Institute for Industrial Productivity

ENERGY IS LIFE
BEE
CONSERVE IT

Knowledge Exchange Platform

Promoting Energy Efficiency through Best Practices in Industries covered under the Perform Achieve & Trade (PAT) Scheme

NEWSLETTER ISSUE-8, NOVEMBER 2017

INSIDE

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The award winning paintings of children who participated in National Level Painting Competition-2013 organised by Bureau of Energy Efficiency, Ministry of Power, Government of India, are presented here. Paintings of Arushi Aggarwal (Haryana), Snigdha Bhattacharjee (Tripura), Priyam Das (Delhi), Anuja Anil Khilari (Maharashtra), Lopa Mudra De (Tripura), Vani Gupta (Uttar Pradesh), Modak Verma (Himachal Pradesh), Deeksha Moolya (Karnataka), Swostishree Mohanty (Odisha) appear below in the same order.

Mr. Abhay Bakre
Director General
Bureau of Energy Efficiency

Message

Warm greetings to industry friends and colleagues!

I would like to congratulate the efforts made by the Industry friends and my colleagues at BEE for realising yet another important milestone under the Perform Achieve and Trade (PAT) scheme with the launch of the ESCert trading platform. While we have reasons to feel happy for the significant achievements made under the PAT scheme, which is now being looked at as a model for other countries to follow, we need to add momentum to these efforts as we broaden the scope and coverage of PAT. This will require a systems approach for transfer of best practices and technologies and build capacity of the industries to adopt them. I am happy that we have been able to extend this support to the industry sectors covered under PAT through the Knowledge Exchange Platform (KEP), by bringing the industry, technology suppliers and other important stakeholders on a common platform and facilitating deployment of best available technologies, practices and approaches. We now need to take this success beyond PAT, by creating awareness that energy efficiency could be a critical game-changer for enhancing productivity, profitability and competitiveness. We have taken a small step in this direction by including case studies, tools and approaches for the building and an energy intensive SME sector in this Newsletter. I am confident that as we expand these efforts and enlarge the footprint of the KEP initiative, it will be able to meaningfully engage with the medium sized industries and SMEs and guide them for voluntary actions towards a cleaner and more productive operations.

In order for our efforts to be responsive to industry needs, we have constantly tried to seek inputs from the industry through the Sector Learning Groups (SLGs) and other feedback mechanisms and have taken steps to address them. Keeping in view the targets under the second and third PAT cycle,we are adopting strategies to enhance industry's access to new and innovative technologies and services that can help them achieve energy savings on a continuous basis which is very much desired under the rolling cycle of PAT. We have carried out sector wise technology gap assessment and mapping of best available international technologies under KEP for key sectors and we plan to add further to these efforts as more sectors are added under PAT. To compliment this effort,we are in the process of developing a mobile application on industrial resource conservation technologies. We plan to launch this in the coming months and start with one sector so that we can get adequate industry feedback on its utility and design before we scale it to other sectors. We are also creating searchable databases on energy efficiency technology, service providers and technology suppliers' among a host of other resources on KEP website that can help industry choose from a range of options. I will encourage the industry leaders to provide their inputs and feedback in making these applications and databases more effective.

We realise that many industries will need support at operational level to identify and implement energy saving options. To help the industry in enhancing their capacity, KEP has introduced a value added service called SPARC- Service Package for Advancing Resource Conservation, which is a package of advisory and information services to address these gaps. The services being offered under this model has been carefully designed to meet specific industry needs, with facilities such as in-plant capacity building and training services, preparatory training program for Energy Managers and Auditors examination, a query-based advisory services on technical issues among others. I am happy to share that based on the mid-term feedback from some of the early members of SPARC, energy saving opportunity of about 300 to 1000 kW per plant has been identified through Small Group Activity, out of which the Industry Members have already achieved 30 % savings in past 3-4 months.

The current issue of the Newsletter brings to you, the experience of the industry as captured in case studies covering Power, Cement and Textile sectors. The issue also includes an article on best available international cement technologies, as also a feature article on ESCert trading mechanism aimed to guide the industry on registry and the trading process.

I will encourage industry stakeholders to strengthen our efforts by providing their valuable inputs and feedback in making this Newsletter and KEP responsive to their needs and help them in their effort to enhance energy productivity.

Abhay Bakre

Greening the Building sector-Brick by Brick

– Ms. Ritu Bharadwaj & Mr. Somnath Bhattacharjee,
Institute for Industrial Productivity India

In India, 590 million people are set to be living in cities by 2030 fuelling demand for residential, commercial, industrial and other physical infrastructure projects. India is expected to build the equivalent of a Chicago every year for the next twenty years and this urbanisation challenge also presents an incredible opportunity for the country. With 70% or more of the infrastructure that India is expected have in place by 2030 yet to be built, India is fortunate in not being `locked in' the energy pathway and accordingly looks at a huge opportunity for adopting a low carbon and energy efficient pathway in the building and infrastructure sectors.

Building sector has always remained a priority area for policy makers. Bureau of Energy Efficiency (BEE) had launched Energy Conservation Building Code (ECBC) 2007, which has been later updated and released as ECBC 2017. The code establishes minimum energy performance standards for commercial buildings or building complexes that have a minimum connected load of 100 kW or a contract demand of 120 kVA. The code is primarily aimed at improving the energy efficiency in buildings and bringing down the operational energy use. It covers aspects such as building envelope, equipments, including heating, ventilating, and air conditioning, lighting among others. With other schemes like appliances star rating program, LED lighting scheme of BEE, the majority of the focus in the building sector so far has been on improving their operational efficiency. However, it is estimated that almost 30% of energy consumed during the lifetime of a building can be in its embodied energy. Embodied energy is the sum of all the energy required to produce any building component/ material. The share of embodied energy was much lower in the past, but as focus on operational efficiency has increased, energy efficiency of houses and appliances have gone up and the contribution of embodied energy is gradually becoming more significant. Research shows that embodied energy can be the equivalent of many years of operational energy and reducing it can significantly reduce the overall environmental footprint of a building.

Embodied energy assessment depends on a number of factors such as efficiency of the individual manufacturing process, the fuels used in the manufacture of the materials, the distance materials are transported and the amount of recycled products used. Consequently, the embodied energy of material such as cement, aluminium, iron and steel can be very high compared to brick, concrete etc. However, it does not mean that materials with high embodied energy will have a higher impact on the overall environmental performance of a building. Materials with the lower embodied energy, such as bricks, concrete, and timber, are usually consumed in large quantities and materials with high energy content such as stainless steel are often used in much smaller amounts. As a result, the greatest amount of embodied energy in a building can be from low embodied energy materials and therefore sectors like brick assume importance, when it comes to reducing embodied energy and improving overall environmental/ energy performance of the buildings.

The embodied energy levels in materials can be reduced by enhancing the energy efficiency of the industries producing them. The Perform Achieve and Trade (PAT) scheme has been working towards enhancing energy performance of large industry sectors, such as the cement, aluminium, iron & steel through mandated specific energy consumption reduction targets. However, brick sector needs a more strategic and focused approach to improve its performance, particularly because of its importance to the economy in terms of job opportunities it creates and because of its unique position in the Indian industry sector. The Indian brick industry accounts for about one-sixth of the total industrial sector's energy demand, producing around 250 billion bricks a year (second only to China), employs an estimated 10 million workers and has around 100,000-140,000 brick kilns distributed throughout the country. As bricks are an important building material, it is expected that the brick industry will significantly ramp up its production to meet the growing demands of the infrastructure projects.

The Indian brick industry is however plagued by several concerns with regard to its environmental and social performance. It is dominated by many small and medium sized enterprises (SMEs) and is characterized by traditional firing technologies; reliance on manual labour and low mechanization rate; limited financial, technical and managerial capacity; dominance of single raw material (clay) and single product (solid clay brick); and lack of institutional capacity for the development of the sector. The most commonly used kiln is the Bull's trench kiln (BTK), that are extremely resource inefficient and highly polluting. Nevertheless, this kiln is commonly used because of its high profit margins combined with low initial investment. As per the widely adopted technology for brick making, bricks are fired to a temperature of 700-1100° C, requiring a large amount of fuel for the firing operation. Brick kilns are estimated

to consume roughly 25 million tonnes of coal every year, making them among the highest industrial consumers of coal in the country. The total carbon dioxide emission from brick production is estimated in excess of 50 million tonnes accounting for 4.5 percent of total GHG emissions in India. The use of coal in not so efficient combustion process is also responsible for large amounts of SPM emissions. Overall, it is estimated that brick making in India accounts for approximately 60% of black carbon emissions from the industrial sector and 9% of black carbon emissions from all Indian emissions sources and offers enormous opportunities for significant reduction in fuel usage as well as environmental footprint.

Options for Greening the Brick Industry

Although the use of fly ash in brick making is not new, two Indians, Dr N Bhanumathidas and Mr. N Kalidas, have invented a new climate-friendly technology that produces bricks without using coal and top soil. The new method, known as FaL-G or Fly ash-Lime-Gypsum has the potential to completely eliminate carbon emissions from India's large brick-making industry which burns huge amounts of coal and emits millions of tonnes of carbon dioxide each year, while at the same time, save precious agricultural land/top soil.

In FaL-G brick making process,fly ash (mostly from coal based power plants) is mixed with two other ingredients available as industrial by products: Lime from the acetylene industry, and Gypsum from chemical plants. This is proving to be a revolutionary invention that produces bricks without the sintering process and consequently no greenhouse gas emissions. Another significant benefit of the new technology is that unlike clay bricks that use valuable top soil as raw material, the new method uses fly ash, an unwanted residue from coal-fired power plants that currently occupies over 125,000 acres of land. Putting fly ash to productive use thus reduces water, air, and soil pollution and respiratory problems of the populations living near thermal power plants. The use of fly ash becomes particularly important as the generation of fly ash is set to increase while the availability of top soil is bound to decrease in future-adversely affecting India's food security.

The new method of brick making offers many additional benefits over conventional brick making technologies. FaL-G plants operate throughout the year, unlike the traditional coal-fired brick kilns, thus providing year long employment for the workforce. The brick reduces plastering cost by 30 per cent and brings down the consumption of cement mortar by 60 per cent as these bricks are available in several load-bearing grades. High compressive strength eliminates breakages/wastages during transport and handling, the cracking of plaster is reduced due to lower thickness of joints and plaster and

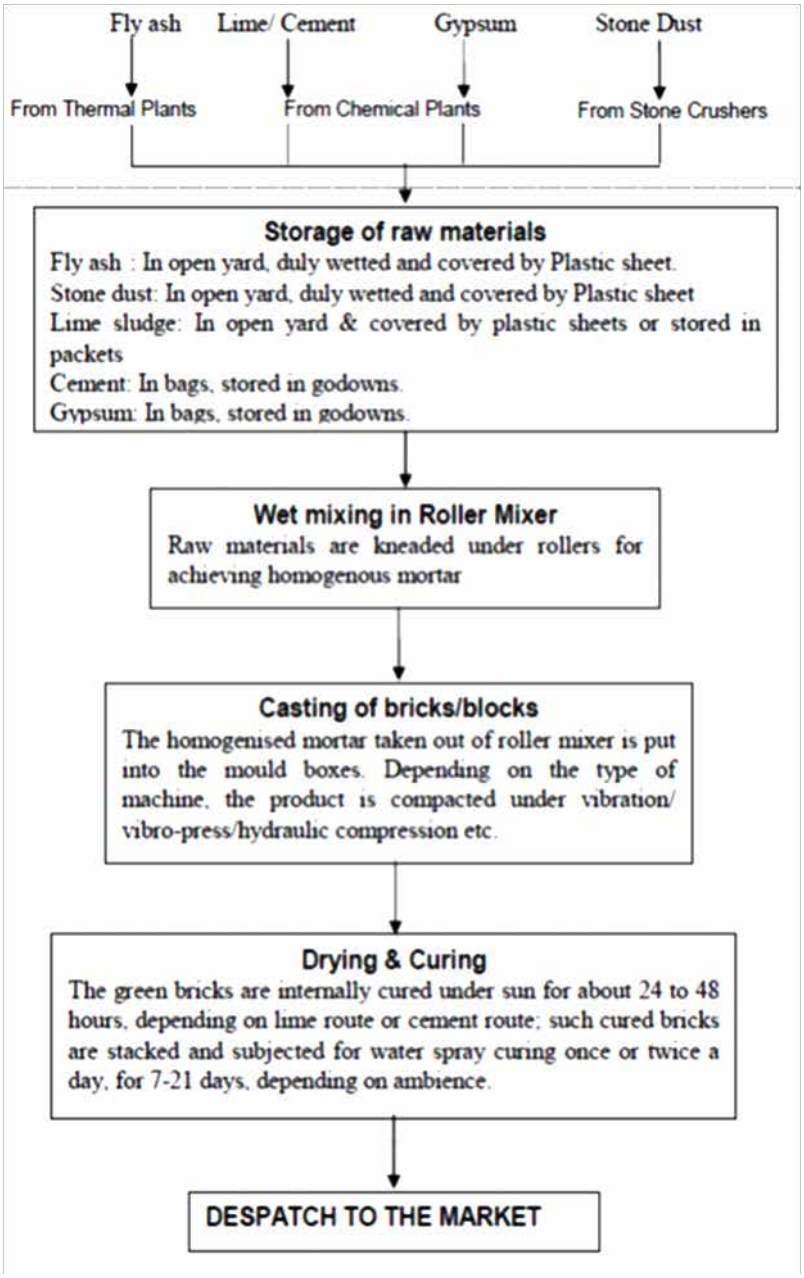


Figure 1: **Typical Supply chain of Fla-G Brick**

Table 1: Thermal Conductivity and Embodied Energy of Different Types of Brick/ Blocks

Materials	Size	Volume (M^3) of a Block/ Brick	Thermal Conductivity (W/M°c Or W/ Mk	Embodied Energy (Mj/ Block)
Fly Ash-Lime-Gypsum (FaL-G) Blocks	230 X 115 X 75	0.00198375	0.35	3.15
Solid Concrete Block	400 X 200 X 200	0.016	1.35	28.15
Autoclaved Aerated Concrete (AAC) Blocks	650 X 240 X 200	0.0312	0.15	70.17
Stabilized Mud Blocks (SMB)	230 X 190 X 100	0.00437	0.9	4.62
Fired Clay Fly Ash Bricks	230 X 115 X 75	0.00198375	0.5	5.01
Fired Clay Bricks	230 X 115 X 75	0.00198375	1.00	4.56

Sources (Original): *Deboucha Sadek & Hashim Roslan (2011), Sabapathy et al. (2011)*

Government directive on use of Fly Ash for Brick Production

With a view to protect the environment, conserve top soil and prevent the dumping and disposal of fly ash discharged from coal or lignite based thermal power plants on land, Ministry of Environment, Forests and Climate Change notification promotes the utilisation of fly ash in the manufacture of building materials and in construction activity within a specified radius of 300 kilometres from the thermal power plants.

basic material of the bricks, which is more compatible with cement mortar.

FaL-G bricks also have low embodied energy compared to traditional fired bricks and other variants of bricks/ blocks available in the market. They are also ideally suited to bring down operational energy in buildings as they have low thermal conductivity. **Table 1** provides data from different sources on the Embodied Energy and Thermal conductivity for different brick types.

Recognizing the importance of restricting the excavation of top soil for manufacture of bricks and promoting the use of fly ash in brick making, the Government of India has taken several measures to promote the use of fly ash based products in construction.

To encourage the widespread adoption of this environment-friendly technology, the inventors of FaL-G are providing the technology without invoking the patent. Institute for Industrial Productivity (IIP) India is also facilitating scale up of the technology in other countries in the South Asia Region grappling with similar issues of environmental pollution and land degradation. The efforts to promote this technology has led to over 18,000 FaL-G brick plants in India and piloting of the technology in Bangladesh.

However, the wider adoption of FaL-G brick technology is a challenge. Clay brick production remains a popular family business in India, with no incentives to innovate or modernize. Moreover, manufacturers still have to bear the cost of transporting fly ash to their production sites. In contrast, top soil for making clay bricks is easily available around the production sites. Here, a demonstrated demand for materials low in embodied energy and environmental impacts will help in stimulating demand for such bricks. Experts feel that if BEE's ECBC regulations become mandatory and promotes such material with low energy and thermal conductivity, the annual demand for fly ash bricks would be about 350 million units. The need for establishing public procurement policies and enabling regulations to create a market for such resource efficient brick is more fundamental now with not just energy saving and GHG emissions reduction agenda but to reduce pressure on fertile agricultural land. As the brick sector is growing there will be competing demand for agricultural land, which is expected to tilt in the favour of brick industry due to the prevalent political economy and powerful contractors managing the industry. This may severely impact the food security of the rising population in the region. On the other hand, ample opportunities exist for the growth of FaL-G brick technology as the fly ash output is bound to increase as a result of the planned increase in coal-fired power plants. India is already grappling with the issue of safe disposal of fly ash generated from thermal power plants and other industries and technologies like FaL-G offers a way of gainfully utilizing this waste while protecting agricultural land from getting converted to barren un-fertile land.

Spreading the Innovation in Bangladesh

Institute for Industrial Productivity India (IIP) is promoting the transfer of FaL-G brick technology to Bangladesh under an initiative based on a'South-South Cooperation' approach. Brick making is a significant economic activity in Bangladesh. There are about 8,000 operating kilns in Bangladesh producing around 17 billion bricks per year, consuming around 45 million tonnes of fertile agricultural soil, nearly 3.5 million tonnes of coal and another 1.9 million tonnes of wood. The brick sector is responsible for 38 percent particulate emissions around Dhaka. FaL-G technology offers a significantly cleaner alternative, address in many of the pressing food security and environmental pollution issues being faced in Bangladesh on account of brick making. IIP is promoting the transfer and scale up of this technology in partnership with Bangladesh Department of Environment and Bangladesh Brick Manufacturers and Owners Association (BBMOA).

Best Practices Case Study

Dalmia Cement (Bharat) Limited, Dalmiapuram

– Mr. R. A. Krishnakumar, Executive Director & Mr. R.Rajamohan, SGM & MR EnMs, Dalmia Cement (Bharat) Limited, Dalmiapuram

Introducing the Plant

Dalmia Cement (Bharat) Limited, Dalmiapuram plant, was established in 1939, and is one of the largest industrial groups in India. Dalmia Cement was one of the first Indian cement companies to be awarded IS/ ISO 9002 certification in 1993 for its quality assurance system, by the Bureau of Indian Standards. Oil well cement production started in 1984 and obtained the certification of Registration from the American Petroleum Institute in 1986. At present, Dalmia Cement, Dalmiapuram plant, has the following certifications: IS/ISO 9001, IS/ISO 14001, OHSMS IS 18001 , IS/ISO 50001. API Spec 10-A, API Spec Q1, SLS 107:2015. So as to meet an increased power requirement, a 27 MW captive thermal power plant was put up in 2005 and an additional captive thermal power plant of capacity 18 MW was commissioned in 2008. The Dalmia group set up a wind power project of 16.5 MW capacity in Tamil Nadu with the aim of encouraging green energy generation. The Dalmia Cement plant in Dalmiapuram, is one of the most modern dry process cement plants, and adheres to all applicable statutory regulations. Also, Product Variety is an USP of Dalmiapuram Plant. As a Customer Centric Plant, producing 13 Varieties to meet varying Customer requirements, perhaps the only Plant in the world making as high as 13 varieties.

Development strategies adopted for implementing ISO 50001, Energy Management System

Development Phase:

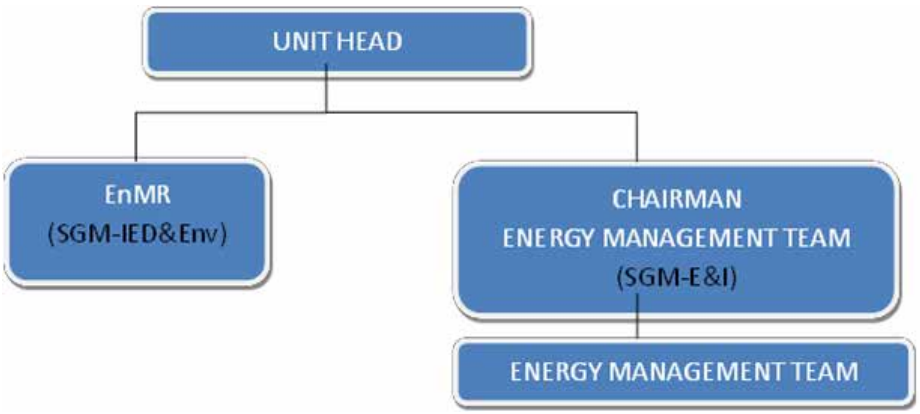
The cement plant at Dalmiapuram had established, documented, implemented and maintained an EnMS and is committed to continually improving its effectiveness in accordance with the requirements of ISO 50001:2011. Adherence to this practice will lead to reductions in greenhouse gas emissions as well as other environmental impacts, and also reduce energy costs through the systematic management of energy.

Organizational

- **Top management:** The Unit Head represents the organization's top management, and is committed to supporting the EnMS to continually improve its effectiveness. The Unit Head had enunciated an Energy policy, which is required to be followed by everyone in the organization.
- **EnMS Team Leader/Management Representative:** The Unit Head had appointed a Management representative, the EnMS team leader for the energy management systems, who irrespective of other responsibilities, has the responsibility and authority to ensure that EnMS is established, implemented, maintained and continually improved in accordance with ISO 50001:2011.

Energy Review & Planning

- **Energy Planning – General:** Energy planning consistent with the energy policy had been done and documented. The emphasis was on fixing SMART objectives leading to activities that continually improve energy performance. This had involved a review of the organization's activities that can affect energy performance.
- **Energy Review:** The organization has established a procedure, to record and maintain an energy review through periodic audits. A procedure was established which defined the methodology and criteria for the energy review. Thro' this review, significant energy consuming areas are identified and given focus.
- **Review, Analysis and Planning – Energy Baseline:** Based on the results of the initial energy review, an energy baseline



had been decided and recorded, using data of the past two years. Changes in energy performance were to be measured against the energy baseline established.

- **Energy Performance Indicators (EnPIs):** The energy performance indicators (EnPIs) appropriate for monitoring and measuring energy performance were identified and were linked with operational performance measurable such as energy used/ton of finished product. These are reviewed on an ongoing basis and compared on monthly basis to the energy baseline and updated as required. Also, these energy indicators are reviewed in a daily technical team meeting and action plans drawn , wherever , scope found.
- **Energy Objectives, Energy Targets and Energy Management Action Plans:** Documented energy objectives and targets had been established for relevant functions, levels, processes and facilities. While establishing and reviewing objectives and targets, due consideration was given to legal and other requirements, significant energy uses, and opportunities to improve energy performance.

Financing

Further consideration was also given to financial, operational and business conditions, technological options and views of stakeholders. Documented Action Plans (EnMPs) were established, implemented and maintained for achieving objectives and targets. These action plans were updated at defined intervals and included designation of responsibility, the means and time frame by which individual targets are to be achieved, statements of methods by which improvement in energy performance would be verified and a statement of the method of verifying the results.

Duration: Implemented in a period of one year.

Use of Professional Expertise, Training and Communications and Tools & Resources

Competence, training and Awareness: Any person(s) working in an area related to significant energy use is made competent through appropriate education, training, skill development or experience. The organization has a system to monitor the competence of its personnel and identify training needs associated with the control of its significant energy uses and the operation of the EnMS. Training is provided or other actions taken, to meet identified needs. Associated records, including evaluation of the effectiveness of actions, are maintained.

Communication: The top management has established appropriate communication processes with regard to energy performance and EnMS. Internal communication at different levels and functions is done through formal meetings, internal circulars, letters, notice/ display boards, an internal mail systems, training programs (including those for Energy Policy), open forum meetings, daily/weekly meetings, safety committee meetings, cross functional teams, quality circles and similar means.

Any person working for, or on DCBL DPM's behalf can comment upon or suggest improvements to the EnMS. Suggestions/ comments received from internal personnel are documented, reviewed and suitable action is taken.

Employee Engagement: Employees at all levels and functions are encouraged and motivated to participate in the EnMS activities through the suggestion scheme, forum of quality circles, cross-functional teams of various sections of the plant, and by nominating them for internal and external training programs, or visits to other cement plants to see best practices implemented there.

Professional Expertise: Energy professionals and experts were called from external agencies such as NCCBM, CII, BEE-accredited energy auditors/ BEE-empaneled energy audit firms, and were engaged to analyze various EnMS activities in the plant. Also, as part of M/s. IFC participatory resource efficiency study, an energy audit was carried out, bringing out further value additions on ENCON front.

Tools & Resources: As all the employees were well-versed with management systems already in place (ISO 9001, ISO 14001 and OHSMS 18001), the implementation of ISO 50001 was smooth. However, education of bottom-line workmen was a challenge overcome by regular and effective training by internal and external resource persons.

Steps Taken to Maintain Operational Control and Sustain Energy Performance Improvement

Operational Control: It is ensured that operations and maintenance activities which are related to significant energy uses and that are consistent with energy policy, objectives, targets and action plans, are identified and it is ensured that they are carried out under specified conditions, by:

i. Establishing and setting criteria for effective operation and maintenance of significant energy uses, where their absence could lead to a significant deviation from effective energy performance;

ii. Operating and maintaining facilities, processes, systems and equipment in accordance with operational criteria;

iii. Appropriate communication of the operational controls to personnel working for, or on behalf of, the organization;

iv. Making available/displaying written work instructions for a specific process or procedure. In case of any contingency, emergencies or disasters, or when equipment is procured, energy

performance shall be included in determining JKLC's response.

Monitoring, Measurement and Analysis: A system is established for monitoring, measuring, recording and analysis at planned intervals of key characteristics of DCBL DPM operations that determine energy performance.

These key characteristics include:

i. Significant energy uses and other outputs of energy reviews;

ii. Relevant variables related to significant energy use;

iii. Energy Performance Indicators (EnPIs);

iv. Effectiveness of the action plans in achieving objectives and targets;

v. Evaluation of actual versus expected energy consumption.

An energy measurement plan has been defined and implemented. This includes utility meters monitoring and measurement systems connected to a software application.

Internal Audit of the EnMS: The internal audits are conducted once in six months. These audits are conducted to ensure and validate that the EnMS meets planned arrangements, ISO 50001:2011 standard requirements and EnMS is effectively implemented and maintained, and improves the energy performance.

Cost Benefit Analysis

During implementation of various energy saving measures, total energy cost savings of Rs 86 million were achieved, with an investment of Rs 30 million and an average payback period of 36 months.

Business Benefits

Energy performance of the plant has improved by 6.5 % from the baseline. The baseline gate-to-gate consumption in 2013-14 was 812 Kcal/kg of major product which improved to 759 Kcal/kg in financial year 2014-15 (April - March).

- Total CO_2 emissions - gross (million tonnes): FY 2013-14: 4.46, FY 2014-15: 3.94
- Total CO_2 emissions - net (million tonnes): FY 2013-14: 3.73, FY 2014-15: 3.27
- Energy saved in the year 2015-16 is 24.0 million kWh

Benefits Achieved

M/s. Dalmia Cements Dalmiapuram benefitted in the following ways by implementing the Energy Management System (EnMS), ISO 50001:

- Got a structured platform for energy consumption, energy conservation and energy management activities.
- Easy approach for identification and prioritization of major energy-consuming activities and equipment.
- Close monitoring of high energy consuming processes and development of mechanisms for communicating changes in energy consumption patterns.
- Improvement in operational efficiencies as well as change in approach towards maintenance and procurement procedures.
- Improvement in the awareness of employees as well as other associates on energy consumption and energy conservation.
- Help in minimizing wastage of energy.

In the duration of PAT (Perform, Achieve & Trade) Cycle-1:

- Overall energy performance improved from 812 kCal/Kg of major product to 759 kCal/Kg of major product.
- Thermal energy intensity reduced from 797 kCal/Kg of clinker in 2014-15 to 765 kCal/kg clinker in 2015-16.
- Overall electrical energy intensity reduced from 67.12 units/ton of cement to 64.26 units/ton of cement.
- Up to clinkerization, electrical energy intensity reduced from 53.6 units/ton of clinker to 51.6 units/ton of clinker.

Mr. R.A. Krishna Kumar
Executive Director
DalmiaCement (Bharat) Limited, DalmiapuramPlant

It is imperative to reduce global warming and remain sustainable; ISO 50001 is a structured approach and one of the steps towards our journey to excel in energy performance.

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Best Practices Case Study

Ankur Textiles

– Mr. R S Patel, Head –Engineering, Ankur Textiles

Brief about the Plant

Ankur is a division of Arvind Limited and is located in the heart of Ahmedabad city. It is one of the oldest running composite Textiles unit in Ahmedabad.

Ankur manufactures cotton as well as blended fabrics. The strength of the unit is dyeing of variety of colors. There are about 1500 colors in which the finished product is made available.

The manufacturing of fabric can be divided into main three parts,Spinning, Weaving and Processing. At Ankur, processing is divided into bleaching, mercerizing, dyeing, finishing and carbonizing sections.

Ankur has a modern Effluent Treatment Plant for primary, secondary and tertiary treatment, as also a Sewage Treatment Plant of capacity of 1500 KL per day. Raw sewage is drawn from the Ahmedabad Municipal Corporation's sewage line, treated and used in Processing.

Table 1: Details of Various steps taken for Energy Conservation

Project	Year of Implementation	Annual energy consumption (kWh) (before)	Annual energy consumption (kWh) (after)	Energy Tariff (Rs/(kWh)	Investment in Rs
160 LED fittings in place of florescent fittings	2014-15	124762	49905	8.25	368000
Invertors in 13fans of Humidification Plant-1	2014-15	1524864	901056	8.25	640000
Invertors in 13 fans of Humidification Plant-2	2014-15	1126320	901056	8.25	520000
Installation of FBC boiler in place of smoke tube boiler with EFFIMAX	2015-16	8323	6615	6200 Rs/ MT of coal	8000000
Alternate operation of 8 aerators and installation of 5 invertors	2016-17	708465	282641	7.5	325000

Table 2: Energy consumption in the plant (2014-2017)

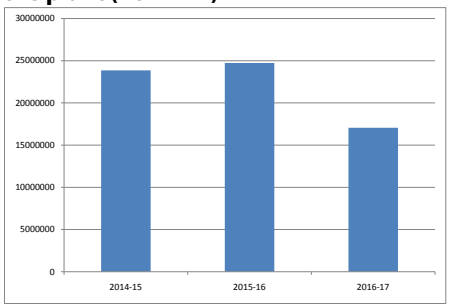
Description	Unit	2014-15	2015-16	2016-17
Annual production (please specify products)	Metric Tonne	3949.42	4037.23	4666.93
Total electrical energy consumption/year	Million kWh	23.85	24.73	18.33
Specific electrical energy consumption	kWh/t	6039	6125	3928
Total thermal energy consumption (used only for process and not for power generation and as a raw material)	Million kcal	59217.3	66142.04	64747.47
Specific thermal energy consumption	Million kcal/t	14.99	16.38	13.88

Innovative Project: Alternate operation of aerators fans in sewage and effluent plants

Background

Microorganisms such as bacteria and protozoa use small particles and dissolved organic matter, in sewage and industrial effluent, as food. Secondary treatment is carried out in a tank containing activated sludge. Aerators are used to provide air to the microbes, which then multiply, using up the particles of sewage/waste as food.

Figure 1: Energy consumption trend of the plant (2014-17)



Normally, the dissolved oxygen (DO) level in aeration tanks is maintained at 6 ppm but for effluent from our plant, DO of 2 – 2.5 ppm is sufficient.

We have three aeration tanks for secondary(biological) treatment:

1) At ETP, 1600 KL capacity with 2 aerators of 25 HP each.
2) At ETP,1200 KL capacity with 3 aerators of 15 HP each.
3) At STP, 1000 KL capacity with 2 aerators of 20 HP each.

Problem areas necessitated innovation

We found excess dissolved oxygen in all three aeration tanks leading to a high growth of mixed liquor suspended solids (MLSS) and problems maintaining the ideal food-to-microorganism ratio, at 0.2.

Methodology Adopted

Ideally, the levels of MLSS would be 4000 ppm and mixed liquor volatile suspended solids (MLVSS) would be 1800 ppm.

Earlier, we had maintained an MLSS level around 4000 ppm with DO at 4 ppm but this led to quick growth and an unhealthy mass of MLSS. This had to be removed for at least four hours per week (about 60 KL effluent from the tank).

Table 3: Impact of the Project in reducing the energy consumption

S. No.	Details	Before change			After alternative aerator started working			After invertor and alternative aerator started working at STP
		Aeration tank No 1 at ETP	Aeration tank No 2 at ETP	Aeration tank of STP	Aeration tank no 1 at ETP	Aeration tank no 2 at ETP	Aeration tank of STP	
1	Number of aerators	2	3	2	2	3	2	2
2	HP of each aerator	25	15	25	25	15	25	25
3	DO in PPM when both aerators are working	4	4.2	5.1	2.8	3	4.1	3
4	MLSS in PPM	4050	4100	840	3750	3800	930	915
5	Aeration inlet COP in PPM	525	505	158	530	500	187	185
6	Output COD	84	86	Nik	85	90	Nil	Nil
7	Total power in Kw	26.5	25.19	29.2	13.5	12.7	14.4	6.08
8	Power consumption in kWh per day	636	604.56	700.8	324	304.8	345.6	145.92
9	Power saving in kWh per day				312	300		555
10	Total saving per day in kWh							1167
11	Power saving kWh per year							425824
12	Saving in Lakhs RS/year							31.94

Before implementation: Both Aerators working.

After implementation: Alternative Aerators working.

We conducted some trials in one aerations tank by operating the aerators alternately, with a cycle time of 12 minutes. This time was gradually increased under close watch; after several trial runs we found that DO levels were maintained at 2.5 ppm and MLSS levels around 3800 ppm with a stoppage time (of the aerator) of up to 22 minutes. There was also a saving of 50% on power consumed by the aerators. After about three months of continued and successful trials in one aeration,we implemented the same protocol in all three aeration tanks.

However, because of lower loads in the STP's aeration tanks (even though aerators were operated alternately), DO levels were rising to between 3.5 and 4 ppm. We then decided to use variable frequency drives (invertors) in both aerators at a frequency of 30 Hz, in place of 50 Hz. This led to reductions in power consumption of about 70% in the aeration tank.

Team of Innovators

The team behind the successful implementation of the project were (L-R), Mr. Pravin M Panchal (Manager Engineering), Mr. Jignesh R Dalal (Chief Manger – Engineering), Mr. R. S. Patel (Head-Engineering), Mr. Jayesh J Thakar (Chief Manger – Engineering) and Mr. Bhadresh M Bhatt (Engineering Manager).

Problems faced while implementing

Stopping the aerator for more than 20 minutes caused sludge to settle at the bottom of the aeration tank so the aerator was operated for 20 minutes.

Impacts & Benefits realized

- **Financial Implications:** Investments and savings: Total investment was INR 3.25 Lakhs. Energy worth INR 31.94 lakhs saved per year.
- **Power consumption of 8 aerators before and after this change:** Before this change the power consumption was 1941 KWH/day, or 70,8334 KWH/year and whereas power consumption of 8 aerators after the change was 774 KWH/day,or 282,510 KWH/year.
- **Power saving with this change:** 60 %
- **Contribution of the project in achieving the PAT Targets:** Reduction in power consumption by 1.72%
- **Impact of the project on the overall performance of the plant:** There is no adverse effect but power saving of about INR 32 Lakhs per year

Mr. Brijesh Bhati
Chief Executive Officer, Ankur Textiles

It is matter of great pride and privilege to acknowledge a great and innovative step towards Energy conservation and sustainability, by our Engineering team, led by Mr. RS Patel. I heartily congratulate the team for successful implementation of the energy saving initiatives at our ETP and STP plant. This not only a commercial saving, but a great step towards sustainability and national energy saving.

I wish the team all the very best for many more such initiatives in future.

Best Practices Case Study

Nabha Power Limited

– Mr. Anand Saxena, Sr.DGM-Technical Services & Planning, Nabha Power Limited

About the plant

Nabha Power Limited is a 2 x 700 MW supercritical thermal power plant located at Rajpura, Punjab. This is the first development project and the first power plant to be owned and operated by L&T. All power generated by this plant is being sold to the Punjab State Power Corporation Limited (erstwhile PSEB) for a period of twenty-five years under a Power Purchase Agreement (PPA). The plant is India's first, of the supercritical type, and uses technology obtained from Mitsubishi, Japan.

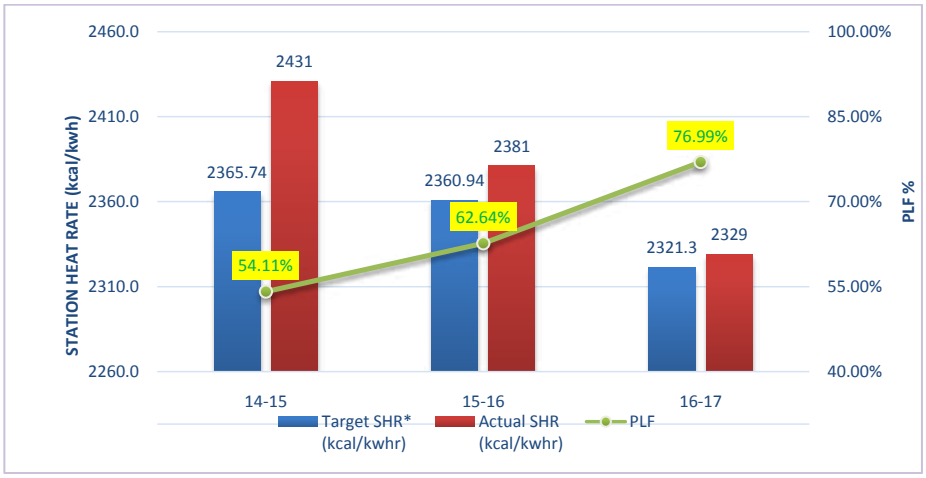
The South Eastern Coalfields Ltd. (a subsidiary of Coal India Limited) supplies coal under a 20-year fuel supply agreement (FSA).The Bhakra-Nangal distributary is a perennial source of water for the plant under an allocation by the state irrigation department. The plant is operated by an in-house team of experienced operations and maintenance professionals.

Both the units commenced commercial operations in 2014. The supercritical boiler and turbine were manufactured indigenously by a joint venture between L&T and MHPS, at Hazira, Gujarat.

Noteworthy points relevant to the plant's efficiency are:

1. Supercritical technology has been used to for superior efficiency and reducede missions
2. Washed coal is being used to meet environmental guidelines
3. 100% dry fly ash utilization on sustainable basis
4. Zero-liquid discharge plant. Water consumption <2.5 m_3/MWh
5. Natural draft cooling towers and turbine-driven boiler feed pumps have been used to reduce auxiliary power consumption.
6. State-of-the-art automated techniques such as wagon tipplers for unloading coal rakes, used for all operations.

Figure 1: Energy consumption trend of the plant (2014-17)



* Target SHR (kcal/kWh) has been derived considering a PPA heat rate of 2268 kcal/kWh at full load

Health Safety & Environment (HSE)

We are committed to generating reliable and environmentally-friendly power under safe working conditions. A policy on quality, environment, health and safety has been put in place and our processes and practices related to environment, health and safety are continually improved. Employees and other stakeholders are trained so as to foster a culture of safety.

We have received the following management certifications:

1. ISO 9001:2015
2. OHSAS 18001:2007
3. ISO 14001:2004
4. ISO/IEC 17025:2005 (NABL Accreditation for Coal Laboratory)
5. ISO 50001:2011

Major energy efficiency initiatives during the last two years (2015-2017)

1. Reduction in cold start-up time from 36 hours to under 24 hours
   - Dissolved oxygen removal method revised
   - Reduction in sampling-tubing bends and pressure-reducing valves to help obtain true samples in the steam and water analysis system.
   - Better atomization of light diesel oil (LDO) with steam (heavy fuel oil, HFO, replaced by light diesel oil).
2. Reduction in specific oil consumption from 0.818 ml/kWh (FY15) to 0.124 ml/kWh (FY17)

- Switchover from HFO to LDO (ease of operation in boiler light-up and better flame stability)
- Reduction in rolling steam pressure from 85-60 ksc.

3. Improvements in ash-handling plant
   - Average operating hours of ash-handling plant per day reduced to 17 hours from 24 hours by reducing line length and number of bends in duct hopper ash conveying line. Specific power consumption reduced from 24 kWh to 15 kWh per ton of ash handled.
4. Improvements in coal-handling plant
   - Use of one crusher and vibrating grizzly feeder (VGF) for washed Indian coal against earlier practice of using two crushers and vibrating grizzly feeders. SPC reduction from 1.8 kWh to 1.45 kWh per ton of coal handled.

Innovative Project: Use of one crusher and vibrating grizzly feeder for washed Indian coal in place of earlier practice of using two crushers and VGFs.

Project Background

The design flow rate of four crushers and VGFs used in the plant to move coal is 1600 TPH; however, after they were commissioned, the maximum flow rate of the crushers was 1100 TPH and the crusher's internal parts required frequent maintenance and replacements.

On carrying out a detailed study it was observed that most of the coal flow was getting diverted into the crusher. With washed coal being used (particle size 35-50 mm) it was weird to see the maximum coal flowing into crusher. At the same time the crusher was found to be drawing comparatively very low power, indicating that it may be handling smaller coal particles.

On checking the performance of the VG Fit was seen that a layer of coal was piling up on the solid deck plate just beneath the chute area and was choking the flow of coal which was allowing smaller coal particles to pass through the crusher, rather than the VGF screens.

Problem Necessitated Innovation

The deck plate of the VGF had one solid stretch (2310 mm x 600 mm) which was directly below the chute area and was obstructing the free flow of the coal mass; this necessitated reducing the loading to allow smooth operation.

Before modification **After modification**

Methodology Adopted

To avoid choking, it was decided to modify the solid deck plate by perforating it with hole size of 80 mm and 65 mm dia so that most of the smaller size coal could pass through the VGF screen leaving only oversized coal flowing to the crusher.

Action Taken

Modifications in the perforating deck plate of VGF (2310 mm x 600 mm with 80 mm and 65 mm dia. holes) raised the loading capacity of the VGF and crusher from 1100 TPH to 1500 TPH, allowing one stream to standby while the other was in operation.

Risk Involved

The manufacturer of the equipment was approached in search of a solution to this problem but they were unable to suggest any suitable solution. An in-house root cause analysis was carried to resolve the issue.

Benefits

This out-of-the-box modification improved the crusher loading and also resulted in power savings of 384070 kWh (equivalent to a saving of INR 1.037 million per annum) as one stream only had to be operated. The project involved an investment of INR 0.11 million as all the solid deck plates were replaced in four crushers.

Contribution of the project in achieving the PAT Targets

Nabha Power Limited is covered under PAT Cycle-III. Similar projects implementation will be a key contributor in reducing our specific power consumption.

This innovative project led to reduce specific energy consumption per MT of coal handled and ISO 50001 and details thereof:

Stopping operation of one stream of washed coal through the VGF/crusher yielded a power savings of 384 MWh which is equivalent to savings of INR 1.037 million per annum. The project involved

an investment of INR 0.11 million as all the solid deck plates were replaced in four crushers.

Team of Innovators

Team members involved in the project (from left to right): Mr. Anshul Mangal(AM – CHP), Mr. Vijay Sharma (AM – CHP), Mr. Shailesh Paun (AGM – CHP),Mr. Yashwant Maurya (Head – CHP & Railways), Mr. Sanjay Sahoo (MGR-CHP)and Mr. Rohit (Technician).

Mr. Gautam Pal
Head Operations & Maintenance, Nabha Power Limited

Energy Conservation is the key pillar in our stride towards making NPL one of the best operating power plant in the country. Understanding the limitations in any system specific to its function and then finding out different avenues to resolve the issue without compromising any of its existing features- should always be a motto while executing an improvement project.

Mr. Anand Saxena
Head Energy Management, Nabha Power Limited

At NPL, managing energy is not a project but a practice involving a set of measures and tools that is in place which is used in our day-to-day activities. This is our key to sustenance of ISO 50001.

Mr. Yashwant Maurya
Head Coal Handing Plant, Nabha Power Limited

I take pride in my team for implementing this out of the box project which has improved the ease of operation and maintenance of coal handling system. I put the trust in my team to identify such key areas in the coal handling chain and contribute towards energy saving targets at NPL.

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Launch of the trading of Energy Saving Certificates (ESCerts) for Designated Consumers under Perform Achieve and Trade (PAT) Scheme

Ms. Vineeta Kanwal
Joint Director
Bureau of Energy Efficiency

On 26th September 2017, Sh. Raj Kumar Singh, Hon'ble Minister of State (I/C) for Power and New & Renewable Energy, launched the trading of Energy Saving Certificates (ESCerts) under the Government's Perform, Achieve & Trade (PAT) scheme. This will pave way for designated industries, under the PAT scheme, to buy and sell ESCerts at the two energy exchanges, i.e. Indian Energy Exchange (IEX) and Power Exchange India Limited (PXIL).

The Ministry of Power, Government of India, is implementing PAT scheme as a market-based mechanism, under National Mission for Enhanced Energy Efficiency (NMEEE), to enhance cost effectiveness through certification of excess energy savings in energy intensive industries that can be traded. The scheme seeks to reduce the specific energy consumption (SEC), i.e. energy used per unit of production in energy intensive large industries. Under this scheme, a Baseline Energy Audit is done to verify the baseline data (current level of efficiency) of designated consumers and thereafter energy saving targets are notified. Energy Saving Certificates (ESCerts) are issued by the Ministry of Power when a Designated Consumer (DC) achieves and surpasses the assigned target in the Assessment year (3rd year of the PAT Cycle). These ESCerts can be sold to DCs who fail to achieve their targets to comply with energy consumption norms and standards.

To facilitate trading of ESCerts, an institutional framework has been established that defines the responsibilities assigned to different entities that will play a vital role in the process. While the Central Electricity Regulatory Commission (CERC) is the Market Regulator for the trading of ESCerts, the Bureau of Energy Efficiency (BEE) is the Administrator. To trade these ESCerts on any of the two power exchanges, designated consumers need to register themselves with Registry as eligible entities through the PATNet portal.

In his Inaugural Address, Sh. Raj Kumar Singh, Hon'ble Minister of State (I/C) for Power and New & Renewable Energy, mentioned that "Indian businesses are leading from the front and adopting a strategic approach to reduce their energy intensity. These actions not only improve their bottom lines but also reduce their dependence on fossil fuels. With the launch of trading of ESCerts and monetizing savings, we are now much closer to incentivizing Designated Consumers for their energy saving initiatives. This will facilitate designated consumers to achieve their legal obligation under the Energy Conservation Act, 2001 and motivate them with necessary market-based incentives to exceed the targets set for them."

In the first cycle, ended in 2015, the PAT scheme covered 478 Designated Consumers from 8 energy intensive sectors. These sectors include Aluminium, Cement, Chlor-alkali, Fertilizer, Iron and Steel, Pulp and Paper, Textiles and Thermal power plant, which covered about 33% of India's total industrial energy consumption. Based on their energy performance and recommendations of Bureau of Energy Efficiency (BEE), the Ministry of Power has issued ESCerts to DCs of PAT Cycle 1 on 16th February 2017.

Sh. Raj Kumar Singh, Hon'ble Minister of State (I/C) for Power and New & Renewable Energy, while launching the trading of ESCerts

Table 1: Summary of traded ESCerts					
No. of session	**Trading date**	**Trade Volume (numbers)**	**Sell Bid (numbers)**	**Purchase Bid (numbers)**	**Cumulative trade volume (numbers)**
1	26th September 2017	10,904	2,39,644	50,904	10,904
2	3rd October 2017	23,295	2,36,031	51,925	34,199
3	10th October 2017	43,078	3,48,587	64,459	77,277
4	17th October 2017	40,148	3,81,443	40,538	1,17,425
5	24th October 2017	41,455	3,49,806	42,271	1,58,880
6	31st October 2017	19,359	3,83,379	21,037	1,78,239

Approximately 38.25 lakhs ESCerts were issued to 306 DCs while 110 DCs have been entitled to purchase approximately 14.25 lakhs ESCerts.

In his address, Sh. Abhay Bakre, Director General, Bureau of Energy Efficiency, thanked the industry for their enthusiastic participation and a remarkable performance in PAT Cycle 1. It has resulted in energy savings of 8.67 million tonnes of oil equivalent (mtoe), which is about 30% more than the target (6.687 mtoe) that was set. This has also resulted in an emission reduction of 31 million tonnes of CO_2. At the same time, INR 9,500 crores have been saved due to reduction in energy consumption. Trading of ESCerts will enable the DCs to reap the benefits of monetization of energy saving initiatives.

The launch event was attended by Sh. Gireesh B. Pradhan, Chairperson, Central Electricity Regulatory Commission; Sh. Raj Pal, Economic Adviser, Ministry of Power; Sh. Ravi Shankar Prasad , Joint Secretary, Ministry of Environment, Forest and Climate Change ; senior officers of Ministries, State Governments, technical bodies, public utilities, multilateral agencies, academicians, and industry experts and consultants across sectors. The event also featured sessions on the various new technologies adopted through PAT Scheme and on the trading of ESCerts.

The certificates are weekly traded on every Tuesday through closed double-sided uniform price auction. In the first Energy Saving Certificate (ESCerts) trading session, which was held on 26 September 17 at IEX, a total of 10,904 ESCerts were traded at INR 1200 per ESCert. The total buy bids were 50,904 ESCerts whereas the total sell bids were 2,39,644. Industry members have come forward and actively participated in the trading sessions.

In the first six sessions, a total of 1,78,239 ESCerts with value more than INR 15 crore have been traded, details of which are presented in **Table 1**. During last 6 trading sessions the average price of ESCerts discovered in IEX is approx. INR 850.

Trading of Energy Saving Certificates is helping DCs in achieving their compliance under PAT scheme. However, it is expected that in forthcoming trading sessions more DCs will come forward for participation in trading and fulfilling their compliance.

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Get an EDGE in the Green Building Revolution

An online tool to help design green buildings and measure their impact, geared to emerging economies

– Ms. Shruti Narayan, Lead - Green Building Program, India
International Finance Corporation

India is the world's fourth fastest-growing economy, currently placed seventh in the world overall,[1] and is projected to become the second largest by 2050.[2] What will be the impact of this growth on climate change and non-renewable resources?

In 2015, the Government of India made an ambitious commitment to address climate change with an Intended Nationally Determined Contribution (INDC) to reduce greenhouse gas (GHG) emissions by 33-35%.[3] Buildings account for 30-40% of energy-related GHG emissions globally across their life cycle. According to a 2013 Global Buildings Performance Network (GBPN) report, the real-estate sector worldwide needs to reduce its emissions by 25% by 2020, and by 50% by 2050, to ensure that global warming does not exceed 2°C. Meanwhile, in India, the emissions from buildings are expected to increase by over 750% and thermal energy consumption in buildings is projected to increase by almost 700% in 2050 compared to what they were in 2005, unless action is taken right away.[4] Energy is an expensive resource, for which India relies largely on fossil fuels. Though the INDC includes a drive to increase production from renewable sources, India has had to import fossil fuels to produce 34% of its energy needs for 2014 (World Bank database)[5], and perhaps as much as 46% of its commercial energy in 2015-16.[6] Another key resource is water. Green buildings - those that save water, energy and materials - should be main streamed in India across the real-estate sector, particularly in view of the fact that a 40% global shortfall in water supply is expected by 2030: India's domestic and municipal water use is expected to reach 108 trillion litres by then (2030 Water Resources Group).[7] Reclaiming water should be a priority, but the UN World Water Development Report 2017 finds that over 80% of the world's wastewater is released into the environment without treatment.[8]

To increase the penetration of green buildings in emerging markets, it is necessary to address certain challenges. A recent innovation addressing such challenges is EDGE (Excellence in Design for Greater Efficiencies), which was launched in 2015 to drive the adoption of green building practices in emerging markets.

A tool to mainstream green buildings

An accessible tool to facilitate the adoption of green building design among large numbers of people can be of great help. Such a tool would establish the rationale for green building design, make resource efficiency easy to measure, simplify certification, and enable the user to make impactful choices without requiring advanced technical training to plan a green building project. Developed by IFC (the International Finance Corporation, a member of the World Bank Group), the EDGE software supports the design, assessment, and certification of green buildings, and is specifically geared to addressing the challenges and needs of emerging economies, given the World Bank's focus on this set of countries. Some of the key features of EDGE designed to help mainstream green buildings are shown in **Figure 1** and discussed in greater detail below.

These features of EDGE address and help resolve some key challenges to the adoption of green building design on a large scale in India:

Access to knowledge and expertise

Knowledge of green technologies, the impact of building materials, and access

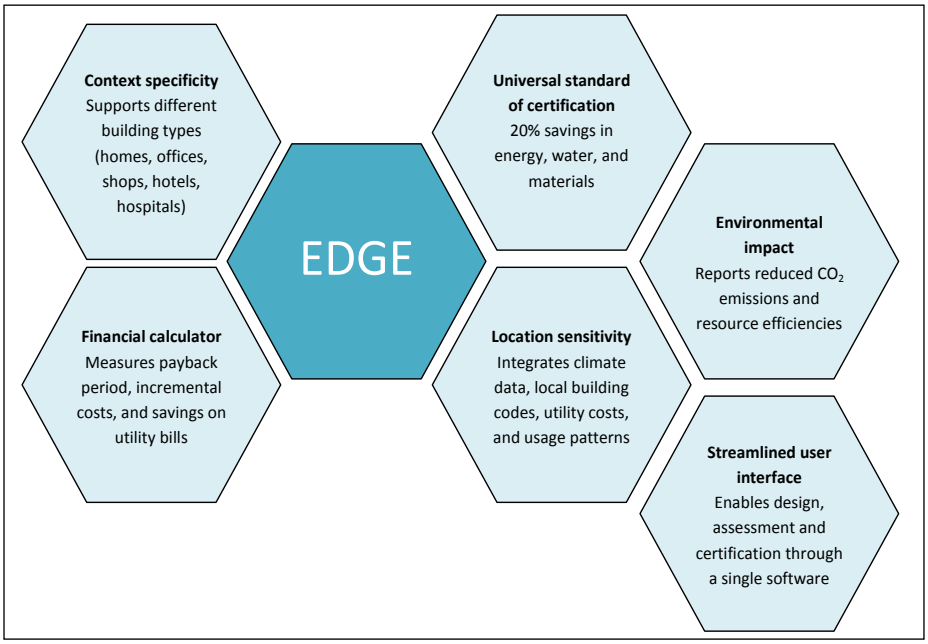

Figure 1: Key features of EDGE

EDGE Professionals

Anyone with three years of higher education or work experience related to the construction industry can train to become an EDGE Expert or Auditor—the candidate may be an architect, engineer, auditor, or have technical experience in some other aspect of the industry. Training takes place through either a scheduled workshop or an on-demand online course.

EDGE Auditors: An independent trained professional, the EDGE Auditor's role is to review the project documentation, verify compliance with certification standards, do a final audit, and recommend the project for assessment to the certification provider.

EDGE Experts: The EDGE Expert helps clients to select the most cost-effective and impactful design elements for their project. Clients may also choose a member of their in-house design team to train as an EDGE Expert. Nearly 600 professionals have been trained worldwide to support clients in fast-tracking certification for their projects.

to professionals with the expertise to guide green design choices can all be challenging in an emerging market. The EDGE software provides a streamlined interface(refer to 'Inside the Dashboard') for design, evaluation, and certification of a green building project through a single browser window, without requiring any specific technical expertise from the user.

A client wishing to design a green building may be unaware of the options available to improve its resource efficiency, and even request features that go against the brief (such as large windows for natural lighting, which also increase heat gain). The EDGE software offers users a toolkit of choices to design a green building, drawing on a global database of construction materials (called GaBI, developed by the German firm thinkstep) that reports their environmental impact.

Buildings of the same type (homes, offices, hotels, etc.) are not built or used in the same way the world over, because of differing needs and habits, determined by climate and culture. To allow a fair comparison, the costs and resource efficiency associated with a project have to be benchmarked against its immediate peers. EDGE is powered by a location-specific data set which was developed by surveys of actual buildings in cities in over 100 countries, so that the software takes into account local building codes, usage patterns, utility costs, and climatic data in its assessments. This enables globally relevant but locally sensitive design.

This entire body of knowledge is freely available through the EDGE software to anyone with internet access. However, if further support is needed, the user can choose to use the services of an EDGE Expert (refer to box 'EDGE Professionals').

The business case for green buildings

The "green premium" is a matter of concern for some developers, who associate an incremental cost with going green. However, global studies indicate that the incremental costs of building green may be as low as 0-2%,[9] and are readily recovered by lower operational costs. The payback period of a green building, within which incremental costs can be recovered by savings on utilities, is a critical factor in convincing clients that green building design should be adopted. Financial considerations are a key driver of decision-making particularly in the informal real-estate sector in emerging markets; however, clients who are building, renting or purchasing a space may even be unaware that choosing a green building will significantly lower their operational and maintenance costs. EDGE makes the business case for the project clear to clients.

EDGE's in-built financial calculator reports potential savings, incremental costs, and the estimated payback period of each project. This allows clients to meet their sustainability goals while staying within budget. For example, in Jakarta, the Daan Mogot Baru Office Park has used EDGE to design a project with a payback period of less than four months; other EDGE-certified projects report payback periods of 2-5 years.

Users of even a certified green building may not be aware of its resource efficiency: designers, developers, and users of buildings need a tool to readily demonstrate a green building project's performance. The EDGE dashboard reports the project's environmental impact in terms of water and energy use, and the greenhouse gas (GHG) emissions and embodied energy of materials.

Ease of certification

In markets where proliferation of buildings is rapid, certification needs to be quick and easy to keep pace and gain wide adoption. Irrespective of usage and location, any project must meet a universal standard for certification under EDGE - 20% savings of energy, water, and materials (the last measured in terms of their embodied energy) - and the software helps the client to evolve a design meeting these conditions. Since EDGE is easy to use, it encourages wider voluntary adoption, and challenges clients to improve on their own design for greater efficiency. To submit a project for certification, the client employs an EDGE Auditor (refer to box 'EDGE Professionals') and submits the project documentation.

Impactful and Evolving

The EDGE software has been used by clients in emerging markets across over

Inside the dashboard

The EDGE software is designed to help all stakeholders—developers, architects, engineers, owners and users—to design or assess a green building. Available online at www.edgebuildings.com, the application dashboard accepts user inputs on the building's design to define the project and evaluates its performance as a green building. EDGE currently supports design and certification for five different types of buildings:

- homes
- offices
- hotels
- hospitals
- retail spaces

The software also employs location-based data for each type of building:

- local building codes
- climate-based needs in that location (for example, energy needs for heating and cooling, humidity control, water use for irrigation)
- typical usage patterns for that building type in that location (diurnal rhythms, water and energy requirements)
- local utility costs (water, electricity and fuels, such as diesel, LPG, or natural gas)

Initial inputs sought from the user include design parameters such as number of floors, units, parking, shared spaces, and various facilities to be included in the project. Based on the selected use and location and these design parameters, the software uses its databases of materials and city-specific information to calculate a base case for the project.

The user can then choose from a context-specific menu of resource-efficient alternatives for energy, water, and materials (refer to **Figure 2**), and the software dynamically reports the improvements over the base case. (EDGE certification can be obtained when the project achieves a 20% reduction in energy use, 20% reduction in water use, and 20% reduction in embodied energy of materials compared to the base case; however, clients can always aim for greater efficiencies.)

The software shows the impact of changing specifications in real-time, whether it is the impact of adding fly ash to concrete, or of using lightweight autoclaved aerated concrete (AAC) blocks in place of clay bricks. By the time the project is fully defined, the resource efficiency and financial parameters associated with the final design are summed up at the top of the dashboard.

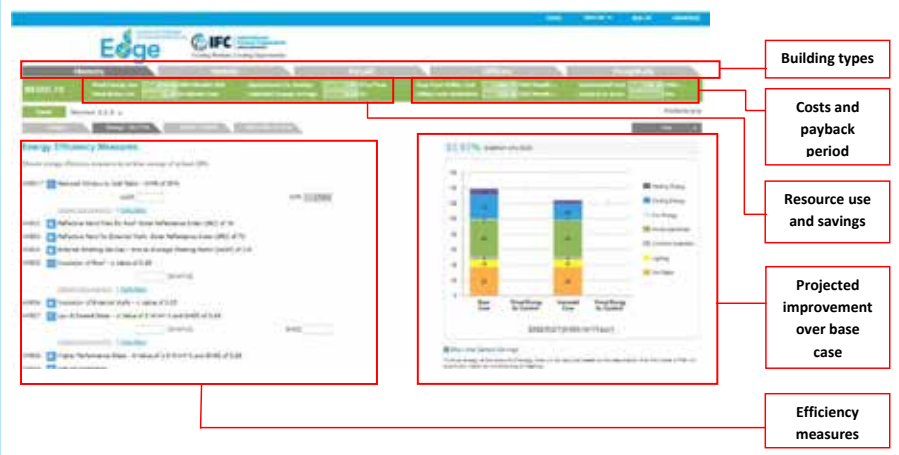

Figure 2: The EDGE Dashboard

130 countries, including Argentina, Brazil, Bulgaria, China, Colombia, Ecuador, Ghana, India, Indonesia, Lebanon, Mexico, Nigeria, Philippines, South Africa, and Vietnam. More than 8,500 projects in various geographic and economic contexts have been created within the software, and in the last year, 1.5 million square meters of floor space were EDGE-certified, with another 1 million square meters awaiting certification.

The wide variety of certified projects establishes that green buildings can exist across a spectrum of socioeconomic contexts, choosing from a large toolkit of technologies to achieve sustainability goals. The EDGE team strives to keep the software updated across markets. For example, the software was adapted when local building codes were tightened in Bulgaria, and to align with China's national green building labelling system. In India, EDGE will incorporate an India-specific database of materials (also developed by IFC) within the next quarter, to reflect local manufacturing practices.

The software has also been evolving in response to user feedback. Though originally developed to design new green buildings, EDGE responded to users' requests to enable certification for existing buildings and retrofitted projects. To support more ambitious green building projects, the team is collaborating with Architecture 2030 (a think tank of architects addressing climate change) to enhance the software to recognize zero net-carbon buildings. EDGE currently supports five building types, and the team is happy to hear from clients with requirements beyond this - for example, designing a green school building, a restaurant or a factory - so that updates are aligned to market needs. IFC's collaborative global team can be

reached at edge@ifc.org, and is happy to welcome feedback and answer questions on EDGE.

Meanwhile, EDGE continues to align itself to the needs of all stakeholders in emerging markets, responding to individual, community, and national aspirations. For example, in India, the Prime Minister's Pradhan Mantri Awas Yojanato achieve 'Housing for All by 2022' has driven growth in the affordable housing sector, which is a need in most emerging markets. Being strategically designed to support this pipeline has allowed EDGE to enable the penetration of green buildings in India's affordable housing sector. Kesar City—an affordable housing project in Ahmedabad—was able to achieve a significant savings of 71% less embodied energy (compared to the base case) by using low-impact in-situ concrete with more than 30% pulverized fly ash (PFA) and fly ash-lime-gypsum (FaL-G) blocks. It also has an estimated 24% reduction in water use from low-flow fixtures and recycled black water for flushing, and 23% energy savings through a lower window-to-wall ratio, reflective external paints and shading, and energy-efficient ceiling fans and lights. It is estimated that residents will enjoy a monthly saving of over Rs 200 on their utility bills as a result.

In another example, the EDGE-certified VBHC Vaibhava multi-residential affordable housing project in Bangalore won a national award for green building design. The project incorporates a rainwater harvesting system, recycled black water for flushing, and low-flow fixtures, and has achieved water savings of 39%. Use of technologies such as low window-to-wall ratios, reflective external paints and shading, solar hot-water collectors, and energy-efficient lights and fans has resulted in energy savings of 33%. The project also achieved a 23% lower embodied energy value than the base case.

Several of the most impactful EDGE projects worldwide have been highlighted on www.edgebuildings.com/projects, and the list of accredited EDGE professionals on the site continues to grow apace as well.

Supporting a Climate-Smart India

Supported by the European Union, IFC has launched the Eco-Cities in India program to promote climate-smart infrastructure, catalyze the green buildings market, and promote competitive SMEs related to these sectors in five Indian cities: Bangalore, Bhubaneswar, Chennai, Mumbai and Pune. Projects within this four-year program are working to promote clean technology and energy efficiency measures, water and waste management, urban mobility and transport solutions, enlarging the green buildings market, promoting voluntary green building certifications, and facilitating financing for small and medium enterprises. Recognizing that appropriate certifications and support for green design is key for green buildings to become mainstream, IFC launched the EDGE software in 2015 in India as part of its global program on green buildings. In India, IFC is also working on a construction materials database that will further calibrate EDGE for the Indian context.

About IFC

IFC, a member of the World Bank Group, is the largest global development institution focused on the private sector in emerging markets. Working with more than 2,000 businesses worldwide, we use our capital, expertise, and influence to create markets and opportunities in the toughest areas of the world. In FY17, we delivered a record $19.3 billion in long-term financing for developing countries, leveraging the power of the private sector to help end poverty and boost shared prosperity. For more information, visit www.ifc.org.

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Increasing Energy Efficiency in Indian Cement Manufacturing

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Limited

The cement industry is among the most energy intensive industries around the world and is therefore, quite rightly, the focus of global strategies to reduce energy requirements. Richard Woosnam of Fairport Engineering examines how the use of a variety of alternative fuels can improve energy efficiency in the Indian cement sector by adopting different strategies for kiln firing and electrical energy generation.

A cement kiln requires a significant amount of thermal energy that is traditionally delivered by fossil fuels, mainly coal and pet-coke. The European average figure (for 2010) was 3,733 $MJ_{(th)}$/Te (888.8 $kcal_{(th)}$/kg) but nowadays modern energy efficient kilns have reduced the thermal energy demand to around 3,300 $MJ_{(th)}$/Te (785.7 $kcal_{(th)}$/kg) using pre-heater kilns and a dry process. Older long dry kilns use approximately 33% more energy (than 3.300 $MJ_{(th)}$/Te), while wet processes typically consume in excess of 80-85% more energy than pre-heater kilns. Indian data indicates that the typical thermal energy to pyro-process cement raw materials to clinker is of the order of 650-750 $kcal_{(th)}$/kg [4]. Comparing this data indicates that India typically uses less energy per tonne to manufacture cement. However, it is known that Europe (and in particular the UK) uses more Alternative Fuels (AF) via thermal substitution in the kiln. If this could be introduced into Indian cement manufacture the potential savings are significant and profitability could be increased as the cost of traditional fuels is saved as a minimum.

The electrical energy consumed in making cement is also of significance and can be sub-divided in to various parts of the process as shown below in **Table 1**. This needs to be related to a broad general assumption that a modern cement plant uses 110 -120 $kWh_{(e)}$/tonne[1] to produce 1 tonne of finished and packed cement.

The UK produces some 10 Mt/a of cement quite energy efficiently using Best Available Techniques (BAT), even though the cement plants are generally older than found in Asia. Countries like India produce considerably more cement. In FY 2016[2] India produced over 282.8 Mt/a of cement and this is forecast to grow to around 400 Mt/a this year, an annual growth rate of 9.7%; with further increases in production predicted to nearly 500 Mt/a production by 2020. The electrical demand for increased capacity of all cement process would add approximately 41.4% power demand by FY17 (compared to FY2016) if growth is accurately forecast, and more than 60.7% increased power demand by 2020. A huge increase that will require significant investment in power infrastructure. While many cement plants in India have some Captive Power Plants (CPP), this increase in production will also increase the amount of emissions; especially if this energy demand is provided by coal and/or pet-coke.

In reality much of this requirement for additional energy, thermal and electrical, can be met by using AF's and increasing Thermal Substitution Rates (TSR). In Europe AF's are regularly used to provide up to 65% of the energy required in kiln firing and even up to 100% TSR has occurred; comparatively in Asia, and India in particular, the use of AF is around 4% and often less than 1.5%. Biomass fired alternative generating plants are only just beginning to become the norm in Europe but increasingly providing electrical energy to their national grids. In the UK some major power stations like Drax, Ferrybridge and Lynemouth now use predominantly biomass (wood pellet and refuse derived fuels) as their fuel of choice.

AF's have come a long way since their early use in the European cement industry. Originally the first AF's were described as RDF (refuse derived fuel). These fuels were originally quite crudely produced from Municipal Solid Waste (MSW) and often came with high levels of moisture that often led to poor firing in the cement kilns. Over time the waste was subjected to more sophisticated treatment in a so called Material Recovery Facility (MRF) where better quality fuels were produced called Solid Recovered Fuel (SRF). Nowadays these facilities have become largely semi-automated and are a corner stone of TSR within a variety of industries.

To facilitate the increased use of AF the UK government supported a 'Demonstrator Technology Programme' to encourage the building of state of the art facilities

Table 1: Approximate Electrical Energy Split by Cement Production Process Step

Proportion of Electrical Energy	Process Step
~38-40%	Cement Grinding
~22-24%	Raw Material Grinding
~20-22%	Clinker Production (including grinding of fuels)
~3-6%	Raw Material Homogenisation
~3-5%	Raw Material Extraction
~5%	All types of conveying and packaging
Total 100%	

Table 2: Comparison of types of Alternative Fuels with traditional fuels for NCV versus embedded Sulphur and Nitrogen

	Fuel	Nitrogen Content %	Sulphur Content %	Nett CV (MJ/kg)	Estimated Global Availability (Mt/yr.)	Estimated Global Heat Value (PJ /yr.)	Coal Equivalent – Mt/yr. (calculated at 25.3MJ/kg)
Alternative Fuels	SRF	0.7	0.17	15.5	1,400	21,700	614.4
	MBM	7.52	0.38	16.2	7	113	3.15
	Sewage Sludge (PSP)	0.84	0.12	15.8	18.5	292	8.12
	Tyre Rubber	0.43	1.54	35.6	5	178	4.94
Normal Fuel	Pet Coke	1.71	4.0	33.7	60	2022	N/A
	Bituminous Coal	1.2	1.3	25.3	6200	156,860	N/A

Note: *Pelletised Sewage Sludge (PSP) is pre-dried to 6% moisture (w/w basis) prior to feeding so as to maximise its Nett C.V., and at that moisture content should have no odours.*

that otherwise would have been viewed as new and too commercially speculative for normal financing channels. Orchid Bioenergy a member of the same group as Fairport Engineering, harnessed this support to build a MSW processing plant that successfully operated for a number of years. This provided the first batches of SRF to several cement plants for initial trials and subsequent adoption as AF material. One novel and patented feature of the Orchid Bioenergy process was the control of the moisture in the finished product. Moisture levels in the product were in the range typically of 12 -18% (on a w/w basis) raising the Gross Calorific Values to 18 to 15 MJ/kg typically. This was proven to be an excellent and reliable AF with which to feed to cement kilns via new, uprated burners.

A major enabling step in this transition from RDF to SRF was the legislative taxation by the UK government of waste disposal on the basis of 'The Polluter Pays', A Landfill Tax was instigated, which monetised the process of disposal of 'wastes'. This is currently not adopted in India but the Indian government has set up a scheme (Perform Achieve Trade) to incentivise the saving of energy, which is another step forward on the road to driving down the energy requirements of industry globally. Ironically many cement plants in the UK today earn as much by "co-processing" waste compared to their primary function of producing cement !!

Other AF materials used during this period in the UK for both thermal and electrical energy substitution included Pelletised Sewage Pellets (PSP) dried to around 6% moisture (GCV 15.6MJ/kg), Meat and Bone Meal (MBM) GCV of ~16.2MJ/kg, and rubber tyres from road vehicles with a GCV of 35.6MJ/kg, that is greater than coal (GCV 30MJ/kg). These fuels also have lower embedded Nitrogen and most have a lower Sulphur content (with the exception of tyres) than traditional carbon fuels. Consequently use of AF can lower the emissions from cement plants compared to the traditional fuels and also save energy. To demonstrate how the use of AF could compare to traditional fuels, the **Table 2** examines various key parameters.

Waste streams may also include organic material naturally containing moisture, so that subsequent processes for maximum energy production may include, Cellulosic Alcohol Fermentation / Bio-Digestion followed by Anaerobic Digestion of the resultant solid discharge to maximise energy production. These wet processes can be followed by thermal drying of the resultant digestate (using recovered waste heat from the process) then combustion of the dried digestate fraction, for final recovery of the remaining of the chemical energy.

The alcohol produced in fermentation makes an excellent Secondary Liquid Fuel (SLF) for the kiln, while the biogas produced from digestion provides bio-methane for firing in the kiln and/or partial drying of the digestate. Any recovered waste heat from the cement process will supply all the remaining heat for the final drying of the digestate to make an AF typically with 15-18 MJ/kg NCV. In this manner all the chemical energy in the AF can be converted into thermal energy and the resultant ash is also incorporated in the clinker as an Alternative Raw Material (ARM).

As can be seen AF can be solid material such as RDF or SRF, or further improved to make Tertiary Alternative Fuels (TAF), or additionally liquids known in the UK as Secondary Liquid Fuels (SLF) can be used as feedstocks for pyro-processing. These SLF's typically have high calorific values and can make excellent fuels for cement kilns, if handled appropriately via a suitable burner train. TAF's have lower glass, stones (all abrasive materials) and a finer particle size to improve combustion properties and typically use recovered waste heat to dry immediately prior to dosing to the upgraded burner.

The use of AF's can be incorporated into most cement plants relatively easily, dependent upon the existing layout and spatial separation of the process components. Heat can be recovered from clinker cooling and/or other process stages, where there is excess process heat to be gainfully recovered and re-purposed. Simple surveys can identify opportunities for energy saving and recovery which can be analysed and placed in order of payback (according to Corporate Investment Rules) when compared to PAT goals and energy gains attained so far. In this manner the cement manufacturers will gain a financial saving each year, plus further saving under the PAT Scheme. India gains because they can re-purpose the power for other uses including Industry and/or socio-economic purposes.

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Direct rolling technology – a game changer in Indian secondary steel sector

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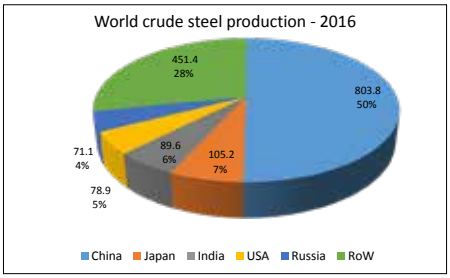
Background

The iron and steel sector is an indispensable one for the development of any nation. The iron and steel industry is the largest in the world after oil and gas with an estimated global turnover of USD 900 billion. The total world crude steel production was 1,600 million tonnes in 2016. Globally, India is the third largest steel producer with an annual crude steel production of 89.6 million tonnes in 2016. China's corresponding annual production was 803.4 million tonnes. Production in the top five steel producing countries worldwide makes up 72 percent of the world's steel production for 2016 as shown in **Figure 1**.

In India, the share of the iron and steel industry in Gross Domestic Product (GDP) is 2%, and it employs 6 lakh people. Though India is the world's third largest steel producer, per capita steel consumption is very low at 59.4 kg per capita when compared with the world average of 216.6 kg per capita in year 2016. South Korea tops the list with 1,119 kg of per capita consumption. The Government of India is targeting an annual steel production of 300 million tonnes by 2030 or even earlier, offering a great challenge and opportunity to the steel sector.

Figure 1: World crude steel production - 2016



Secondary Steel Production Route

Scrap steel or a combination of scrap/ sponge iron is processed in electric induction furnaces and electric arc furnaces, where the raw material passes on to a temperature of 1,650 ^{0}C. The molten metal passes on to a continuous casting machine or ingot mould machine to produce billets/blooms/ingots. These billets/ingots are then reheated in a reheating furnace to 1,150 to 1,200 ^{0}C (steel recrystallization temperature) and then rolled in a rolling mill to required sizes and shapes. In some places, both, electric induction furnaces and steel re-rolling mills are housed in the same facility, known as a composite unit. The cost of energy is about a third (35 to 40%) of the total cost of conversion in the process of steel-making with both, thermal and electrical energy being used. Between 700 and 800 kWh are used in an electric induction furnace to make one tonne of steel, while 80 to 100 kg of coal are consumed in making one tonne of steel in the reheating furnace. In a rolling mill, between 100 and 120 kWh are used to make one tonne of steel. The energy consumed in different parts of a typical composite mill are shown in **Figure 2**.

Direct rolling – a Game Changer

The concept of direct rolling evolved in the process of steel-making, particularly in the production of long steel products. In this process, hot material in the form of billets/ blooms emerging from the continuous casting machine (CCM) is directly passed to the rolling mill though conveyor rolls, eliminating the reheating process and thus thermal energy consumed by it. The concept of direct rolling was practiced in Europe and other Western countries in the early 1950s in hot strip mills. Later, in the seventies, China adopted the practice while in India, Shri Bajrang Power and Ispat Ltd., Raipur, Chhattisgarh, were the first steel re-rolling mills to use direct rolling under the UNDP-MoS-GEF project, 'Removal of barriers to energy efficiency improvement in the steel re-rolling mill sector in India'. Three units successfully implemented direct rolling during the project's first phase. Building upon this success, 25 more units came forward and successfully implemented direct rolling technology in Phase 2 of the project, 'Upscaling energy-efficient production in small-scale steel industry in India'.

In a typical composite steel re-rolling mill, the bulk of energy is consumed at three points: in the electric induction furnace (EIF), reheating furnace (RHF), and, the rolling mill (RM). Scrap metal and sponge iron are heated to over 1600°C in the

Figure 2: Energy share of typical composite mill (in MJ/t)

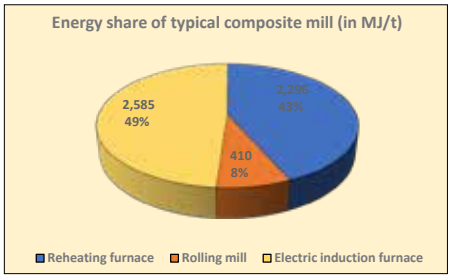
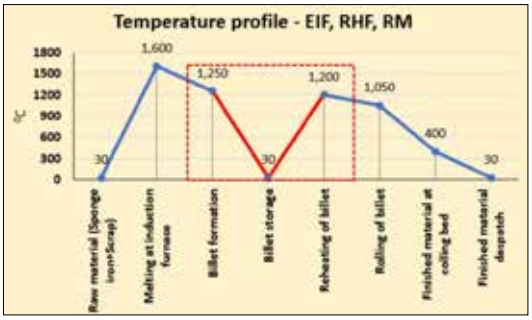


Figure 3: Temperature Profile - EIF, RHF, RM



electric induction furnace to form molten metal which is converted into billets through a continuous caster. These billets from the caster are then made to cool down to ambient temperature. On cooling, the billets pass through the reheating furnace, where the temperature is raised to about 1200°C. Finally, in the rolling mill, hot billets from the reheating furnace are given their final shape. Direct rolling technology disrupts this industry layout by transferring billets directly from the induction furnace to the rolling mill. In doing so, it bypasses the reheating furnace, making it redundant. This process is shown **Figure 3** where the red part of the graph is avoided by introducing Direct Rolling.

Benefits of Direct Rolling

Direct rolling reduces energy costs by upto 60%, leading to significant monetary savings. Energy audits conducted before and after interventions also showed reduction of burning loss to an extent of 1.5–3%, iron reacts with oxygen to form iron-oxide inside the reheating furnace. Direct rolling increases the yield of the unit and avoids the formation of mis-rolls. For a composite mill, the approximate investment in direct rolling is 300,000 to 470,000 USD, depending upon the mill's capacity. However, the payback period for the investment is about one year with substantial reductions in fuel usage, not to mention benefits due to reduced scale losses, and reduced manpower for managing the re-heating furnace (**Table 1**).

Thus a typical direct rolling:

- Reduced energy consumption by 84.3% with steel rerolling mill as boundary (completely eliminates use of reheating furnace and thereby furnace oil use; however, electricity is consumed in rolling section)
- Improved mill yield by 2.5%
- Reduced burning losses by 1.39%
- Reduced GHG emissions by 5327 tCO_2 annually

Results & Way-forward

Under the Ministry of Steel-UNDP partnership project, 28 composite steel units had implemented direct rolling technology leading to annual monetary savings of about INR 120 crore (energy savings: INR 80 crore + material savings: INR 40 crore) and mitigated about 230,000 tCO_2 annually. A recent survey conducted as part of the project showed that 300 composite units have introduced direct rolling without any direct support from the project.

Work done in the study estimates that about 450 more units in the country can introduce this practice, leading to an annual monetary savings of INR 1,442 crore and mitigation of about 3.4 million tCO_2/y.

Table 1: Impact of introducing direct rolling on nine parameters based on measurements in a typical unit.

No.	Parameter	Unit	Before project	After implementation	Impact
1	Furnace capacity	t/p	18	–	Furnace usage is eliminated
2	Productivity	t/p	10.5	13.20	Increase of 25.7%
3	Specific fuel consumption (SFC)	l/t	45.34	–	Furnace usage is eliminated
4	Specific power consumption (SPC)	kWh/t	98.83	90.34	Reduction of 8.6%
5	Specific energy consumption (SEC)	kcal/t	493,686	77,692	Reduction of 84.3%
6	Mill yield	%	96.06	98.49	Improvement of 2.5%
7	Burning loss	%	1.39	0	Burning loss is avoided, eliminating furnace usage
8	Unit GHG emissions	tCO2/t	0.22	0.08	Reduction of 63.3%
9	Annual GHG emissions on equalized capacity	tCO2	8,400	3,073	Reduction of 63.3%

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KNOWLEDGE EXCHANGE PLATFORM UPDATE

The Knowledge Exchange Platform, a joint initiative of Bureau of Energy Efficiency and Institute for Industrial Productivity, is operational since February, 2015 and within this short span, has made substantial progress in achieving its objectives by establishing it as a forum for sustained interaction within Industry and between the Industry and BEE. The overall guiding philosophy behind all the activities carried out under KEP has been to make it an effective and a vibrant platform, which is responsive to the needs of the Industry.

As PAT moves in to the subsequent cycles of implementation, the targets for energy efficiency are expected to become more challenging, with the need to (i) build the capacity of the industry, particularly at the plant level, to handle the operational and technical aspects of implementing new energy efficient technologies and approaches, (ii) enhance the knowledge of the industry on cutting edge innovative technologies, and (iii) provide hand holding support to implementation of energy management practices.

Building on the success of KEP, SPARC (Service Package for Advancing Resource Conservation)- a package of advisory and information services was introduced on April 1, 2017, aimed to address the specific needs as highlighted above and to guide the Indian industry to a more energy efficient and environment friendly growth trajectory.

What is SPARC?

SPARC is a membership driven package of services offered on an annual Membership fee of INR Five Lakhs (plus GST) under the KEP umbrella. The exclusive 'Value Added Services' being offered under this model has been carefully designed and developed keeping in mind the needs and requirements of the industry for implementing better energy management services in general and the PAT scheme in particular, covering the following specific services:

- Free Two Days' Plant level Training and Capacity Building Program for Enhancing Industrial Energy Efficiency
- Free Three Days' Small Group Activity (SGA) Program for achieving Continuous Improvement in Energy Efficiency
- Free enrolment for the preparatory training program of 2 engineers for National Certification Examination for Energy Managers and Auditors
- Free advisory services (query-based) on technical issues related to energy efficiency
- Free subscription of the KEP Newsletter

Based on the mid-term feedback from some of the early members of SPARC, energy saving opportunity of about 300 to 1000 kW per plant has been identified through Small Group Activity, out of which Industry members have already achieved 30% savings in past 3-4 months. Click here to learn more and become a member of SPARC: http://knowledgeplatform.in/sparc/

ACTIVITIES SO FAR

5 Day Preparatory Training Program for the National Certification Examination for Energy Managers and Energy Auditors"

The 5 day preparatory training program was organized at India Habitat Centre, New Delhi from 17 July to 21 July, 2017, which was attended by 24 officials working in various sectors viz. Aluminium, Cement, Iron & Steel, Pulp & Paper and Textile. This program was organized to meet the following objectives:

- To provide an in-depth, comprehensive learning and problem-solving forum to help the candidates prepare for the examination.
- Outline key concepts, approaches and examining the basic fundamentals within all key areas of energy management.
- Broader understanding of the thermal systems within facilities like boilers, steam distribution, fuels and combustion, furnaces, insulation and refractories, cogeneration, waste heat recovery, and evaluating their energy usage.
- Broader understanding of the electrical systems within facilities like motors, pumps, compressor systems, HVAC and refrigeration system, fans, lighting, cooling tower and evaluating their energy usage.

Participants at the 5 Days' Preparatory Training Program

- To enhance the knowledge and confidence it takes to effectively apply state-of-the-art principles of energy cost management.
- Enhancing critical workforce competencies by providing foundational knowledge, updates on advanced technologies and tools.
- Comprehensive practice sessions with question bank to build the confidence of the candidates.

Two Days' Plant Level Training and Capacity Building Program

The Two Days' Plant Level Training and Capacity Building workshops were organized to meet the following objectives:

1. To create awareness in the plant personnel at operational level on various provisions of PAT scheme, international standards and energy management approaches such as ISO 50001, total energy management approaches etc. – the challenges and opportunities
2. Identify and assess plant specific opportunities and potential for achieving energy efficiency under PAT scheme (2nd and subsequent cycles)
3. New, cutting edge and innovative technologies on Thermal & Electrical efficiency suitable for the specific to the plant operations
4. Build the capacity of the plant personnel to handle the operational and technical aspects of implementing new energy efficient technologies and approaches

The two days training and capacity building workshop was organized at Arvind Limited, Santej plant on 8 and 9 August, 2017, which was attended by 24 officials working in electrical, maintenance, instrumentation, utility and process departments.

The two days training and capacity building workshop was organized at Vedanta Limited, Jharsuguda plant on 21 and 22 August, 2017, which was attended by 42 officials working in potline maintenance, potline PRC, case house, bake oven, GAP, utility, rectifier, potroom, mechanical, electrical, OPD, CPP, IPP and O&M departments.

The two days training and capacity building workshop was organized at Raymond Limited, Vapi plant on 18 and 19 September, 2017, which was attended by 41 officials working in mechanical, electrical, instrumentation, utility, boiler, U&M and process departments.

Promoting Small Group Activities as means of insuring Continuous Energy Management at Plant Level

The SGA program was designed to ensure that employees from all levels of production participated and went through a series of guided/ facilitated process that included self-assessment, listing of options, and assessment of options on their relative economics and impact and prioritization of actions most suited to meet the energy efficiency requirement of their specific area of plant operation. These sessions were carefully facilitated so that the employees work as a team in coordinated fashion and there is a healthy competition within and across groups in different operational areas. The basic objectives of carrying out these activities were:

(i) To use the existing knowledge experience and wisdom of plant level operators to identify and analyse energy efficiency opportunities

(ii) To build the capacity of the plant level operators to implement energy efficiency actions.

(iii) To contribute to the improvement of productivity, profitability and development of the organization.

A three day SGA for Arvind Limited, Santej was organized during 10 to 12 August, 2017, which was attended by 17 officials working in electrical, instrumentation, mechanical, product development, engineering and packaging plant. A total number of 4 groups were formed and tentatively 227 kW energy saving target has been planned.

A three day SGA for Vedanta Limited, Jharsuguda was organized during 23 to 25 August, 2017, which was attended by 42 officials working in potline maintenance, potline PRC, case house, bake oven, GAP, utility, rectifier, potroom, mechanical, electrical, OPD, CPP, IPP and O&M departments. A total number of 10 groups were formed and tentatively 5000 kW energy saving target has been planned.

A three day SGA for Raymond Limited, Vapi was organized during 20 to 22 September, 2017, which was attended by 36 officials working in mechanical, electrical, instrumentation, utility, boiler, U&M and process departments. A total number of 10 groups were formed and tentatively electrical energy saving of 34,00,000 kWh/ year and thermal energy saving of 974 tonnes of coal /year target has been planned.

Knowledge Exchange Platform
Transmitting Knowledge through Best Practices

Comments and feedback welcome:
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