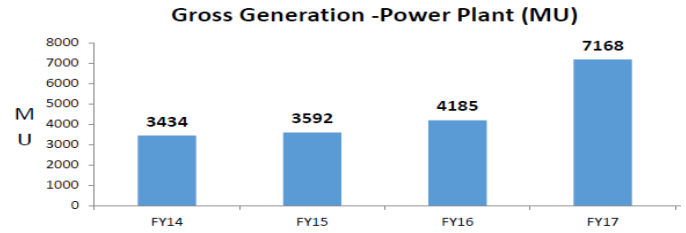
Driver

Adopt & maintain global best practices on energy & carbon management & minimize GHG emission throughout its operations. Define, measure, review & communicate our energy performance. Ensure the establishment of systems and processes necessary to improve energy performance with commitment for continual improvement provide a framework for setting & reviewing energy objectives & targets and take corrective & preventive actions for deviations supported by adequate resources. As our Energy policy says -Report carbon emission as per internationally recognized protocols & comply with applicable legal & other requirements with respect to energy consumption. Invest in clean energy & maximize benefits of energy from waste recovery. All future purchase of energy equipment’s and appliances considering Bureau of energy efficiency star rating & energy efficiency.

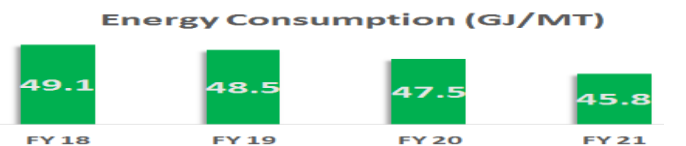
Foster research & innovative techniques are constantly up-grade to feasible alternate cleaner source of energy with continuous focus on minimizing energy consumption. Ensure energy and climate change awareness at all level through policy roll-out, communication, and training. Consider energy efficiency & carbon emissions for its projects R&D investment in line with our commitment to sustainable development Work with our staff, supply chain, wider communities and other stakeholders to demonstrate commitment to GHG and energy reduction principles & practices.

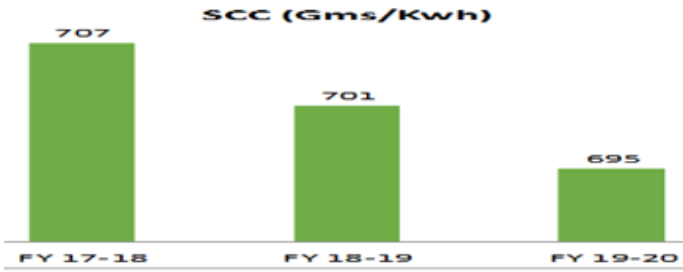
Our Growth Story & Energy Conservation journey through ENMS 50001

Below fig showing expansion of our Metal & Power business [Fig-no 1](#) (Metal Growth- 100KTPA to 575 KTPA - YEAR 01-16) [Fig-no 2](#) (Power Growth -270 MW to 2010 MW - YEAR 01-16)



Huge Expansion in Metal & Power Business yet Reduction in specific energy & coal consumption through implementation of EnMS as near to achieve Global benchmark [Fig no-3](#)





Energy Conservation Vision 2021 Fig no-4

“A nation that can’t control its energy source can’t control its Future-In line we have energy conservation Vision for our organization”

-BARACK OBAMA

- Energy Management System conforming to ISO 50001:2011 in 2015
- National Energy Conservation Award 2015 from B.E.E Government of INDIA.
- Excellent Energy efficient unit award for metal area in 2015, 2016 & 2017 & Power sector for 2017 by CII.
- Sustainable Energy Development Merit award from CREDA in 2016.
- DL SHAH Gold Award for FIP on HFO consumption reduction in Bake-oven plant.
- In BALCO one month is dedicated for increasing awareness and encouraging energy conservation with Involvement of stakeholders, suppliers and contract partners Fig no-5



Energy management Programs

Installation of Solar plant as per Government of India Renewable purchase obligation (RPO). Fig no-6



State Government LED & Energy efficient light fittings and fans Distribution program in discounted rates – Balco distributed around 48717 Nos Led light & Fans under State Govt Ujjala & Pawan Scheme through EESL:- (May-16-June-16) & (Jan-17 –Apr-17) LED distribution Counter (EESL) at township Fig no-7 *Switch to Led & switch off when not in use*



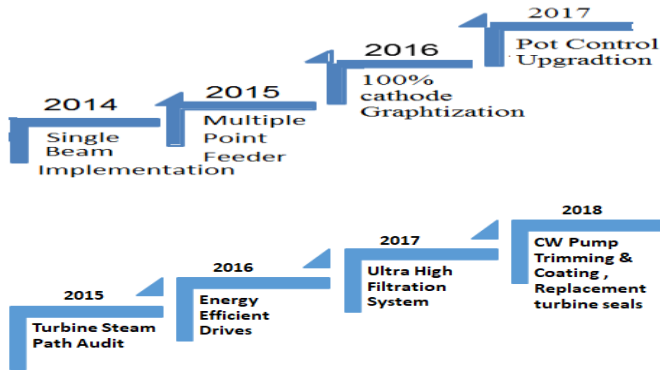
Achieving of Specific Energy Consumption target Notified by Government of INDIA PAT (Perform achieve & Trade scheme)-**Successfully completed PAT Cycle I PAT cycle - 1 target over achieved by 0.088 TOE (awarded 22203 E-Scerts certificate).**Complying -INDIAN government-Energy Conservation Act.

Energy Reduction Approach & EnMS Implementation

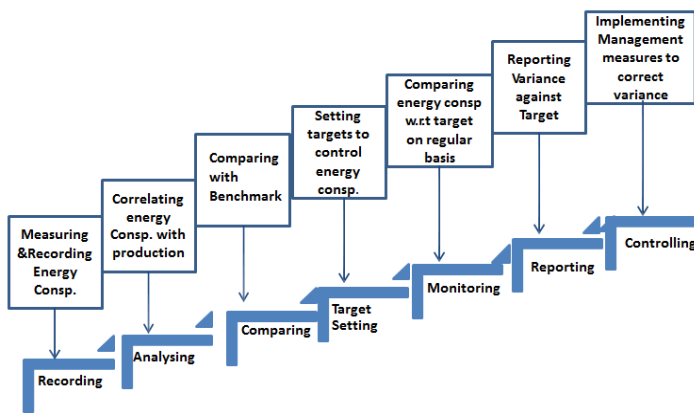
Balco adopted Energy management system ENMS in 2014 earlier there was no planning & structured approach for energy management, people lacked awareness regarding benefits & approach of energy management system due to which desired output was not getting achieved. Specific consumption of Aluminium production 54.4 GJ/MT which is very high compared to Global Bench Mark even our plant is going for expansion of both Metal & power production so the problem of high energy consumption was to be addressed soon.

Balco got certified in EnMS ISO 50001 in 2015 by DNV-GL. The scope of the Energy management covers the Aluminium manufacturing process at BALCO as well as the power generation setup which supplies captive power to the process plants 3 units which operational were certified ,than in 2016 we gone for scope extension of remaining sites 2 units which were under commissioning earlier. For Implementation of EnMS organization adopted **structured approach** as Fig no –8 & **Energy Excellence Model** Fig no-15 -as a result drastic decrease in Specific Energy consumption from 54.4 to

49.3 GJ/MT by Technological upgradation Potline & Power plant Fig no-9, awareness through Energy management programs.



Technology Upgradation of Potline Fig no-9



ENMS Implementation Structured Approach Fig no-8

“There is no elevator to success you have to take the stairs- that’s why we have taken step by step structured approach for ENMS implementation”

- ANISH RAO, Energy coordinator(Rectifier)

Energy performance indicator ENPI

BALCO has identified energy performance indicators for all, its unit which are assessed to be significant in terms of energy usage. These energy performance indicators help to assess if the process is energy efficient or in-efficient and is used to compare the energy performance of the unit over time. A Brainstorming session among the process owners helped in identification of these EnPI.

Energy Team & Responsibility-

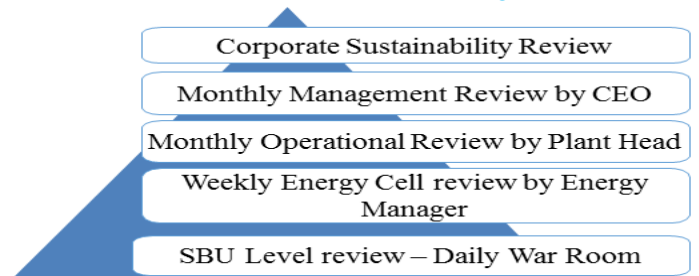
The top management has nominated a dedicated energy management team & energy manager to work alongside the MR and help in implementation of the other management systems and procedures. The common responsibilities are: Data authentication, EnPI determination, relationship evaluation, expected vs. actual, deviation analysis, internal audit Fig no-10

SNo.	SEU Areas	Responsibility	Verification & authentication	Review & Approval
1	CPP-3 (1200 MW)	Individual area	All Energy coordinator report to Energy Manager & MR as they verify data as per determination, relationship evaluation, expected vs. actual, deviation analysis, internal audit	Final report submitted to Plant HEAD Power, METAL BOTH & FINANCE HEAD
2	CPP-2 (540MW)	Energy Cordinator		
3	Pot Room (Potline-1 & 2)	collect Energy Report & Data		
4	Bake Oven	,EnPI		
5	Foundry	determination,		
6	SRS	relationship evaluation,		
7	Compressor House	expected vs.		
8	Cast House 2	actual,		
9	Cast House 1	deviaton analysis,		
10	Green Anode Plant	internal audit		
11	Rodding Plant			

Energy Review and Planning

Energy parameter, projects & deviations discussed in Daily War Room at SBU level & review done by top management and report to corporate sustainability team as shown in War Room energy review process Fig no-11. Data from all the process / sub-processes included within the scope of the energy management system. The boundary conditions for the energy review are given below.

War Room Energy Review process Fig no-11-



Data points: All processes included within the boundary of EnMS

Data sources: SAP, registers, Daily Energy

Data interval: Daily data collated to form monthly data

Data type: Fuel consumption, energy consumption, energy generation (gross, aux and net), energy export, energy import, Energy loss, production data, variable data Affecting energy performance, list of drives with load connection, average working hours of drives (in absence of energy consumption data drive-wise), other data.

The above data was collated to understand the energy balance of the entire setup. On confirmation of the total energy consumption the energy is summed up process wise and the data is then segregated using PARETO analysis to identify the areas which consume the majority of the energy.

The 99.90 % of energy consuming processes are identified as areas of high risk with respect to energy consumption; the areas thus identified as areas as **significant energy use (SEU)** Fig no-10 and are focus areas for implementation of energy management systems.

Once the areas of significance are determined their performance for the reference year is taken as the baseline year performance and all future targets are based on the medium to long term vision of the management.

For effective control of risk the persons working on or behalf of the organization in areas of significant energy use are identified (**Energy coordinator**). Along with these operating personnel all the drives in those areas of significance which are beyond a pre-determined rating value are identified as critical drives in the energy management system

All ideas for improvement of performance of these SEU's are pooled together for further analysis. The ideas are pooled from the following sources.

- OEM recommendations, Public sources from similar sites.
- Employees, Third party service providers engaged in those areas.
- Technology providers and open forums.

These inventories of ideas are then filtered and prioritized and segregated. The top prioritized ideas are taken forward as energy management improvement plans under the EnMS.

During assessing opportunities for improvement, all means to substitute the power from **alternate renewable energy sources is also assessed.**

Tools, Resources & Approach used for energy performance improvement & to validate Results

Installation of Online EMS system Fig no-12, Integrated Energy Meters are installed and configured in DCS. Meters used for all measurements are calibrated as per ISO QMS Standards, Related Process parameter are displayed on the DCS screen. Fig no-11, Fig no-12

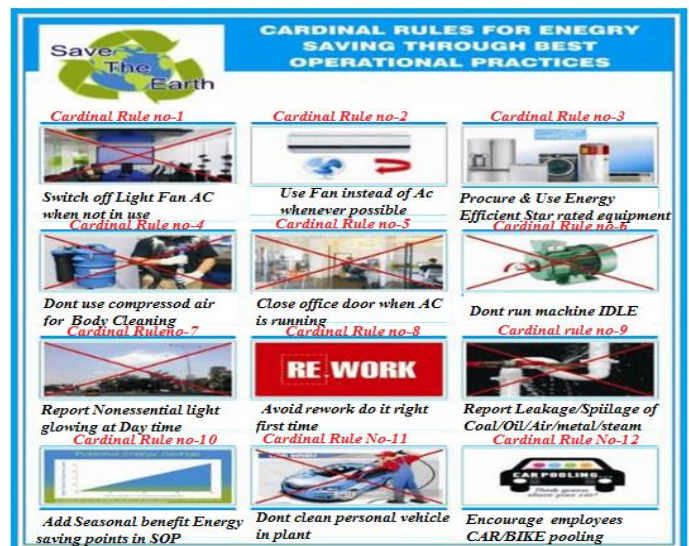


ENERGY IN WAR ROOM KPI DISCUSSED

Energy manager recognizes the relationship these parameters have with the energy performances of the processes in the unit and regression analysis is used to build a relation between the energy performances as against these parameters. individual SEU areas is validated by respective energy coordinator & verified by Energy Manager as per Fig no-10.

Scheduled Internal Audit by cross functional energy coordinator /Internal energy auditor, External audit by **third party energy auditing team-FICCI.**

Operational Control & Energy performance sustainability



Implementation of Cardinal Rules for energy saving through Best Operational practices Fig no-13 & creating awareness among all employees to follow these rules. We have also incorporated EnMS aspects & impacts, Do & Don'ts in our Standard operation & maintenance procedure in local language also so that it is understood by all level of employee for sustainable energy performance.

“1 single unit of Energy Saved is = 2 units of Energy Generated” As we all know as energy coordinator, So we made & implemented Energy saving cardinal rule through best operational practices for increasing awareness among all.

-Avinash P Chavan, AGM Electrical (MRSDS)

Training & Awareness

The organization has **skill matrix** sets of operating personnel working for and on behalf (third party service providers) in areas of significant energy use. The skills of these persons as mapped against.

- Education, Experience in related field, Special skills

As per skill matrix the Training are identified & some training which are mandatory (Legal, Management system requirement).

External and Internal Training

Internal EnMS Auditor training By –SGS

- Energy conference on new technologies by-CII
- Motivated & Got certified Energy Auditor & Manager in Both Power & metal sector by Govt of India Bureau of energy efficiency BEE, Green Building training
- Energy efficient equipment & new technology exchange platform BY -CREDA
- Energy management system, Energy efficient equipment (Lights, motor & pumps)

Awareness-

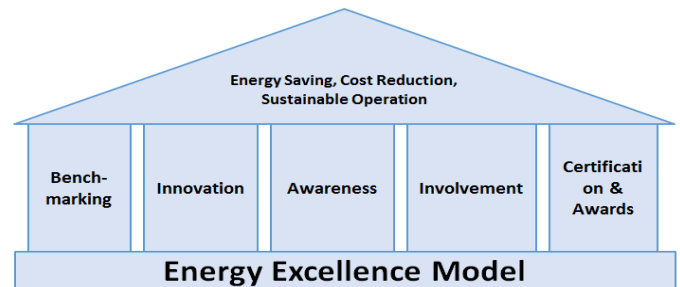
Celebration of Energy month In December every year Fig no-05, Distribution of 5000 nos. Energy booklet Fig no-14,

Energy saving cardinal rule Fig no-13, in all employees & schools of BALCO for increasing awareness towards energy conservation.



Cost Benefit Analysis & Business Benefits

For Cost benefit No of units saved through innovation ,awareness, benchmarking & involvement calculated after completion of project, Specific energy reduced per MT of Aluminium produced is calculated, For payback calculation -Cost of production of one unit, maintenance cost & project cost included taken into account and compared with energy cost saving.



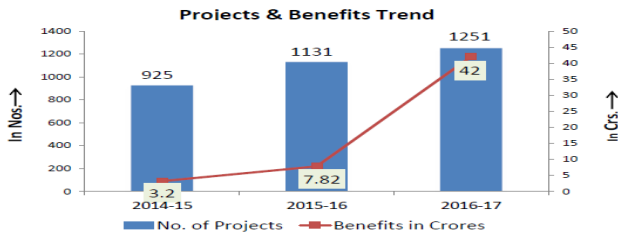
By Energy excellence model Fig no-15 – Not Only Energy & cost saving but Sustainable Operation, Reduction in GHG emission, Increase in plantation drive, Energy saving projects through - QC, Six-sigma, Kaizen & FIP after implementation of EnMS structured approach & Energy Excellence model.

Reduction in GHG emissions Fig no-16

Year	GHG emissions per Ton of Aluminium
2014 - 15	23.7
2015 - 16	18.9
2016 - 17	18.5

PLANTATION DRIVE
 FY 15 –183700
 FY 16 –102500
 FY 17 –87000

Cost Saving & Energy Saving projects Fig no-17



Keys to Success

- Implementation ENMS structured approach Fig no-8
- Brainstorming through War- room energy review system Fig no-11
- Application of Energy excellence model Fig no-15
- Corporate & Government Energy management programs -Fig no-6 & 7.
- Formation of Energy-Team individual department energy coordinator & team including representative of all employees & contract partners Fig no-10.

*“1Year =365 IDEA & opportunities per person”
Implementation of Idea generation portal & !DEA@BALCO APP for generation of idea for All Balco & Contract employees.*

-Subhadeep khan (Head Business Excellence)



- Energy reduction project through Quality circle, kaizen, Six Sigma Fig no-17.

Energy team continuously working on energy innovation & excellence for energy security, sustainability & social responsibility



- Energy management system -online energy recording & report generation Fig no-11&12.
- Visit of companies for energy benchmarking & horizontal deployment of best practices in our plant.
- Implementation of energy saving cardinal rule for increasing awareness in employees & and in township Fig no-13.
- Participation in National & State level- energy seminar, technical paper & awards.
- Reduction of specific energy through technological improvement in pot-line Fig no-7
- Continuous Internal & external audit & training

Lesson Learned

Operational excellence, unleash employee potential & effective collaboration with stakeholders, Ensure resources security through effective supply chain management, benefits of- EnMS structured approach global benchmarking, Use of Technology.

“There is too much “Energy Conversation” instead of “Energy Conservation”. Let us Walk the Talk.” Balco stepped to its Energy Conservation journey towards Excellence through implementation of ISO 50001.

- VIKAS SHARMA (CEO& DIRECTOR, BALCO)

“If you focus on results you will never change, If you focus on change you will get results” in same view our organization learned to continually improve its technology to achieve its vision

- DEEPAK PRASAD, (HEAD – ALUMINIUM OPERATIONS, BALCO)