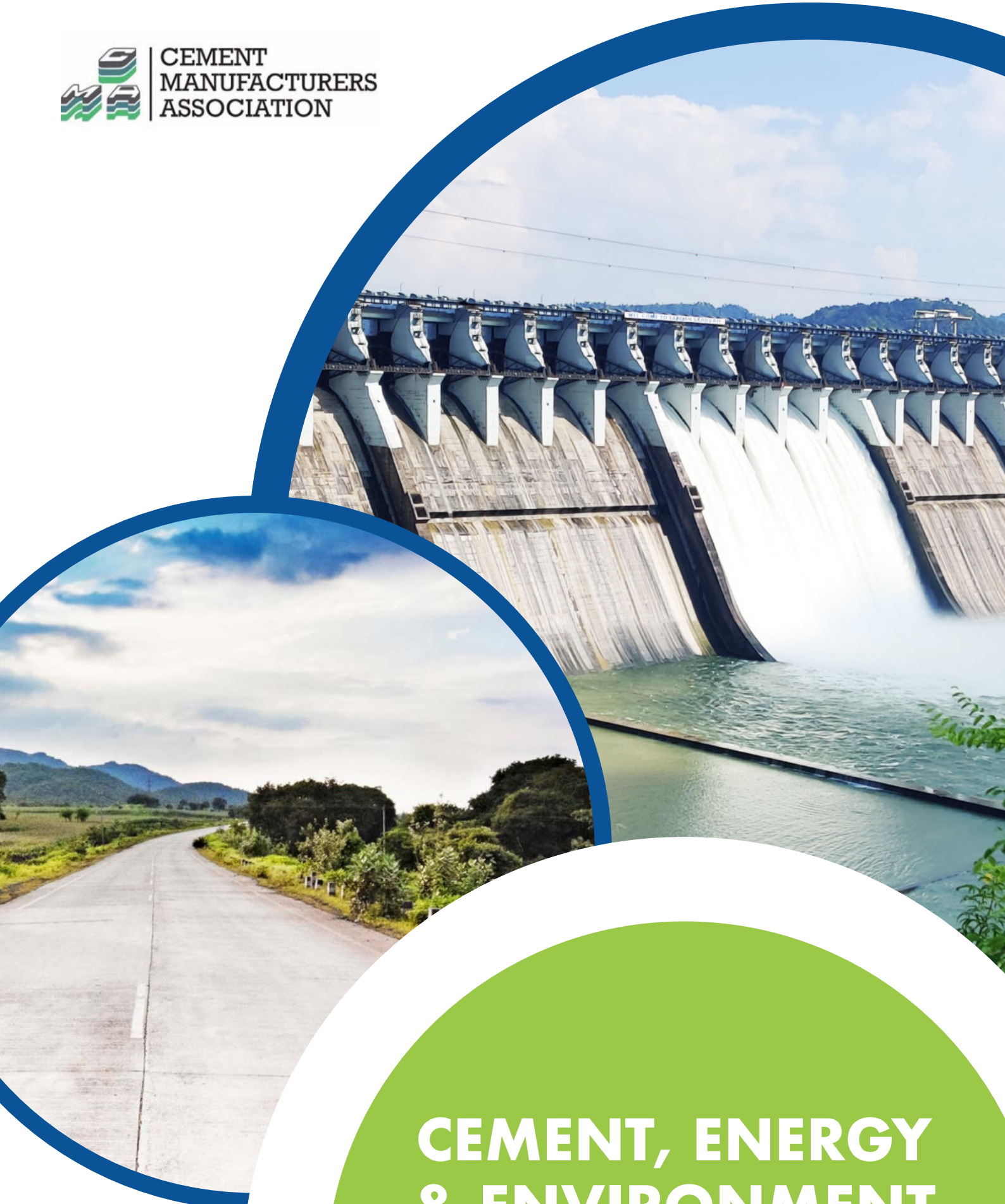
CEMENT MANUFACTURERS ASSOCIATION



CEMENT, ENERGY & ENVIRONMENT

JANUARY - JUNE 2021, VOLUME 20, NO 1

EDITORIAL

At the outset, I would like to extend my good wishes to all our readers and trust you are doing well. We are happy to share with you the January-June 2021 edition of the *CMA Cement, Energy and Environment Journal*. Over the years, we have endeavoured to share with you the developments in the Cement Industry from the technology perspective to energy efficiency to AFR and much more. It has been our effort to keep you updated not only on the developments within the Cement Industry but also its response to the changing landscape and environment around us. I do hope you continue to find value in the *Journal*. I would like to thank the contributors to the *Journal* and invite many more experts to share their experiences in the Cement Industry, which can be fruitful learnings for all of us.

I wish you a good read! Stay safe!

APARNA DUTT SHARMA
SECRETARY GENERAL

Editor: K K Roy Chowdhury

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CARBON DIOXIDE
MAKING A VIRTUE OUT OF NECESSITY

By Martina Scherbel
VDMA Germany

It is an undisputed fact that CO_2 contributes to the greenhouse effect. The substance is generated when fossil fuels such as coal, crude oil and natural gas are combusted, primarily through the production of electricity and heat, in households, traffic and industrial production. With the Paris Agreement, 195 countries have set a clear objective for the first time: By the year 2050, the output of greenhouse gases must be reduced drastically in order for global warming to remain clearly below 2° Celsius by the end of the century.

Cement, water and aggregates are the main components of concrete, the most popular construction material worldwide. It is therefore a great shame that the production of this cheap and versatile construction material is one of the largest sources of CO_2 emissions. For every ton of cement produced, up to one ton of CO_2 is produced. After all, the production of cement alone contributes between 7 and 8 percent of global CO_2 emissions!

Cement with potential

CO_2 is found naturally in limestone, which is the main component of cement. The limestone is heated in large rotary kilns at high temperatures to produce Portland clinker, an intermediate product. During this process, the limestone is broken down and the carbon dioxide escapes into the air.

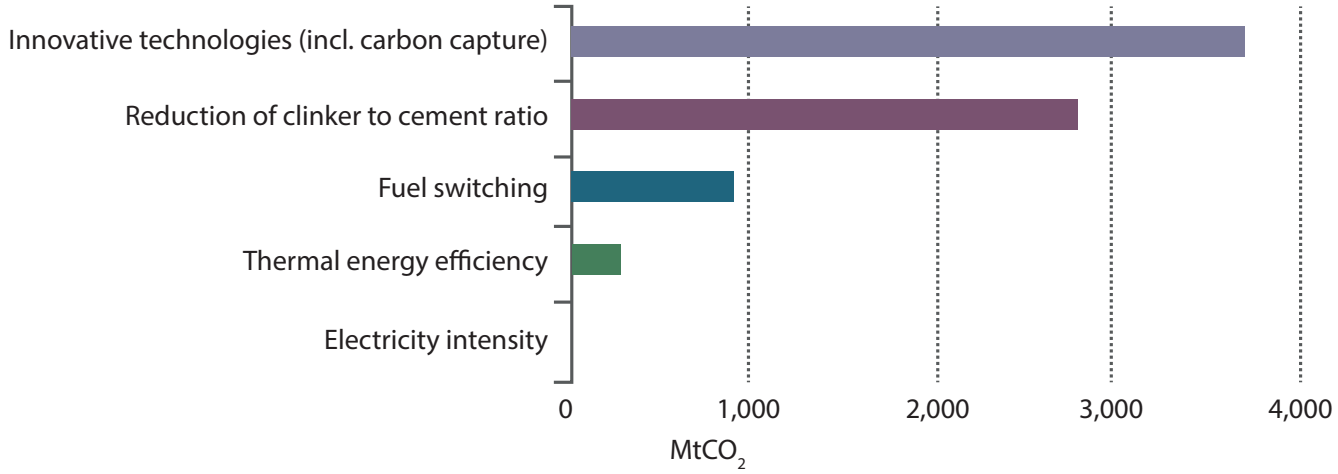
It is therefore possible to substitute the heated cement clinker in the cement or concrete with alternative materials, resulting in a significant decrease of potential greenhouse gases. For example, approximately 30 percent of CO_2 emissions can be reduced in each ton of cement by substituting calcium clays. Currently, there is no complete replacement for the raw material, as the clinker which is derived from the limestone is responsible for the strength of the concrete.

The industry has begun developing solutions which could reduce this output to almost zero through the targeted deployment of concentration and separation procedures. Carbon capture and storage (CCS) and carbon capture and utilization (CCU) are two processes which separate the CO_2 produced during the manufacturing of cement, enabling it to be stored or used for subsequent chemical processes.

CO_2 as a reusable raw material

The "Low-Carbon Transition in the Cement Industry"1 technology roadmap from the OECD / International Energy Agency has calculated that using new technologies such as carbon capture and storage or carbon capture and utilization would result in a substantial reduction of CO_2 emissions.

"Innovative technologies including carbon capture (CO_2 emissions reduction of 48%) and reduction of the clinker to cement ratio (CO_2 emissions reduction of 37%) lead the way in cumulative CO_2 emissions reductions in cement making in the roadmap vision compared to the RTS by 2050."2



Global cumulative CO_2 emissions reductions by applying the roadmap vision (2DS – 2 Degrees Scenario) compared to the RTS2

Note: Cumulative CO_2 emissions reductions refer to the period from 2020 to 2050 and are based on the low-variability case of the scenarios.

A new combustion process

An alternative solution for reducing emissions must be found. To this end, thyssenkrupp has been researching a new oxyfuel combustion process in which the combustion air is replaced by pure oxygen. The emissions would then almost completely consist of pure CO_2 and steam, thus radically simplifying the complicated separation process and enabling the CO_2 to be stored or processed. The first experimental plants for the cement industry in the USA and Europe were introduced from 2010, but the project has not yet moved beyond the experimental phase.

Operators can retrofit their existing plants to the oxyfuel process. For older concepts (from around 2005 onwards), exhaust gas recirculation systems can be retrofitted to existing plants. This requires additional equipment, which in turn significantly increases the complexity and the operating costs. Engineers at the research center of thyssenkrupp Industrial Solutions AG are therefore working on an improved process, and success is within reach. The new polysius® pure oxyfuel procedure uses pure oxygen as a combustion gas and does not require exhaust gas recirculation, thus significantly reducing the effort required to separate CO_2. For all known CCS or CCU procedures, retrofitting represents a notable change in plant operation.

thyssenkrupp Industrial Solutions is also researching processes to convert the separated CO_2 into reusable materials such as methane or methanol. Methane can be fed into the natural gas network, while methanol is a base for synthetic fuels such as kerosene. This process enables CO_2 to be used in a sensible way while also reducing the demand for fossil fuels.

Exhaust gas cleaning through Calcium looping

Alongside oxyfuel combustion and solvent-based separation after combustion, calcium looping is regarded as a further promising new technology for CO_2 separation in cement plants as it enables the utilisation of numerous energy and material synergies. Calcium looping is a regenerative process that uses the capacity of sorbents based on calcium oxide to separate CO_2 at high temperatures.

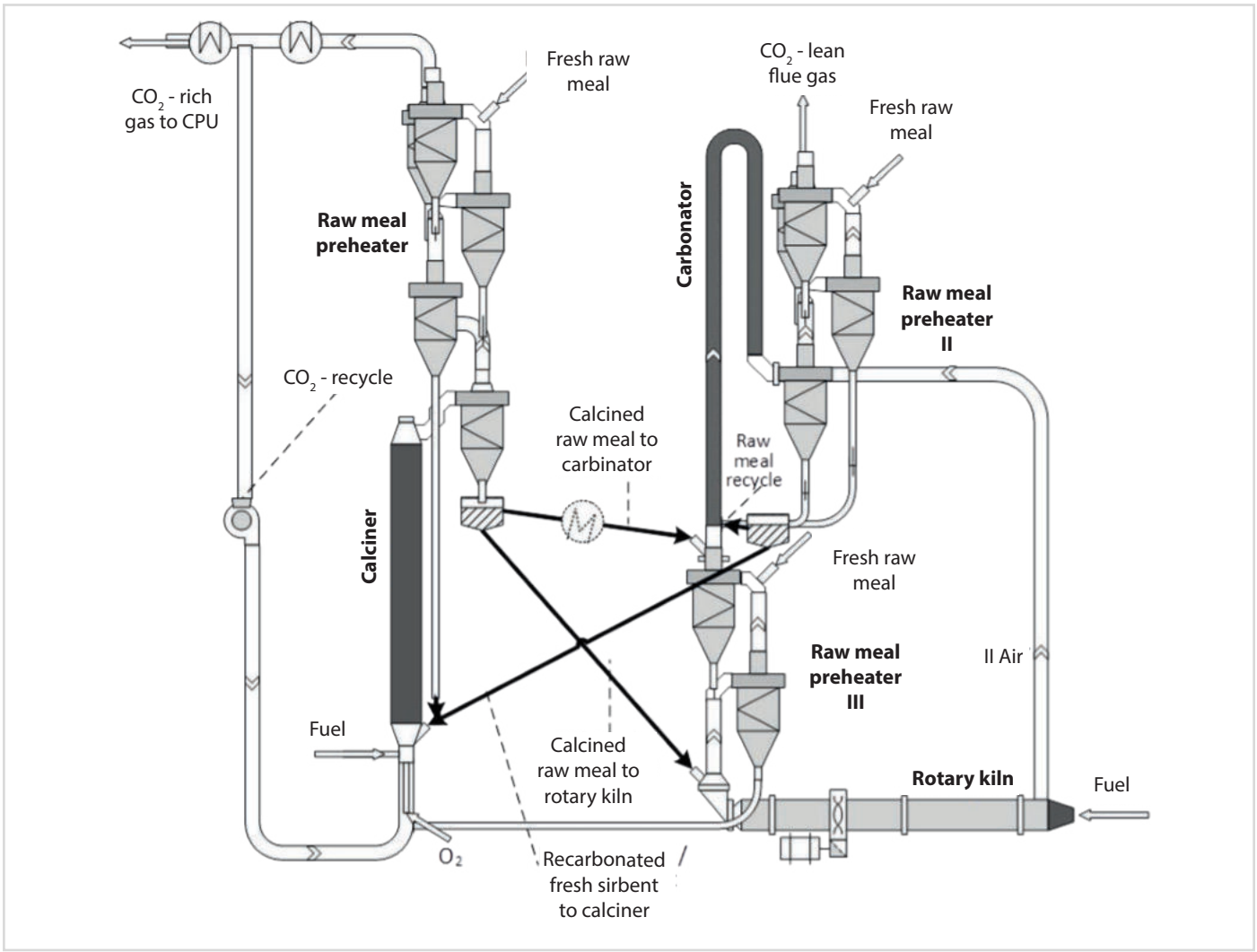
The process is divided in two basic steps:

1. The capture of CO_2 by "carbonation" of CaO to form $CaCO_3$ in a reactor operating around 650°C: $CaO + CO_2 - CaCO_3$ + heat; the heat development is negligible here.

2. Oxyfuel calcination in a reactor operating above 900-920°C, which makes the CaO available again and releases a gas stream of nearly pure CO_2: $CaCO_3$ + heat - $CaO + CO_2$

In the highly integrated Calcium Looping process configuration the carbonator is used to capture the CO_2 contained in the kiln flue gases and the pre calciner of the cement plant is oxy-fuelled and it coincides with the calciner of the CaL process. the CaO-rich pre-calcined raw meal produced in the calciner is broken down into two streams: one goes to the rotary kiln for clinker production, the other to the carbonator, to act as the sorbent of the CO_2 released in the kiln. The solid stream with re-carbonated raw meal is returned to the calciner to be regenerated, together with the raw meal coming from the pre-heating tower. CO_2 from fresh raw meal calcination, from kiln fuel combustion and from calciner fuel combustion is collected in the single flue gas stream exiting the calciner.

In order to demonstrate the technical and economic feasibility of the integrated CaL process in large, retrofitted cement plants under realistic conditions, a test plant is currently being built in Italy within the scope of the EU Horizon 2020 CLEANKER project (www.cleanker.eu). As a technology partner, the IKN GmbH engineering firm from Neustadt is one of 13 international consortium members in this project, which is financed through EUR 8.9 million of EU funds. The objective is to lay the foundation for companies in the EU to use this technology on an industrial basis. https://cordis.europa.eu/project/rcn/211877/factsheet/en



Picture Source: Politechnico di Milano
Implementation of an integrated CaL concept in a cement plant

What is missing, however, is the infrastructure required to transport the carbon dioxide and an approval framework covering how it can be reused or stored.

In the view of VDMA Construction - Equipment and Plant Engineering, it is conducive to promote the standardization of alternative cements, as well as the approach of the BMU of developing a sales market for cements produced using greenhouse gas-neutral procedures. It is, however, necessary to create an approval framework quickly, and therefore also the requisite infrastructure for transporting and reusing the separated CO_2.

Alternative fuels

Alongside the possibilities for separating and reusing CO_2, there are also ways to prevent it from being generated in the first place. Various non-fossil fuels are options here, including biomass such as wood chips, rice husks, sewage sludge or refuse-derived fuel (RDF). In order to ensure that the clinker is of a sufficient quality, cement manufacturers must keep the temperature of the kiln at a constant level. They do this by feeding the fuels at an even rate. Although alternatives are cheaper, they are more difficult to dose as they can vary significantly in terms of their composition, shape and size – even when using the same type. Powders, flakes and fibres have a complicated discharge behaviour and a low bulk density, and are difficult to feed into the combustion process evenly. Some of them are unhygienic or explosive, presenting an additional challenge.

With its rotor weighfeeders, FLSmidth Pfister in Augsburg offers solutions for plant operators that wish to switch their production to alternative fuels with a minimum of effort and expense. The system is closed from the silo to the kiln and is designed in such a way that it is resistant to pressure surges. The patented rotor weighfeeders utilise the functional principle of horizontally positioned, gravimetric rotary valve feeders (DRW, URW, SRW) for pulverised secondary fuels, or rotors designed for fibrous, flaky, pelletised and fragmented secondary fuels (TRW). The simple and closed design enables direct silo discharge, weighing, dosing and direct feeding of the bulk material using a single device.[3]

As a general rule, it is prudent for cement manufacturers to use fuels that are available in their local area. This reduces the CO_2 emissions produced when transporting the material.

Cementos Molins is a cement manufacturer in Sant Vicenç dels Horts near Barcelona. The company operates a kiln around the clock, which is fired using a main burner and a precalciner. Both are fed with petroleum coke and around 40 percent alternative fuels. The company uses various FLSmidth Pfister rotor weighfeeders in order to gravimetrically dose solid fuels continuously. Three different dosing stations were installed between 2011 and 2014. The patented predictive dosing control (ProsCon) feeds the fuels precisely and controls the burning process in a stable manner, resulting in lower CO_2 emissions while at the same time saving costs. Another advantage is that a single system can be used for all fuels. The company is planning to use more alternative fuels in the future.

What to do with the CO_2?

A key technology in this scenario is power-to-X, with which both synthetic gas and liquid fuels can be manufactured. Alternative energy sources can be used as seasonal storage in electricity or transport applications, such as in heavy-duty transport or in shipping and aviation. One significant benefit is that the infrastructure which is in place to transport and fill fossil fuels can continue to be used for the synthetic gases and fuels. As research projects have shown, these synthetic fuels can also be admixed to fossil fuels in almost any ratio, thus contributing to the quick reduction of greenhouse gases.

VDMA views power-to-X as a guarantor of the energy transition. As CO_2 is required to convert hydrogen into alternative energy sources, cement plants could therefore contribute to the reliable and permanent generation of energy.
https://p2x4a.vdma.org/viewer/-/v2article/render/29977950

Becoming active

The work by VDMA and its member companies makes a significant contribution towards achieving the goals set out in the Paris Agreement, while simultaneously safeguarding Germany's standing as an industrial location, its jobs, its leading technological position and its social cohesion and prosperity. This is a task which requires all involved parties to act. Companies which wish to contribute are invited to join VDMA and take on an active role here.

[1] The roadmap is the result of a collaborative effort between the International Energy Agency (IEA) and the World Business Council on Sustainable Development (WBCSD) Cement Sustainability Initiative (CSI).

[2] IEA (2018). Technology Roadmap: Low-Carbon Transition in the Cement industry. All rights reserved. S.22

[3] Dosierte Aufgabe von Sekundärbrennstoffen für den Klinkerbrennprozess, H. W. Häfner, G. A. Kudorfer, Augsburg/Germany; (Volume 53) No. 4/2000 – ZKG INTERNATIONAL, S.206-207

Important links:

bub.vdma.org
https://webstore.iea.org/technology-roadmap-low-carbon-transition-in-the-cement-industry
https://ec.europa.eu/clima/policies/international/negotiations/paris_de
https://p2x4a.vdma.org/viewer/-/v2article/render/29977950
https://cordis.europa.eu/project/rcn/211877/factsheet/de

VDMA represents more than 3,200 mostly medium-sized companies in the mechanical and plant engineering sector. With over 1.3 million employees and sales amounting to approximately 232 billion euros (2018), the sector is the largest industrial employer in Germany and one of the leading German industrial sectors.

NET ZERO MINING EFFECTIVE STEPS TOWARDS CLIMATE CHANGE

By Bhanu Prakash Bhatnagar, Head Mining
Adani Cementation Limited, Ahmedabad

Climate change has manifested as a real and serious threat globally that requires effective and sustainable efforts to be addressed. During the past several years, Global carbon emissions are on a constant rise. In fact, since 1850, global CO_2 levels have risen over 30%, from 284 ppm to ~408 ppm in the year 2018. Key factor for the climate change is due to

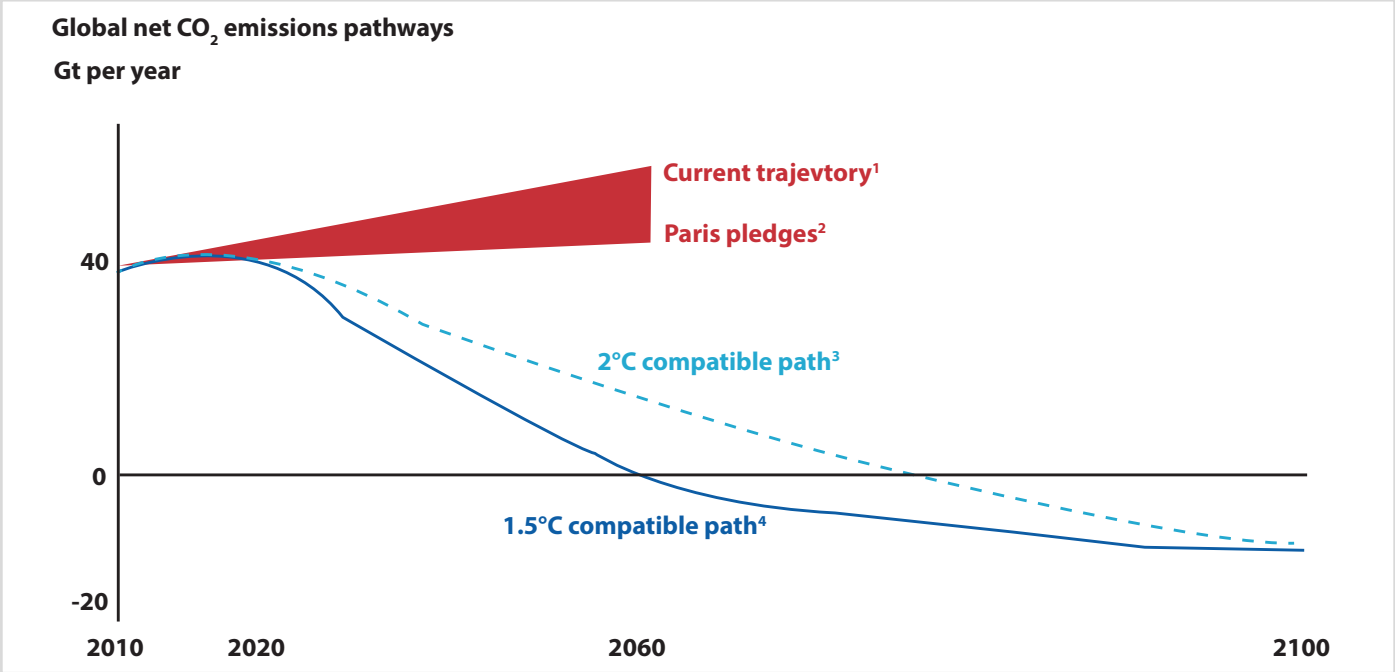
Concentration of CO_2 released into the atmosphere annually has increased due to approximately 35 billion tons, primarily by human activity.

These emission levels on an annual basis are almost stable from 2014 to 2016, but they have increased again since 2017.

Cement with potential

A recent report by CDP (formerly known as the Carbon Disclosure Project) shows that in 2015, half of the global industrial greenhouse gas emissions (GHGs) can be contributed by just 50 companies (called carbon majors) working in heavy fossil fuels. This includes four Mining companies, particularly those involved in coal extraction, which ranked high on the list, taking two of the top five spots, and 20 spots overall.

During the 2015 Paris Agreement, 195 countries across the globe, pledged to limit global warming to well below 2.0°C, and ideally not more than 1.5°C above pre industrial levels. It is evident that if we have to meet the goal of the Paris Agreement, to limit global warming to 2°C, urgent action is required from all sectors, including the mining sector. This target would manifest in decarbonization across mining industries, creating major shifts in commodity demand for the mining industry and likely resulting in declining global mining revenue pools. To sum up, meeting the goal of the Paris Agreement will require, to significantly reduce the amount of CO_2 released by mining industries and, in some cases, the types of resources they extract.



Already, many mining companies across the globe, are making progress toward reducing emissions, but their focus has primarily been on incremental targets instead of planning holistically, with the desired end in mind. Mining companies should target the carbon reduction necessary to keep global warming below 1.5°C of pre-industrial levels. There are many strategies that can facilitate this goal, including leveraging new technologies and innovations to add renewables to electricity supply, improving mining processes, switching from fossil fuels to renewable fuels, reducing waste, and optimizing transportation. The article details few of the actionable efforts, which can be incorporated in practice of mining operations.

Each mining company needs to evaluate alternate options internally and choose the most beneficial and cost-effective approach for their unique circumstances, but every plan must have an appropriate target as well as public disclosure of progress.

NET ZERO Mining - The Basic Concept

The best concept for effectively reducing global warming and to achieve the 'Gross Zero target', is to effectively reduce greenhouse gas (GHG) emissions from all sources including human & Industry sources, uniformly to ZERO. But this is a very idealistic situation, as achieving Gross Zero target is almost impossible to attain, and will need lots of efforts to be put in. In short, it can be said that the complete elimination of emissions from the industry sectors is either too expensive or impossible, so residual emissions will remain.

On the other hand, 'Net Zero Target' is to achieve an overall balance between emissions (GHG) produced and emissions (GHG) taken out of the atmosphere. To explain the concept in a simple way, to consider a bathtub with the water taps turned on,

'Gross Zero target' approach can be achieved with turning down the taps (the complete removal of emissions)

'Net Zero Target' approach is to drain an equal amount down the plug (removals of emissions from the atmosphere, including storage for the emissions such as "carbon sinks") with keeping the tap on.

Net Zero means consuming resources and replenishing them, such as using energy as much as is produced, achieving a sustainable balance between water availability and demand, and eliminating solid waste sent to landfills in mining practices.

Achieving Net Zero Energy means producing, from renewable resources, as much energy on site as is used over the course of a year.

Achieving Net Zero Water means limiting the consumption of water resources and returning it back to the same watershed so as not to deplete the resources of that region, in quantity or quality over the course of the year

Achieving Net Zero Waste means reducing, reusing, and recovering waste streams to convert them to valuable resources with zero solid waste sent to landfills over the course of the year.

The Net-Zero emissions target is more realistic because it allows for some residual emissions to remain in system. These are emissions produced by "hard-to-treat" sectors where emission abatement is comparatively costly and making whole mining production un-economical. These residual emissions are allowed as long as they are offset by gross negative emissions, achieved by removing emissions using natural or engineered sinks. A situation of net-zero emissions then occurs when the gross negative emissions match the gross positive emissions. Using "negative emissions" technologies will help in removal of greenhouse gases and will help in achieving net-zero targets. With the efforts of achieving 'Net Zero Targets' This is certainly plausible that some industries will be net-negative rather than just net-zero.

For achieving the 'Net Zero Target', there are requirements for 'offsetting' that every effort needs to be made to reduce emissions in the mining process. This offsetting will play an important role i.e. effective land use and power that have the potential to deploy greenhouse gas removal technologies, that will need to offset residual emissions from the hard-to-treat sectors in order to achieve net-zero across the world.

Concept of Greenhouse Gases Emissions Types

Three "scopes" (scope 1, scope 2, and scope 3) are defined for GHG accounting and reporting purposes, for delineating direct and indirect emission sources, improving transparency, and providing utility for different types of organizations and different types of climate policies and business goals. Out of three, Scopes 1 and 2 are carefully defined to ensure that two or more companies will not account for emissions in the same scope. This makes the scopes amenable for use in GHG programs where double counting matters. Companies shall separately account for and report on scopes 1 and 2 at a minimum.

Scope 1: Direct GHG Emissions

Direct GHG emissions occur from sources that are owned or controlled by the company, for example,

- emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc.
- emissions from chemical production in owned or controlled process equipment.

Direct CO_2 emissions from the combustion of biomass shall not be included in scope 1 but reported separately. Emissions not covered by the Kyoto Protocol, e.g. CFCs, NOx, etc. shall not be included in scope 1 but may be reported separately.

Scope 2: Electricity Indirect GHG Emissions:

Scope 2 accounts for GHG emissions from the generation of purchased electricity consumed by a company.

- Purchased electricity is defined as electricity that is purchased or otherwise brought into the organizational boundary of the company.

Scope 2 emissions physically occur at the facility where electricity is generated.

Scope 3: Other Indirect GHG Emissions:

It is an optional reporting category that allows for the treatment of all other indirect emissions

- Some examples of scope 3 activities are extraction and production of purchased materials; transportation of purchased fuels; and use of products and services, etc.

Scope 3 emissions are a consequence of the activities of the company, but occur from sources not owned or controlled by the company.

NET ZERO Mining approach: Understanding contribution of mining

Mining, being the starting point, in the supply chain for much of the global economy, decarbonizing in this sector will be critical in meeting global emissions targets. In the mining process, the energy transition increases demand for a number of clean energy raw materials. The mining sector has a great role to play in hitting the target of substantial decarburization across the global economy.

As per the studies carried out by McKinsey & Co, it is evaluated that ''mining'' is responsible for 4% to 7% of global greenhouse gas emissions in terms of the sector's Scope 1 and Scope 2 emissions. If we include Scope 3 emissions, then it links the sector to around 28% of global emissions.

Furthermore, we cannot ignore that the mining companies are vulnerable to both societal pressure and policy changes. Simultaneously, these companies have to produce minerals economically, there is possibility of exploiting easy to reach minerals, as compared to remote and inaccessible mineral and ore bodies.

Emissions Gap Report 2019 (EGR-2019) of the United Nations Environment Program(UNEP) mentions that G20 countries are accountable for 78% of the total greenhouse gas (GHG) emissions as of November 2019. It is established that the G20 nations have a greater role in determining the extent to which the 2030 emission gaps can be closed.

The EGR-2019 report further mentions that the needs phase out of coal-fired power plants alone has annual GHG reduction potential of 4 Gigatonnes of CO_2 by 2050, just this would be about 13.1% of 2010 total emission levels. Thus, the Coal mining, associated with coal based power generation and transmission industries are part of this category which are ramping up global temperatures by release of GHGs.

International efforts towards Net-Zero mining as demand rises for clean energy raw materials

Mining companies across the globe are working to slash greenhouse gas emissions, but many of the largest mining giants, are yet to align their goals with international targets to reach net-zero emissions by 2050. Several big mining companies have installed their own sustainability committees, signaling that mining is joining the wave of corporate sustainability reporting and activity, which includes, reporting emissions and understanding decarburization pathways are the first steps.

S&P Global Market Intelligence reached out to 30 mining companies ranking among the world's largest by market capitalization, while just eight have committed to reaching net-zero emissions by 2050 or sooner, or already tout carbon neutrality. Many of the remaining companies have set less ambitious targets, are updating goals, or have different climate-related aims.'

Institution name		Market cap	Climate goal
Existing net-zero target			
BHP Group *Diversified metals and mining*	116.1		BHP has committed to reaching net-zero emissions by 2050.
Rio Tinto *Diversified metals and mining*	95.2		Rio Tinto has committed to reaching net-zero emissions by 2050.
Vale S.A. *Steel*	52.4		Vale has committed to reaching net-zero Scope 1 and Scope 2 emissions by 2050 and announced ambitions to reduce Scope 3 emissions.
Fortescue Metals Group Ltd. *Steel*	29.4		Fortescue has committed to reaching net-zero emissions by 2040.

Anglo American Pic *Diversified metals and mining*	28.6		Anglo American has committed to reaching net-zero emissions by 2040.
Wheaton Precious Metals Corp. *Diversified metals and mining*	19.7		Wheaton Precious Metals, a royalty and streaming company, touts its operations are already carbon neutral.
Sumitomo Metal Minings Co. Ltd. *Diversified metals and mining*	7.7		Sumitomo has said it is formulating a plan to reduce emissions in the second half of the century.
South32 Ltd. *Diversified metals and mining*	6.8		South32 has committed to reaching net-zero emissions by 2050.
AngloGold Ashanti Lyd. *Gold*	12.1		AngloGold Ashanti has reported it is working to update goals around climate change, including setting emissions targets.
Antofagasta Pic *Copper*	11.4		Antofagasta has identified climate change as a risk and has reported it is working to set emissions reductions targets in 2020.
Saudi Arabian Mining Co. (Ma'aden) *Diversified metals and mining*	11.4		As of 2019, Ma'aden has reported it is working on finalizing a greenhouse gas emissions reductions strategy.
Kirkland Lake Gold Ltd. *Gold*	11.4		Kirkland Lake has said it is "actively working" to reduce its environmental and carbon footprint and currently tracks emeissions at all operations.
Hindustan Zinc Ltd. *Diversified metals and mining*	9.8		Hindustan Zinc has reported it is committed to reduce absolute Scope 1 and 2 greenhouse gas emissions by 14% and absolute Scope 3 GHG emissions by 20% by 2026 from a 2016 base-year.
PAO Severstal *Steel*	9.4		Severstal has reported it is working on setting carbon reduction targets.
Polymetal International Plc *Gold*	9.4		Polymetal aims to cut greenhouse emissions intensity by 5% by 2023 compared to 2018.
Royal Gold Inc. *Gold*	8.2		Royal Gold primarily acquires passive interests in mineral productions and generally does not have direct influence over operatrions, but does support efforts to promote sustainable gold mining and acknowledges international concerns related to climate change.
Fresnillo Plc *Precious metals and gemstones*	7.7		Fresnillo reported its greenhouse gas emissions incresed 4.9% in 2019 as electricity demand for its operation rose, but the company is targeting 75% of its electricity to come from renewables.
PJSC ALROSA *Precious metals and gemstones*	6.5		Alrosa has stated its emissions intensity is well below the industrty level and has plans to further reduce its CO_2 emissions as renewables are expected to account for a significant pasrt of its energy consumption by 2024.

Data compiled July 20, 2020
Company list is based on the lasrgets miners as of March 31, 2020. The list is obtained from mining-focused companies included in the most recent Industry Monitor.
Shenzhen, Hong Kong, or Shanghai Stock Exchanges were excluded from the list of top mining companies.
Climate goal details include select goals and may not be comprehensive.

Source: S&P Global Platt – Coal / Metal - 27 Jul 2020 / 21:12 UTC - New York

From the above list of major mining companies, we find that out of 30 listed above, only 8 have set target for Net Zero Mining, whereas the rest have only a partial commitment towards Net Zero approach. Indian Mining company i.e. Hindustan Zinc has set Climate Change Goals as reduction of absolute Scope1 and 2 GHG emissions by 14% and absolute Scope3 by 20% by 2026 against 2016 as base year.

At global level, ICMM (International Council for Mining and Metals) which was Formed in 2001 bring various different mining companies together and now is dedicated to work towards safe, fair and sustainable mining practices for Mines & Metals Industry. At present, 27 mining and metals companies are members (like BHP, Rio Tinto, ARM, Alcoa, AngloAmerican, Barrick etc.) and over 35 national, regional and commodity association members. ICMM provides a large section of the mining industry in both geography and resources extracted, these companies represent almost half of the global mining industry by value, and are committed to reducing carbon emissions. Members have set goals to strengthen environmental and social performance and serve as a catalyst for change, thus enhancing mining's contribution to society. This maximises opportunities for collaboration among mining and metals industry leaders.

Member companies have started strategically and operationally to address the Net Zero Targets. Major thrust areas are

- Reducing water usage
- Swapping diesel trucks for electric vehicles
- Mining with limited environmental impact
- Lowering exposure to fossil fuels
- Localizing supply chains
- Increasing technological innovation
- Recycling more materials

It is evident that setting and meeting environmental, social and governance targets will become the "new normal" for mining companies. The mining industry has only just begun to set emission-reduction goals. Current targets published by mining companies range from 0 to 30 percent by 2030, far below the Paris Agreement goals. Many of the largest mining companies will need to rebalance their portfolios as the world shifts to an economy with reduced emissions. Worldwide efforts of mining have been recognized, as

- Mr Tania Constable, CEO of Minerals Council of Australia emphasized that A net-zero emissions future is only possible with the minerals and other raw materials provided by mining. He asked for emissions-reducing projects by mining companies, such as Rio Tinto's 34-MW solar farm in the Pilbara region and Glencore's carbon capture and storage demonstration project in the Surat Basin.
- The National Mining Association, USA calls for policies that would support both coal demand and lower emissions through greater deployment of carbon capture, utilization and storage technology. Efforts of mining shall include setting emission reduction targets in line with climate science; tracking progress rigorously, consistently, and publicly; evaluating long-term climate risks and opportunities; and actively seeking out or developing technologies and strategies to reduce carbon emissions.
- Adair Turner, chair of the Energy Transitions Commission, supports an absolutist view: "We should have a target in 2050 which is zero in the U.K., and not zero because we are buying offsets from the rest of the world. Real zero." Of the limited number of countries that already have adopted a net-zero target, this approach would only mirror Costa Rica's.
- The Minerals Research Institute of Western Australia (MRIWA) aims to reduce the carbon footprint, lower overall energy costs and improve energy efficiency of the Western Australian mining sector through harnessing collective efforts, enabling decarburization to become an opportunity for the sector, not a cost. Western Australia supplies the minerals used for wind and solar energy generation; electric vehicles; and battery storage which will enable the international community to achieve the Paris 2015 goals of net-zero emissions by 2050. At the same time the Western Australian mining sector will make efforts toward eliminating their own operational greenhouse gas emissions by 2050.
- Recently in a published report on 11th January, 2021, the International Energy Agency (IEA) announced that, at the request of the UK COP Presidency, it would be producing a comprehensive roadmap for the energy sector to reach net zero by 2050. In his speech to the Climate Ambition Summit in December'2020, Mr Alok Sharma (President COP26) included enhanced international collaboration as one of his main goals for COP26. By setting out a clear pathway, the IEA roadmap will support this agenda. The next step is to ensure we have the right structures to turn this into action. As the IEA Executive Director Dr. Fatih Birol said: "That means better, less fragmented mechanisms to coordinate support for emerging and developing economies – to ensure they have rapid access to the know-how, the financing and the technologie, and it means stronger international cooperation that can drive unprecedented innovation and deployment of new technologies.''

Net Zero Mining – Indian Scenario

On a broader perspective, India produces 95 minerals, i.e., 4 fuel-related minerals, 10 metallic minerals, 23 non-metallic minerals, 3 atomic minerals and 55 minor minerals (including building and other minerals). India holds a fair advantage in production and conversion costs in steel and alumina. Its strategic location enables export opportunities.

Rise in infrastructure development and automotive production are driving growth. Power and cement industries are also aiding growth for the sector. Demand for iron and steel is set to continue given the strong growth expectations for the residential and commercial building industry.

On the mineral production front, India is the third largest producer of coal i.e. around 729.10 million tons (MT) coal produced in FY20. Similarly, India

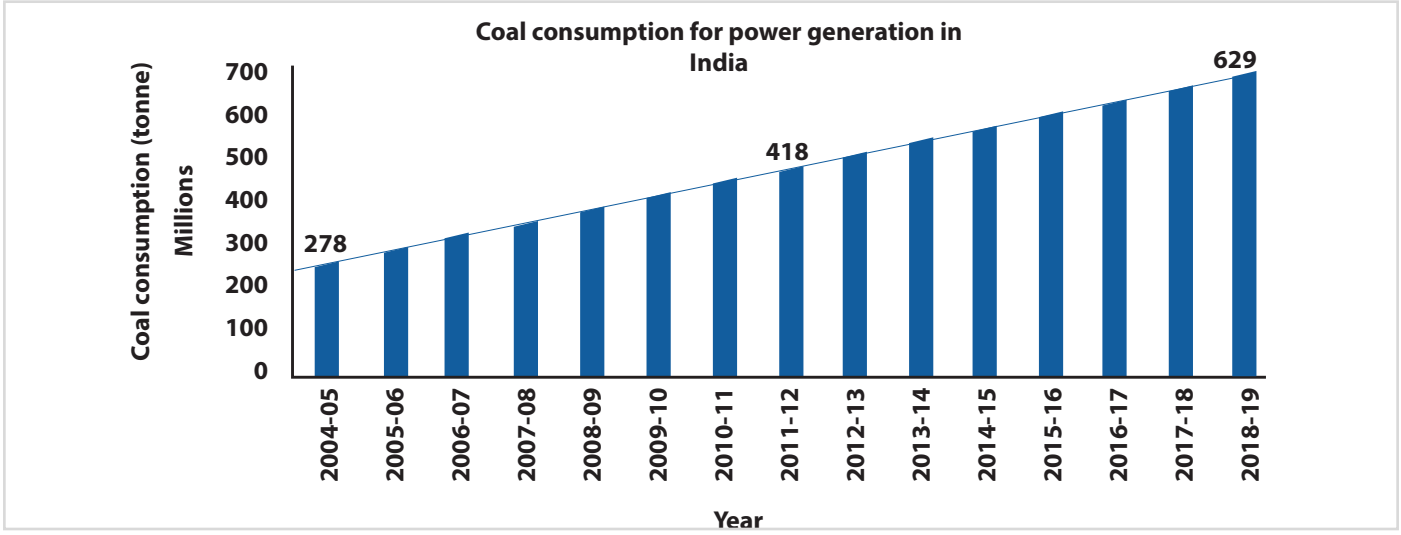
ranks fourth in terms of iron ore production globally. Production of iron ore in FY20 stood at 205.70 MT. India has around eight per cent of the world's iron ore deposits. India became the world's second largest crude steel producer in 2019 with production at 111.2 MT. Production of aluminum stood at 3.65 MT in FY20.

The COVID-19 pandemic has brought significant social and economic challenges on top of a series of climate disasters such as Cyclone Amphan. The economic standstill due to the pandemic is leading to sharp reductions in emissions in the short term, but they will start increasing again at the same rate unless India develops a focused green COVID-19 recovery strategy. With a large stimulus package of 10% of GDP announced, and the experience of clean air during lockdown, the crisis presents an opportunity for India to accelerate a transition away from coal to renewable energy as well as accelerate an uptake of electric mobility. There are no clear signs that India is seizing this opportunity. While no new coal power stations have been built in 2020, the government is encouraging more coal mining and increased coal production which is not consistent with a green recovery. India needs to develop a just transition strategy to phase out coal for power generation before 2040. The CAT rates India's NDC target as "2°C compatible" indicating that India's climate commitment in 2030 is considered to be a fair share of global effort based on its responsibility and capability. Following is India's commitment towards various efforts on international forums for effective control on emissions.

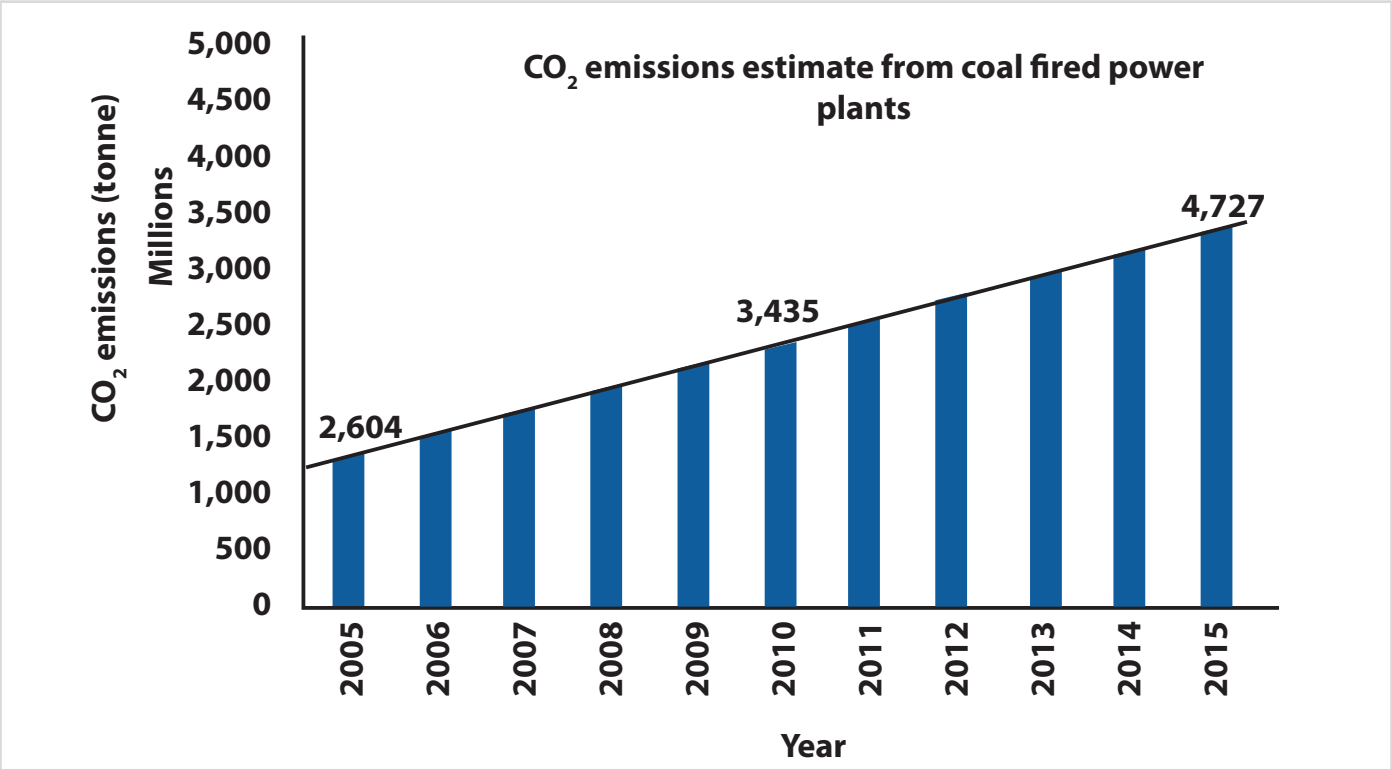
INDIA	Summary of pledges and targets	
PARIS AGREEMENT	Ratified	Yes
	2030 unconditional target (s)	33% to 35% below 2005 emissions intensity of GDP by 2030 [413-445% above 1990 by 2030 excel. LULUCF] [146-161% above 2010 by 2030 excel. LULUCF]
	2030 conditional target (s)	Non-fossil share of cumulative power generation capacity 40% by 2030 [371-373% above 1990 by 2030 excel. LULUCF] [126-127% above 2010 by 2030 excel. LULUCF]
	Condition (s)	Transfer of technology and low cost international finance incl. from GCF
		Not specified
	LULUCF	Additional (cumulative) carbon sink of 2.5-3 GtCO2e by 2030
COPENHAGEN ACCORD	2020 target (s)	20-25% below 2005 emissions intensity of GDP by 2020 [216-245% above 1990 by 2020 excel. LULUCF] [52-66% above 2010 by 2020 excel. LULUCF]
	Coverage	Excluding agriculture sector
	Condition (s)	None
LONG-TERM GOAL (S)	Long-term goal (s)	Per capita emissions never to exceed those of the developed world

As per the CAG report on January'20, the Intergovernmental Panel on Climate Change (IPCC) special report concluded that limiting the temperature increase to 1.5°C would require a reduction of carbon dioxide (CO2) emission by about 45% from emissions of 2010 levels. Further -

- It is recommended to reach this target of 45% reduction by 2030.
- Followed by achieving net zero target around 2050.
- India is the fourth largest emitter of GreenHouse Gases and a member of the G20 group.
- India's coal consumption for coal-fired power plants has more than doubled in the last 15 years (figure 1).



- CO_2 emissions estimate from coal based electricity production has risen by 1.8 times in the ten-year period between 2005 to 2015 (figure 2).



- Out of 198 gigawatt (GW) of installed capacity of coal-fired power plants in India (as on 31 October 2019), 62.5% is owned and operated by the state. Thus Coal Mining has a major impact on climate change.
- Emission Gap Report-2019 shows that for India, the most important step towards a zero carbon future is the phase out of coal based power plants that further expands to other industries that are carbon intensive.
- As an alternative, increase of renewable energy will see a boost with regulatory and policy support from the central and state governments.

The mining industry generates between 1.9 and 5.1 gigatons of CO_2 equivalent (CO_2e) of GHG emissions annually. The majority of emissions in this sector originate from fugitive coal-bed methane that is released during coal mining (1.5 to 4.6 gigatons), mainly at underground operations. Power consumption in the mining industry contributes 0.4 gigaton of CO_2e. Further down the value chain, what could be considered Scope 3 emissions, the metal industry contributes roughly 4.2 gigatons, mainly through steel and aluminum production. Coal combustion for the power sector contributes up to roughly ten gigatons of CO_2.

With the release of India's National Action Plan on Climate Change (NAPCC), on the Low Carbon report over the last few years, the pilot initiative on trading of pollutants from power plants and the mandatory scheme on energy efficiency trading, the discourse regarding the role and involvement of Indian industry in achieving the country's energy and carbon intensity goals has matured considerably. At the same time, a small number of Indian mining companies are becoming more open to their stakeholders, investors and consumers about their environmental footprint, including carbon footprint, as they realize the business benefits of doing so.

The India GHG Program led by WRI India, Confederation of India Industry (CII) and The Energy and Resources Institute (TERI) is an industry-led voluntary framework to measure and manage greenhouse gas emissions. The programme builds comprehensive measurement and management strategies to reduce emissions and drive more profitable, competitive and sustainable businesses and organizations in India. The programme is supported by the Shakti Sustainable Energy Foundation, the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and Pirojsha Godrej Foundation.

The India GHG Program, aims to establish a robust & effective institutional set-up providing access to

- **Internationally recognized and locally relevant GHG measurement and accounting tools**

The program will provide companies with tools and technical assistance to build inventories, based on the GHG Protocol, to reduce emissions and drive more efficient, resilient, & prosperous businesses and organizations.

- **Customized training and capacity building initiatives**

The program will create a pool of certified GHG practitioners, by developing and delivering training and course modules to help businesses make informed decisions and adopt a globally consistent approach to GHG reporting and accounting.

- **Relevant industry specific best practices, benchmarking data and analytics**

The program will convene industry, sectoral and regional peers to foster collaboration, dialog and competition on a single platform.

- **Expertise on appropriate goal setting and voluntary targets**

The program will establish both annual and long-term reduction goals, identify reduction opportunities, and track their progress for efficient and effective emissions management.

- **Business solutions to facilitate GHG emission reductions Programs such as Green Power Market**

Development Group, Offset Platforms and Market Mechanisms offer businesses this opportunity.

The New Mineral Policy, 2019 has also been focused on the main theme of mining being environmentally sustainable, which answers for the mining activities ever become environmentally sustainable for both environment and our health, with Net Zero targets.

It is very much possible to make mining more environmentally sustainable, there are few practices being followed across international mines, which can be implemented at Indian Mines to minimize GHG emissions. All we have to do is to develop and integrate these practices that reduce environmental effects resulting from mining operations. Sustainable mining practices are fundamentally mining practices that meet the present demand without compromising the future generation's needs. In the process, the advent of new mining methods, tools, regulation and legislation, significant efforts are essential to make mining more environmentally friendly.

Cement giant Dalmia Cement committed to a SBT in August 2018 and committed to become a carbon negative cement group by 2040.

Effective steps by mining companies towards Net Zero approach

Mining companies have been making efforts for reduction of emissions by lowering exposure to fossil fuels, localizing supply chains, increasing technological innovation and recycling more materials. However, once a mineral leaves the mine, companies no longer have control of future emissions. Electric vehicles and battery storage are likely to create growth markets for lithium, nickel and cobalt. At the same time, emerging technologies in hydrogen fuel cells and carbon capture may boost demand for platinum, palladium and other catalyst materials.

Major objectives of mining practices for Net-Zero Mining targets – There are several interrelated objectives whose success will involve the issues most frequently linked to another. They can be summarized as follows

- Healthy Life: Eradicate poverty and hunger
- Universalize access to basic services: Includes water, sanitation and sustainable energy
- Support the generation of development opportunities: Inclusive education and decent work
- Foster innovation and resilient infrastructure: Converting surrounding communities and cities able to produce and consume sustainably
- Reduce inequality in the world: especially that concerning gender
- Care for the environment: combating climate change and protecting the oceans and land ecosystems
- Promote collaboration: between different social bodies to create an environment of peace and sustainable development.

Major Concerns for Mining Industries are facing today, which are linked to climate change -

- Water Scarcity
- Mineral Resource Scarcity
- Energy and Fuel resources
- Wealth disparity
- Ecosystem decline
- Urbanisation
- Deforestation

Inspite of above concerns, mining industry has to meet the production demands. Meeting demand is a critical issue due to risk pressures including dwindling global reserves, increasing project complexity and government intervention. Significant growth of low-carbon technologies will occur if mining industries commit to cutting emissions in line with the Paris Agreement targets. Technologies that support decarburization include wind turbines, solar photovoltaics, electric vehicles, energy storage, metal recycling, hydrogen fuel cells, and carbon capture and storage. The mining industry will be part of the decarburization campaign by providing the raw materials needed for these technologies.

Accordingly, mining companies need to lay out the operational, investment, and portfolio options that mining executives can use to create an actionable climate strategy and set ambitious targets. Simultaneously, their growth will alter demand patterns for upstream mining commodities. Coal, consisting of about 50 percent of the current global mining market, would be the most obvious victim of such shifts. Decarbonization of the power sector would mean taking net GHG emissions to zero, implying an almost complete reduction in the combustion of coal. And if metal companies switch to hydrogen and biofuels as energy sources, demand for metallurgical coal will weaken. While coal demand is still rising, capital investments in coal mines have become more difficult, with public opinion hardening and some banks pulling away from the industry in certain regions.

Some decarbonization actions will benefit the bottom line, while others will prioritize social responsibility. Future regulatory and technological developments may change the viability of certain actions, one thing is certain: the business case will vary for each mine—and each company. To date, mining companies have viewed sustainability mostly through a local lens, but achieving a 1.5°C to 2.0°C pathway will require significant global action. Several big mining companies have installed their own sustainability committees, signaling that mining is joining the wave of corporate sustainability reporting and activity. Reporting emissions and understanding decarbonization pathways are the first steps toward setting targets and taking action.

There are two basic concept of Mining Sector to achieve Net Zero

1) Digitalisation during mine planning and operation

Application of the latest digital technology like 5G Technology brings incredible changes in the mining industry. For example, in one of the mines of the leading cement industry in China, all machineries operate by remote control and have no operators in mining equipment operating in fields like for Dumpers and Excavators. Another example is the use of robots for dust control in a mine at Orissa.

Robotic intervention to control dust in mines

PNN & AGENCIES

Sambalpur/Bhubaneswar, Oct 15: In a first, Mahanadi Coalfields Limited (MCL) has introduced robotic intervention in mining operations to control the dust pollution and combat fire.

MCL has successfully tested the remotely-controlled mechanised swivel nozzle, popularly known as 'Robotic Nozzle', with variable cone mist and straight throw capacity to deal with fire and dust suppression in effective way.

MCL sources said that the introduction of 'Robotic Nozzle' will be of great help to fire-fighting operations in coal mines besides effective dust suppression using conical mist function.

Being a remotely-controlled system to operate from a safe distance, the 'Robotic Nozzle' throws mist with variable cone envelope with a solid angle from 0 to 120 degrees with additionally covering 360 degrees horizontal pan and 180 degrees vertical pitch. The system has been retrofitted in 28 KL water tanker at Lakhanpur OCP designed and integrated by YK Singha, Manager (E&M/Innovation Cell).

Two more such systems will be retrofitted in 28 KL tankers at Basundhara OCP in Sundargarh district and Lingaraj OCP, Talcher in Angul district.

In the past one year, the company has introduced hired mobile fog canons, and hired mechanical sweepers for better and effective dust control.

The company has also used drones for mine monitoring, planning and critical decision making, introduced horticulture and agriculture in mining areas and Introduced Aahar Mandal for nutrition sustenance of tribal families.

The fog canons of MCL have also been extensively used for sanitization operation to assist district administration in fight against Covid-19.

MAKING THE MOST OF TECHNOLOGY

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Mining Digital Wheel

Digital levers that strengthen a digital agenda in a mining origination:

2) Sustainability concept during mine planning and operation

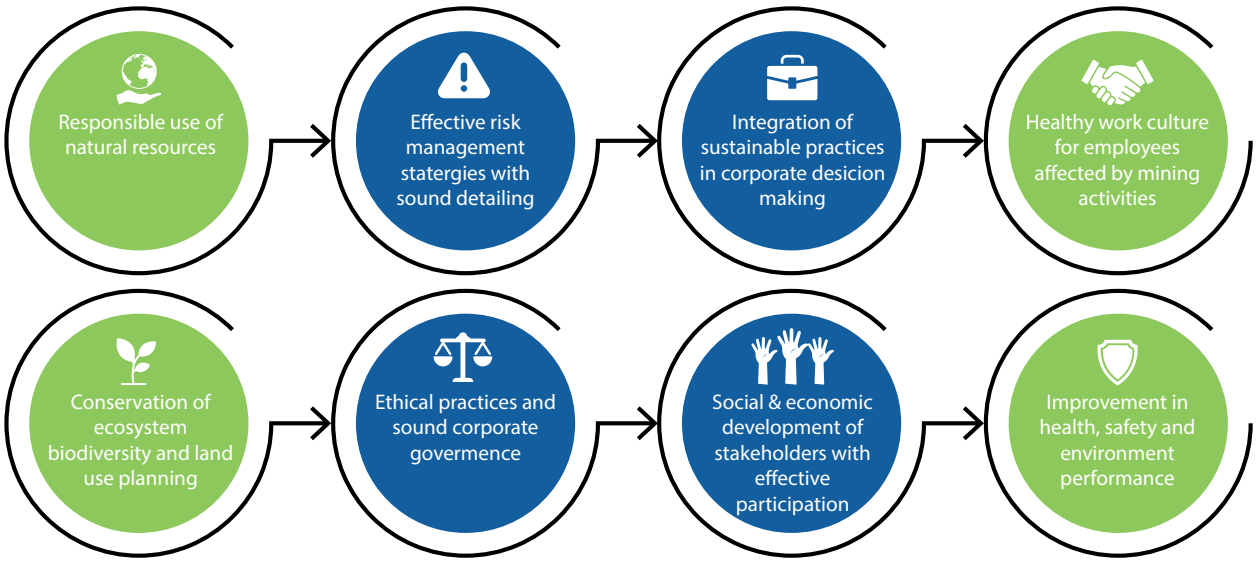
There are several effects of sustainable mining practices in future, which are interrelated and success will involve the issues most frequently linked to another. They can be summarised as follows

Following are few actionable suggestions by Indian Mining companies to effectively reduce GHG emissions during the mining process. While there's no single silver bullet, there are many actions companies can take depending on their unique circumstances. These include followings

- Introducing new technologies and innovations
- Improving mining processes
- Switching fuel to renewable sources
- Optimizing transportation
- Reducing waste, and recycling

At global level, the heads of 193 UN member states prepared a set of 17 Sustainable Development Goals (SDGs), which is for global development framework available for the society and generations. 17 SDGs are guiding principals for Mining Industries, out of which focus areas depicting effects of sustainable mining practices will be

Effects of sustainable Mining practices

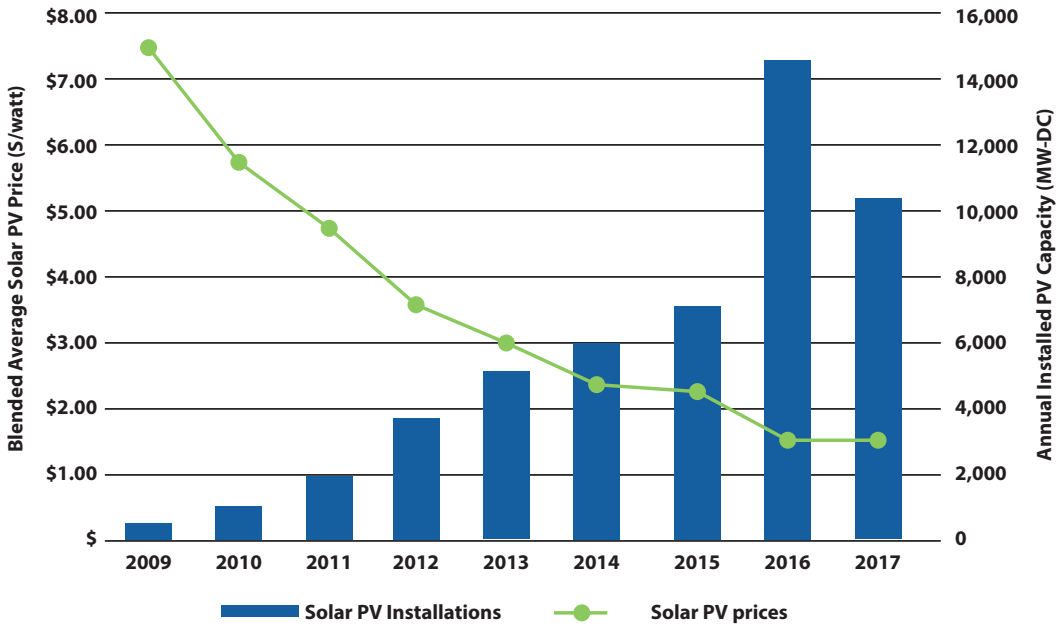


Introduction of new technologies and innovations

As a latest and new technology, the Mining companies can use clean electricity supply, by replacing on-site diesel generation. Off-course in some remote areas, there will be high cost of clean electricity supply, but It is important for mines to understand their energy security risks and is to consider renewables as a possible mitigation. Compared to other heavy industries, such as cement, steel, and chemicals, the mining is at an advantage because a large proportion of mining industry emissions are driven by electricity supply.

New technologies that support decarbonisation include wind turbines, solar photovoltaics, electric vehicles, energy storage, metal recycling, hydrogen fuel cells, and carbon capture and storage.

Out of the above, renewable resources which are getting a lot of attention is solar photovoltaic power supply. Evidently, cost for photovoltaic solar panels have fallen dramatically, averaging a 10–15% reduction each year from 2010 to 2016. Depending on local utility tariffs, power generation sources, taxes, and other incentives, solar is at or below cost parity with the electric grid as an energy source in many parts of the world.



Along with solar PV, energy storage (ES) is a frequently mentioned technology. While already commercially viable for certain markets and applications, Energy Storage is expected to continue decreasing in cost. This will be a game changer for renewables integration, as it has the potential to offset much of the need for base load power. Energy storage is often treated as synonymous with batteries, but it also includes Pumped-Hydro Energy Storage, Compressed-Air Energy Storage, Flywheels, etc. Energy storage can provide several advantages to mines, including

- Smoothing renewable intermittency
- Lowering peak demand
- Providing backup power/increasing reliability

Renewable energy, especially achieved through large-scale systems, is attractive not just for active mines, but for legacy mines as well. Major considerations are

- Mining leases having large areas, not immediately utilised, can be provided for generation of renewable energy.
- The backfilled areas can also be utilised.
- Old Mine have a large amount of unused land with limited direct economic value, and sites during the reclamation process
- Grid connected sites will give excess transmission capacity to help wheel power away, for which the mine can be compensated.
- Development of renewable resources offers value in asset conversion by providing a second productive life to closing mine sites.
- Mines can simultaneously explore power purchase agreements (PPA). Generally, PPAs and VPPAs reduce project risk (because a third party builds, owns, and operates the renewable system, which may be located on- or off-site), but increase project costs to cover the third party's margins. Large companies with concentrated operations may find these to be an attractive option with only a small premium.

Sites typically have a range of applicable technologies that can be developed, allowing a degree of flexibility in matching various electricity markets' demands and constraints. However, for the greatest chance of a successful project, renewables on a legacy site need to be considered and planned well before the expected mine closure.

Improving mining processes

Process Improvements

Mining companies are able to lower their carbon emissions through process changes along with use of electricity in mine operations, with inclusion of design to increase efficiency by obtaining and leveraging data to make their operations more efficient. Few actionable suggestions are listed below, to save resources and achieve net zero targets for emissions

- Advanced Maintenance Planning – Preventive & Planned Maintenance of HEMMs prevents failures and lowers overall operational costs.
- Unmanned aerial vehicles (UAVs), commonly referred to as drones, for pit and stockpile measurements and quantity assessments, mine surveying, and operations planning for blasting and rehabilitation. This is helpful in a quick, cheap, and safe manner.
- Optimisation of Haul roads and mine layouts.
- Accurate Planning of Mine to avoid wastage of resources i.e. Man, Machinery and Material etc.
- Reducing water stress – Mining companies can reduce the water intensity of their mining processes. Also recycle used water and reduce water loss from evaporation, leaks, and waste.
- Mining companies can prevent evaporation by putting covers on small and medium dams.
- Companies can also rely on so-called natural capital, like wetland areas, to improve groundwater drainage.

Technological Improvements

New technologies which are more efficient & represent novel ways of accomplishing the same task is available, which can be used in mining

- Upgradation of Mine Lighting from Metal-halide lamps to LEDs
- Installation of variable-frequency drives (VFDs) at crushers and conveyor belts.

- Bio-mining process application - the process of using small organisms, such as bacteria, to extract metals from ore, has a lower environmental impact and requires less energy.
- Replacing drilling and blasting methods with continuous miners with dust suppression methods. It involves fewer people, can be performed remotely, and will operate on an around-the-clock schedule.
- If blasting is required then it should be effective blasting with better fragmentation, which helps in reducing GHG emission levels in subsequent processing of material, as it
    - Reduces the amount of ore sent to crushing/grinding,
    - allows for bulk sorting (takes out less-viable rock earlier) is easy
- Few mines (example – Rio Tinto mine) developed a more efficient aluminium smelter that lowered its costs & emissions while improving productivity by 40%.

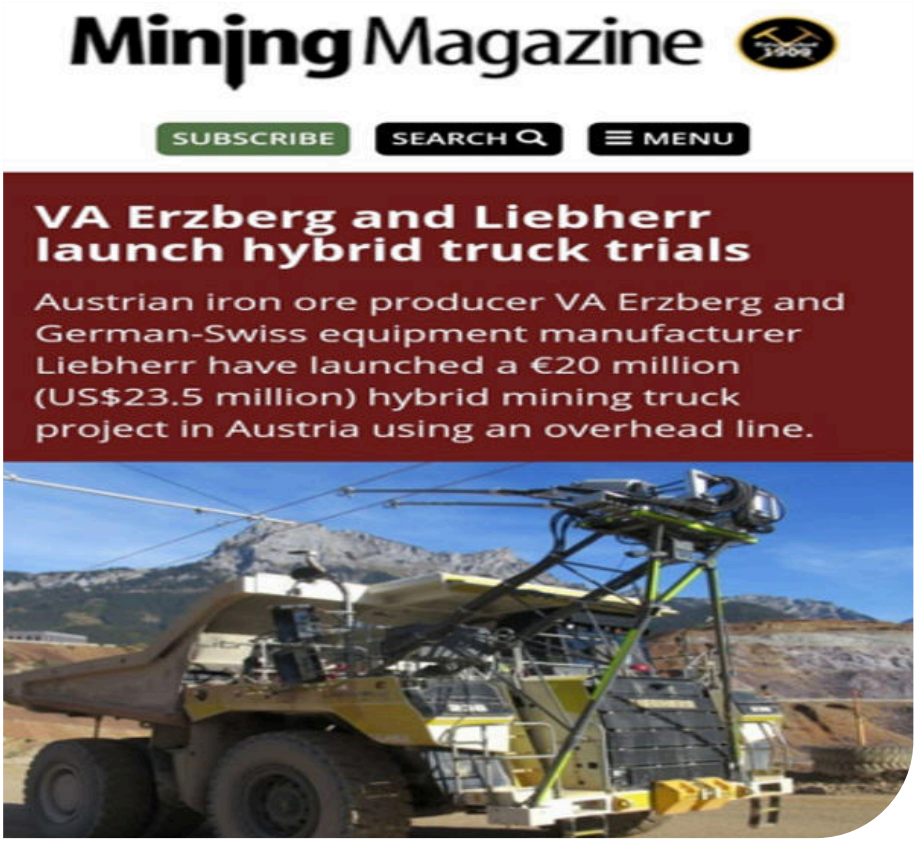
Switching from fossil fuels to renewable fuels

Environmentally beneficial electrification refers to the "electrification of energy end uses that have been powered by fossil fuels (natural gas, propane, gasoline, diesel, or fuel oil) in order to reduce GHG emissions."

- Use of Electric Motors tend to be more emissions-efficient than similar diesel-powered machines.
    - the electricity source is cleaner
    - Less noisy
    - less maintenance
    - Less noxious fumes exhausted or diesel particulate matter for U/g Mining
    - produce less heat than diesel equivalents, reducing ventilation needs.
- OEMs such as Sandvik, MacLean Engineering, and others are developing battery or electric-powered drills, bolters, and other mining machines.
- By using electric machines instead of diesel, Goldcorp Borden Lake Gold Mine in Ontario, Canada, expects to save 7,000 tons of CO_2, 2 million litres of diesel, and 1 million litres of propane annually. This help Goldcorp's bottom line, and it will help its social license as well; operating a cleaner mine makes obtaining the necessary environmental permits easier.
- Ministry of Mines, Govt of India, vide letter no. 20/55/2016 dated 01.07.16 have already emphasized on application and adoption of solar power in the form of Mega watt scale Solar plants in mining fields and to use minimum 5% of the total power consumption through solar energy.

Optimization of Transportation

Transport of material is pivotal concern in mining activity. In the transport activity, major innovations can be done by way of electrification and automation. The electrical operated vehicles produce less carbon, but they often have lower O&M costs because their fuel is cheaper and they break down less often because electric motors are mechanically simpler.



- Several OEMs are leading the way toward electrification. For example:
  - Liebherr prepared prototype diesel-electric truck that will be commercially available by 2021 (Trial taken in Austria)
  - Komatsu developing a 45-ton all-electric dump truck with regenerative braking to take advantage of moving heavy loads downhill.
  - Artisan is a smaller company specializing in electric vehicles for underground use. Recently unveiled a 40-ton underground hauler.
  - Rio Tinto operates autonomous haulage trucks at four mines in Australia. In Rio Tinto is working on an autonomous rail system, AutoHaul.
  - Fortescue mining has the world's first fully autonomous hauling fleet at an iron ore mine.

- Electrical Vehicles have Advantages of less carbon, lower O&M costs, less breakdown as electric motors are mechanically simpler etc.
  - Automation added that MOEF has issued an OM dated 29.10.20 for coal transportation to power plants shall be with covered wagons or Conveyor belt from delivery point to plant only, no truck transport to curb emissions.
  - Hindustan Zinc is the first Indian mining company to introduce Electrical vehicles in underground mining, signs MoU with Epiroc Rock drills AB for zero emissions & sustainable mining by introduction of battery electric Vehicles (BEV) in underground mining.

Reducing waste, and recycling

Recycling of Metals in other words, Say No to mining fresh & add to Linear Economy. Metals are eternally recyclable and can be indefinitely recycled, maintaining their quality and functionality. At their end-of-life stage, products made out of metals can be re-processed via recycling by adopting right treatment and reprocessing. This in turn helps in reduction of emissions from mining practices by of recycling of material without production of new minerals.

Metal recycling closes the loop within the production process, therefore it

- Reduces the amount of waste that goes into landfill
- Saves Energy and significantly reduces CO_2 emission
- Metal recycling value chain contributes to reduce dependency on imported materials.
- Recycling of metals is labour intensive and creates a wide variety of job opportunities.
- Create awareness in all stakeholders.
- Establish recycling value chain (Collection, Pre-Treatment & Material Recovery).
- Use of Advanced Technological Solution.
- Material recovery should be encouraged and incentivized.

Two major consideration with fundamental shifts

- The mining industry needs to recycle more to reduce the quantity of new resources needed.
- Extraction and production methods need to be designed to optimize on-site resource productivity rather than separating functions.

Steps by Major Mining Companies towards Net Zero approach

Described below are steps taken by major mining companies towards approaching for Net Zero Targets and about the achievements done. This includes, cement giant i.e. LafargeHolcim group, Mining Companies like Rio Tinto, Arcelor Mittal etc.

LafargeHolcim Group

LafargeHolcim is reinventing how the world builds for people and the planet, to become a net zero company. It is targeting for accelerating green construction by joining the net zero pledge with science-based targets, as under

a) Setting ambitious 2030 climate targets that are validated by the Science-Based Targets initiative (SBTi)

- Science Based Targets initiative mobilizes on set science-based targets and boost competitive advantage in the transition to the low-carbon economy.

b) Accelerating reduction in CO_2 intensity to exceed 20% (compared to our 2018 baseline)

c) Partnering with SBTi looking beyond 2030, to support the development of the first climate targets for a 1.5°C future in the cement sector

- Business Ambition for 1.5°C is an urgent call to action from a global coalition of UN agencies, business and industry leaders, calling on companies to set science-based targets in line with a 1.5°C future

Key Initiatives for Road-Map to 2030 is as under

1. Scope 1 emissions

- Reduce carbon intensity to 475 kg net CO_2 /t. cement.
- Reduced clinker content to 68%
- Increased use of waste-derived fuels to 37%
- Alternative raw materials
- Carbon capture and storage

2. Scope 2 emissions

- Reduce carbon intensity from purchased electricity to 13 kg of CO_2/t. cement
- Waste heat recovery
- Renewable energy portfolio

3. Reduce Scope 3 emissions

- Optimization of transportation networks
- Optimization of routes & loads by better logistics & distribution
- Vehicle optimization to reduce traditional fuel consumption
- Green KMs: drivers (own fleet & third parties) to drive more safely and efficiently (reducing fuel consumption on the order of 3% to 6%)
- Fossil fuels: Emissions from transportation of fuels are optimized by purchasing fuels from local markets and by using environmentally friendly inbound transportation means.

LafargeHolcim subsidiary Ambuja Cement has begun a trial of bio-diesel fuel blends for its shipping fleet. It says that the fuel change will reduce the fleet's CO_2 emissions by 25%. As per report published in Global Cement News, Managing Director and chief executive officer Mr Neeraj Akhoury said, "With the introduction of bio-diesel blends, we are significantly contributing towards the reduction of greenhouse gas emissions by introducing a suitable alternate green fuel that helps achieve our parent, LafargeHolcim's, sustainability vision of 'net zero pledge 2030'."

Rio Tinto Group

Rio Tinto being a big mining giant has adopted following approach to Climate Change and to strive for net zero emissions: ambition is to reach net zero emissions across our operations by 2050
Immediate steps to reduce carbon footprint: by 2030 to reduce carbon intensity by a further 30% & absolute emissions by further 15%

- Invest $1 billion in climate-related projects: Including R&D and projects to reduce emissions and enhance the resilience of business
- Build partnerships across our value chain: No company can adequately address the climate change challenge alone
- Support climate advocacy: Carbon pricing through market mechanisms is the best way to accelerate innovation and achieve emissions reductions at least cost
- Work with industry associations : Industry associations play an important role in constructive engagement on climate policy issues
- Be transparent : We support the recommendations of the Task Force on Climate-related Financial Disclosures and are enhancing our climate reporting

Climate Change Strategy of the company includes

- Producing materials essential for a low-carbon future
- Reducing the carbon footprint of operations
- Partnering to reduce the carbon footprint across our value chain
- Enhancing our resilience to physical climate risks

Progress on climate change

- 46% reduction in our greenhouse gas emissions from our managed operations since 2008 (18% when excluding divestments)
- 29% reduction in greenhouse gas emissions intensity since 2008
- Target to reduce our absolute greenhouse gas emissions 15% and our emissions intensity 30%, both by 2030
- $1bn estimated spend on climate related projects over five years
- Ambition for our operations to be net zero greenhouse gas emissions by 2050
- Overall, carbon neutral growth between now and 2030

ArcelorMittal Group

The group announces a group-wide commitment to being carbon neutral by 2050 (Net Zero Target), building on the commitment made in 2019 for its European business to reduce emissions by 30% by 2030, and be carbon neutral by 2050.

The group has identified two low-emissions steelmaking routes, both of which have the potential to lead to carbon-neutral steelmaking

- The Hydrogen-DRI route, which uses hydrogen as a reducing agent

- The Smart Carbon route is centred around modifying the blast furnace route to create carbon neutral steelmaking through the use of circular carbon.

The Company has outlined the policy framework environment, believes that is required for carbon-neutral steelmaking to become a reality, which includes

- A global level playing field which avoids the risk of carbon leakage through mechanisms such as green border adjustments
- Access to abundant and affordable clean energy
- Policies which support the development of the necessary clean energy infrastructure
- Access to sustainable finance for low-emissions steelmaking, and
- Policies which accelerate the transition to a circular economy.

The group is a member of the Energy Transitions Commission (ETC) and is an active member of the ETC's Net Zero Steel Initiative underway in partnership with the World Economic Forum.

ArcelorMittal is also actively engaged with the Science Based Targets Initiative (SBTI) to define an achievable SBT for the steel industry taking into account the two distinct routes in operation today.
In its Climate Action Report and Europe Climate Action Report, ArcelorMittal refers to three clean energy vectors: clean electricity, circular carbon, and CCS.

Conclusion

It is evident that to reach net zero, the world will need to set in train rapid and deep transitions in each of the sectors that contribute to global emissions starting from power and transport to shipping, aviation, and the mining which is in the roots of all these industries. We have a long way to go in a limited amount of time. Today's early stage technologies will likely need to contribute almost half of the emissions reductions required to set the world on this path. To respond to the impact of climate change, mining companies must undertake the following five actions.

- Perform an end-to-end diagnostic of climate change's effects on the business. This will help in assessing the assets to protect from climate change and which stand to gain or lose from decarbonization. The physical risks of climate change, such as water stress, precipitation, heat, etc. must be evaluated at a localized, asset-specific level. Such analyses may require technical expertise from outside the organization, tailored to the company's specific footprint and operations. Decarbonization scenarios should be built into demand forecasts for a company's commodities, including accounting for at-scale renewables, metal recycling, and even metal-process-route shifts. Site-specific baseline emissions should be realized, and potential abatement levers evaluated.
- Climate change, its risks and the opportunities, should be considered a board-level discussion, given its systemic, long-term, and potentially dramatic impact.
- Focus on operational transformation, investments, and innovation. Several points of no-regrets energy-efficiency moves can often be found at mines, and climate targets can focus efforts to unearth them. Shifting to renewables can offer benefits, such as lower electricity costs and reduced volatility. Bolder investments, such as reimagining processes to account for shifting water demand and embarking on a decarbonization plan using both existing technologies and promising new alternatives—may also be made.
- Evaluate and potentially reshape your portfolio. Climate change introduces unpredictability, requiring "climate intelligence" to be embedded in decision-making processes, such as capital allocation.
- Continue to engage through reporting, partnerships, and other proactive measures.

However, these actions are too modest to reach the 1.5°C to 2.0°C scenario and may not be able to keep up with society's expectations—as increasingly voiced by investors seeking disclosures, companies asking their suppliers to decarbonize, and communities advocating for action on environmental issues. Mining companies concerned about their long-term reputation, "license to operate," or contribution to decarbonization efforts may start to consider more aggressive decarbonisation and resilience plans.

In the efforts for net zero targets, mining companies may see demand rapidly decline, new technologies supporting decarbonization efforts, including wind turbines, solar photovoltaics, electric vehicles and energy storage, will increase demand for other mining materials. Some miners are well placed to access new green-focused sources of capital; however, the pressure is on miners to prove they are running their business with limited environmental impact.

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BRAZILIAN CEMENT INDUSTRY WITH FOCUS ON 2050

By João Butkus, Senior Consultant
Brazil

Brazil has numerous deficiencies, and its housing and infrastructure gaps are two of the main shortfalls that impact its people´s wellbeing and quality of life. Brazilian cement industry currently demonstrates one of the lowest global CO_2 levels per ton of cement produced. The Paris Agreement, negotiated in 2015 under the Conference of the United Nations Framework Convention on Climate Change (UNFCC) and ratified by Brazil in 2016, established guidelines and commitments as an attempt to limit global average temperature increase to lower than 2°C. The Brazilian Cement Industry launched in 2019 a technology roadmap that reiterates the cement commitment to progress, which evaluates a series of measures that might accelerate the transition to a low carbon economy, contributing to a 33% reduction in the industry´s carbon intensity by 2050.

This article will cover general information about Brazil, its Economy and the Brazilian Cement Industry and Market. Focus is given to the actions of the Brazilian Cement Industry to stay competitive and with continuous improvement reach the emissions targets for 2050, through its "Cement Technological Roadmap".

Brazil

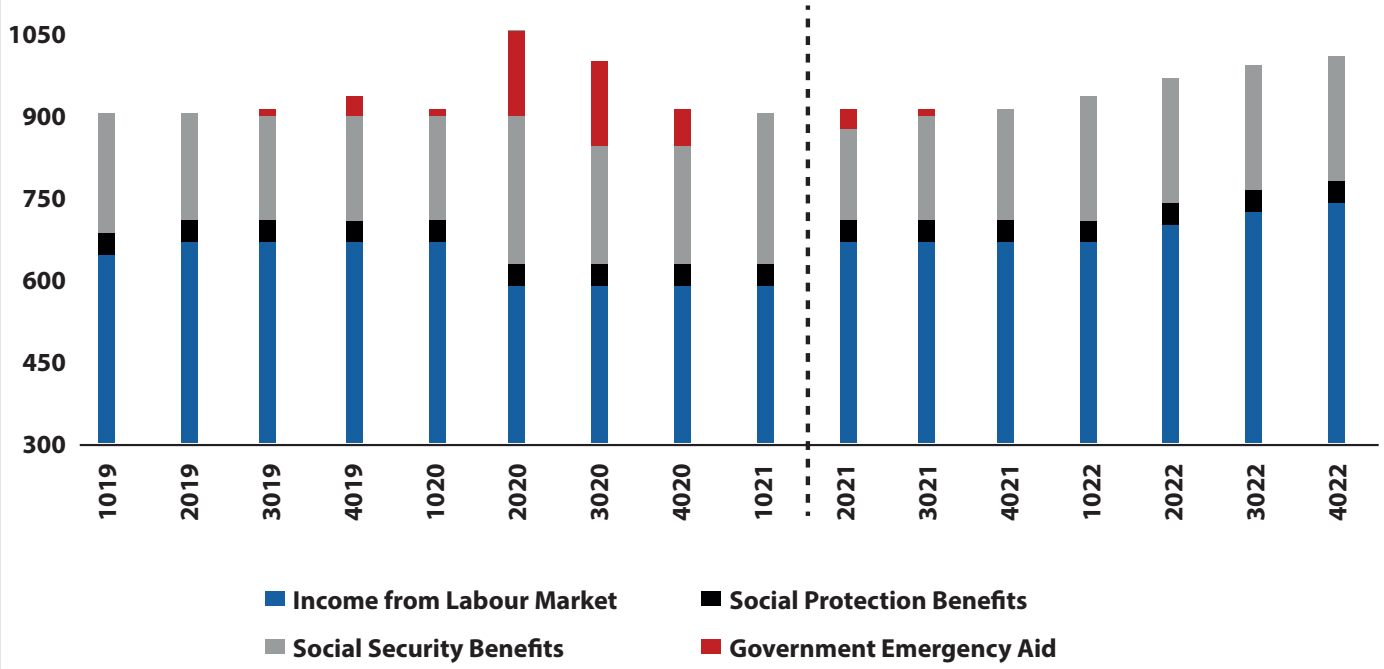
- Occupies about 50% of South America.
- Almost 7,500 km long coastline at the Atlantic Ocean.
- Area of 8,514,877 km², fifth-largest country in the world and the largest country in the Southern Hemisphere.
- Population more than 213 million people.
- 26 states and one Federal District.

Brazilian Economy

- 2020 economy was strongly affected by Covid19 but in some sectors the Emergency Aid was well received (R$290bi, USD55bi)
- Brazilian industrial activity should maintain a stronger performance in 2021 compared to other sectors.
- 2nd Emergency Aid released by the government on April (R$30bi, USD5.5bi) and will be well received by the economy.

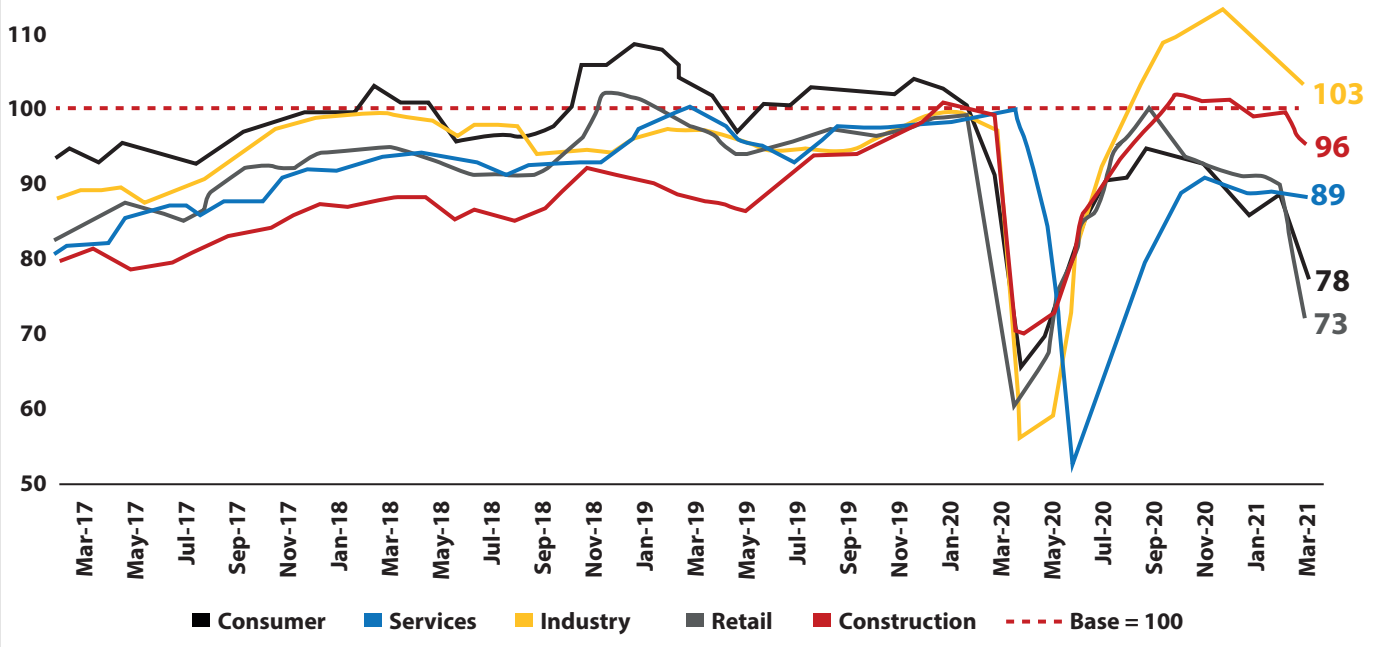
Real Household Disposable Income

BRL bollion (12 month accum), seasonaly adjusted series.
Source: IBGE, Central Bank, Caixa Economica, National Treasury,
Ministry of Social Security Estimates by XP.



Confidence Indexes

Seasonally adjusted series. Feb/20 = 100.
Source: FGV. By. XP.



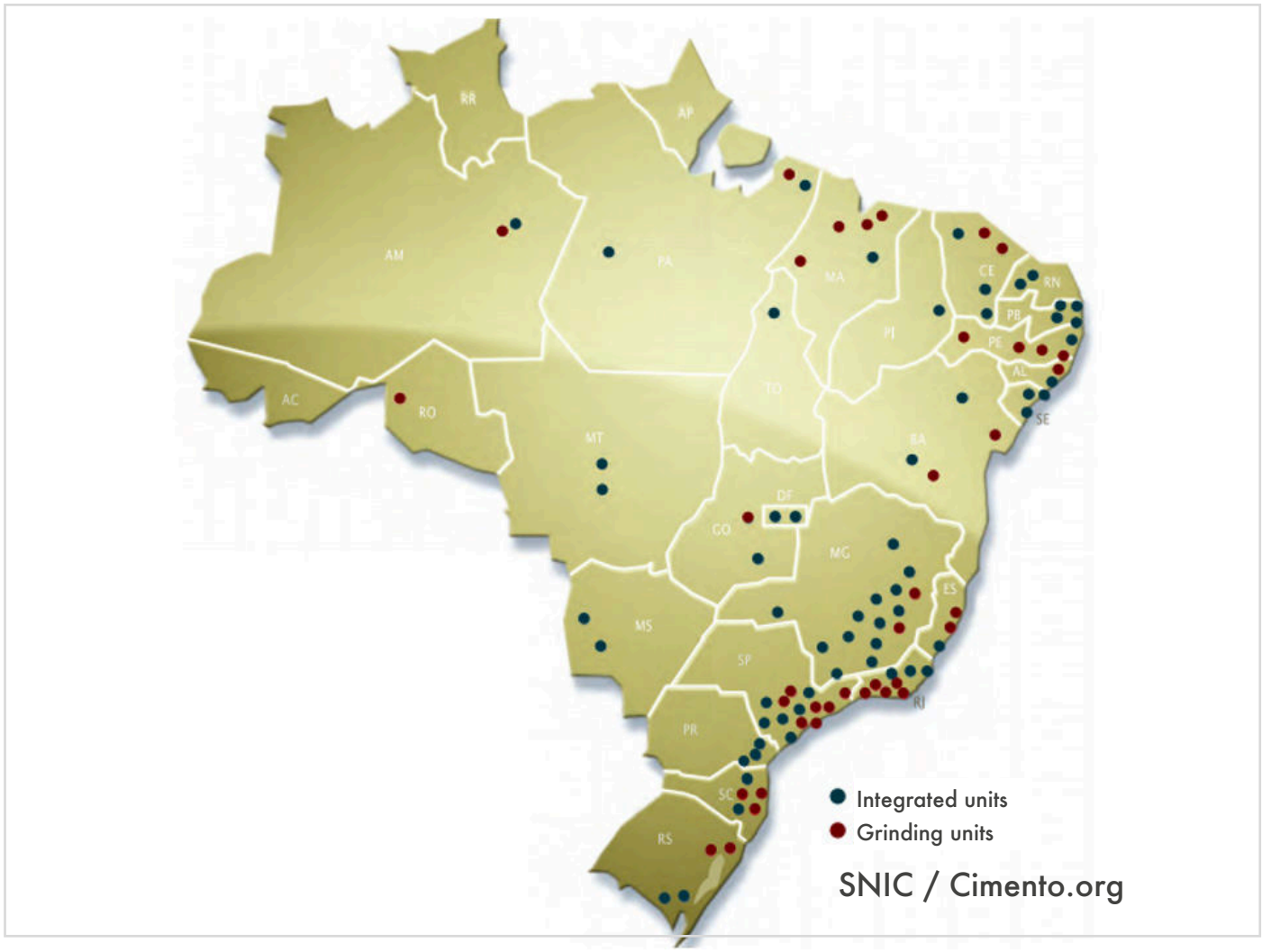
Historical and forecast data of the Brazilian economy

	2019	2020	2021	2022
GDP growth (%)	1.4	-4.1	3.3	2.0
Consumer inflation - IPCA (%)	4.3	4.5	5.0	3.5
Wholesale inflation - IGP-M (%)	7.3	23.1	12.0	4.1
Selic Rate (%, eop)	4.50	2.00	5.25	6.25
Exchange Rate (BRL/USD, eop)	4.03	5.20	5.60	5.60
Industrial Production (%)	-1.1	-4.5	6.0	1.9
Retail Sales (%)	3.9	-1.5	6.3	3.6
Job Creation (in thousands)	1816	-6619	2876	1350
Unemployment Rate (% of labor force, avg)	11.9	13.3	14.7	14.2
Outstanding Credit Growth (%)	6.5	15.7	8.0	9.2
Trade Balance (USD bn)	40.5	43.2	67.5	70.4
Current Account (USD bn)	-50.7	-12.5	3.4	-2.7
Primary Balance (BRL bn)	-61.9	-700.1	-246	-157
Gross Debt (% of GDP)	74.3	88.8	90.2	91.5

Brazilian Cement Industry and Market

The Brazilian cement industry has made a significant contribution to the development of the country, supplying a high-quality product from a modern industrial complex, in line with the most demanding requirements of sustainability and making it an international reference. Brazil was, in 2016, the sixth largest producer and the eighth largest consumer of cement in the world. The total cement industry consists today of 24 cement groups, 94 plants, located in 80 municipalities and 23 states, 54 being integrated units and 39 grinding mills.

Most of the plants are in coastal regions of the country, accompanying the greater population density and the consumer market. From 2003 to 2014, Brazil's annual consumption of cement practically doubled, due to income and job growth, strong expansion of mortgage lending, a fall in interest rates and inflation, and investments in infrastructure programs, reaching a record consumption of 72 million tons in the last year. During this same period, there were significant investments in expansion of installed capacity, reaching currently around 94 million tons per year. Since 2015 the country has been facing a serious political-economic crisis, which resulted in the reduction of investment in infrastructure and an increase in unemployment. The increase in interest rates and salary losses reflected heavily on the real estate market, civil construction consequently suffering a strong downturn, culminating in the worst crisis that the Brazilian cement industry has ever faced, with a cumulative drop in production of 25% in the last three years. Brazilian per capita consumption is currently (260 kg/person), less than half the world average (553 kg/person/year) and well below countries in full development or already developed. The high housing deficit and the precarious infrastructure base demand implementation of important investment programs in Brazil. Considering the increase in population, with growth predicted up to mid-2040, and cement being the indispensable basis for the construction of infrastructure, an increase in the production of the product is predicted for the next decades. To reconcile this growth with a reduction in its carbon emissions is a priority for the sector.

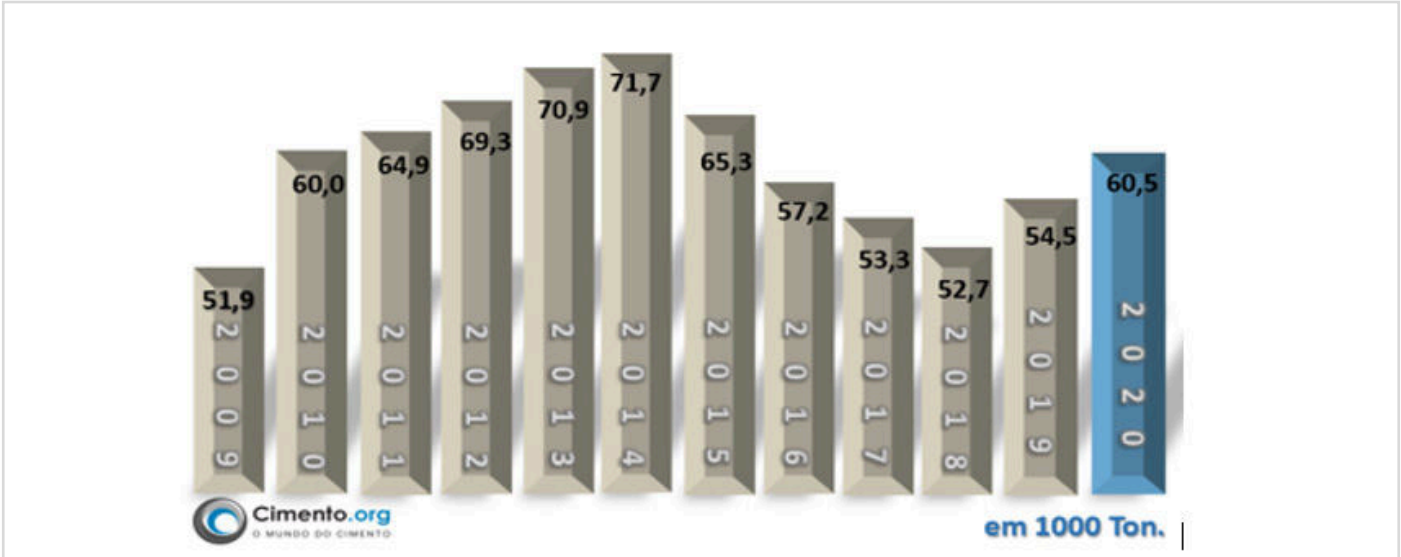


Production and Consumption

From 2003 to 2014, Brazil's annual consumption of cement practically doubled, reaching a record consumption of 72 million tons in the last year. During this same period, there were significant investments in expansion of installed capacity, reaching currently around 100 million tons per year.

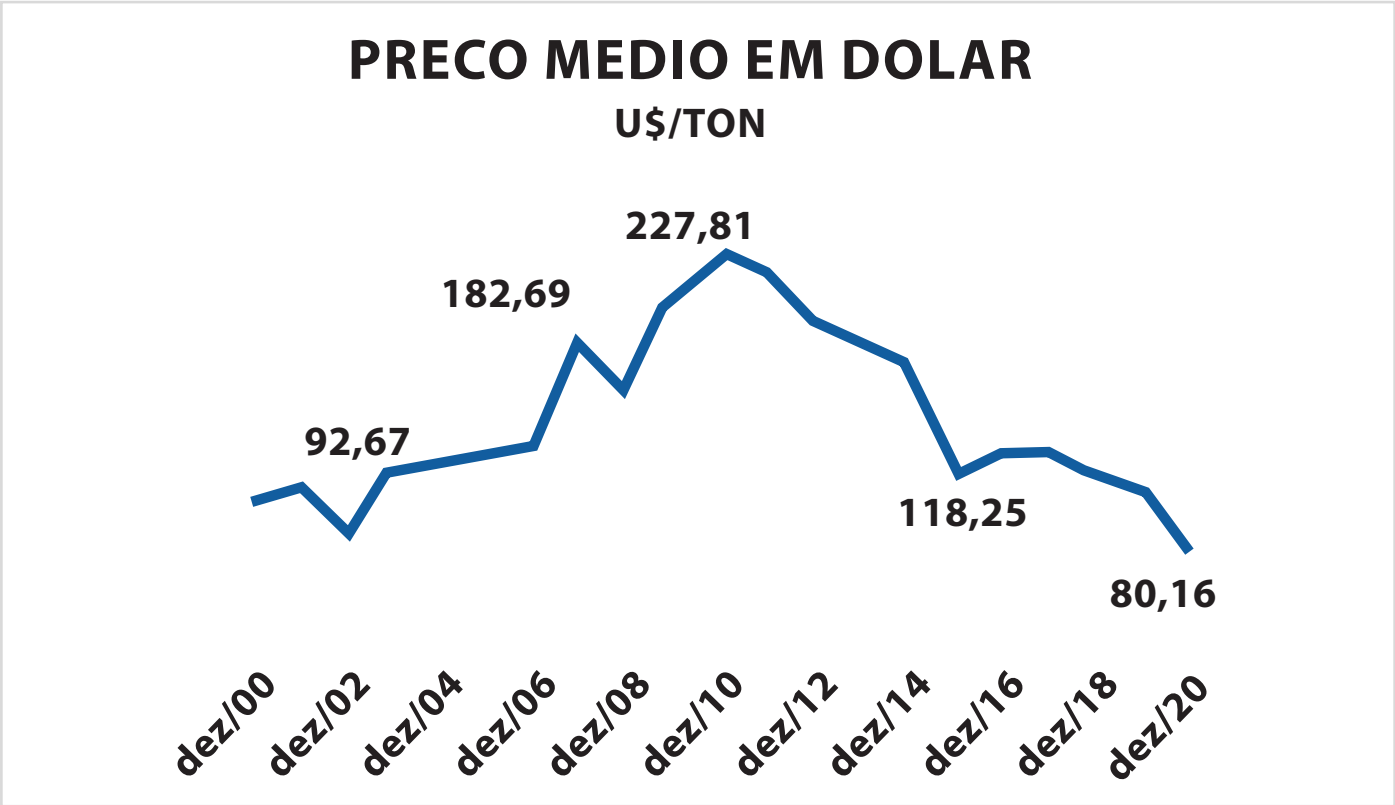
Since 2015 the country faced a serious political-economic crisis, culminating in the worst crisis that the Brazilian cement industry has ever faced, with a cumulative drop in production of 25% till 2018 when the idleness reached 48,3%. In 2020 cement sales reached 60,5 million t, still with a idleness of +-40%.

Consumption 2014 (72,7 Mt), 2018 (52,9 Mt), 2020 (60,6 Mt)



Prices

Average price in USD, end of 2020 100 USD/t



Brazilian Cement Market 2020

> We experienced a roller coaster in the 2020 projections. Before the pandemic, we estimated a 3% growth. In April, with the sharp drop in demand, we expected a retraction of 7% to 9% in the year. From June to October, the cement industry recorded a strong recovery followed by a November and December of moderate growth. All of this led us to a surprising result of an 11% increase in sales.
>
> **Paulo Camillo Penna**
> **President of SNIC and ABCP**

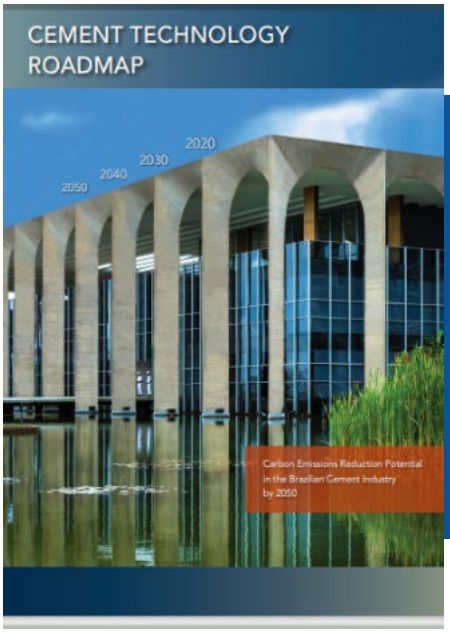
Main drivers

- Emergency Aid
- Self-construction
- Real Estate resuming construction.

Brazilian Cement Market 2021

Paulo Camillo Penna
President of SNIC and ABCP

Despite the good performance at the beginning of 2021, we must be very cautious in the projections until the end of the year. The scenario is one of countless uncertainties and any type of demand projection would be an exercise in futurology without any reliable database of data and information. We should have good results by May, as last year's base was very low. Starting in June, we will have a greater challenge, which is to overcome the excellent results obtained between June and December 2020, but we will certainly close the year 2021 in the positive.



Aware of the need to embrace the challenge of further reducing its CO_2 emissions, the Brazilian cement industry repeated the collaboration with International entities to develop its own Cement Technology Roadmap – Brazil.

The Brazilian Cement Industry launched in 2019 its "Cement Technological Roadmap" to demonstrate all actions and activities showing the Carbon Emissions Reduction Potential in the Brazilian Cement Industry by 2050.

Key Findings during Roadmap elaboration

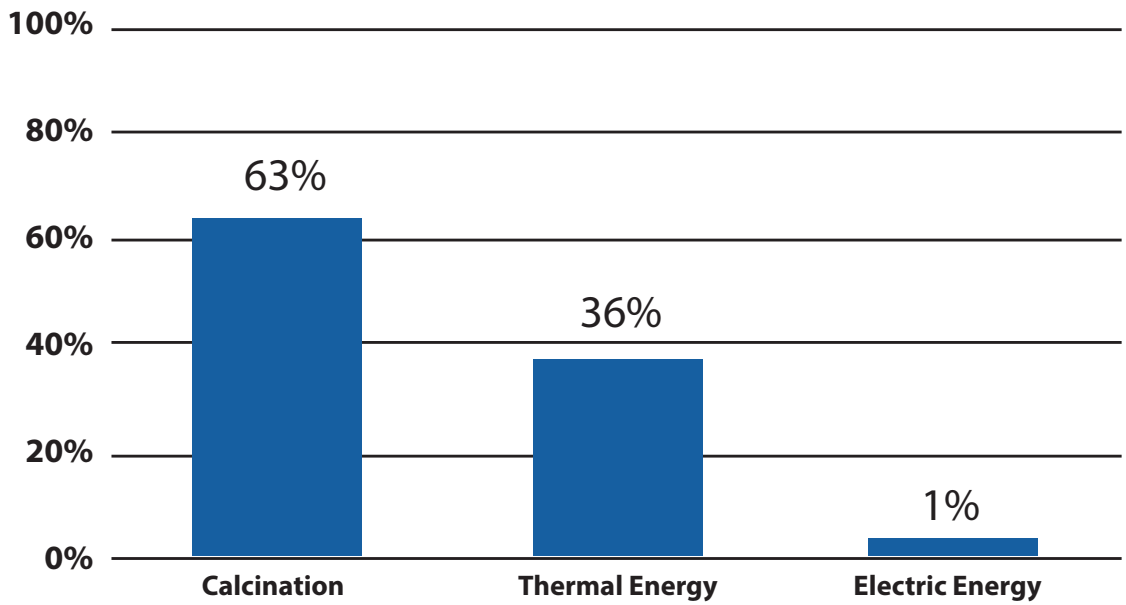
- The Brazilian cement industry has one of the lowest levels of specific CO_2 emissions in the world, thanks to mitigating actions implemented by the sector over recent decades. While cement production increased by 273% between 1990 and 2014 (from 26 million to 71 million tons), total emissions grew by 223% over the period, due to the 18% reduction in emissions intensity (from 700 kg CO_2 /t cement to 564 kg CO_2 /t cement).
- In the same period, thermal intensity had a reduction of 17%, the use of alternative fuels increased from 5% to 19% and the use of clinker substitutes increased from 20% to 33%.
- The low per capita cement consumption in Brazil (260 kg/person/year) when compared to the worldwide average (553 kg/person/year), and coupled with the high housing deficit, the country's infrastructure, and the expected population growth, indicates a resumption of production in the medium to long term, increasing between 60% and 120% by 2050 compared to 2014 (in the variants of low and high demand respectively).
- Regarding mitigating its CO_2 emissions, the main alternative and the biggest challenge to the sector is to further increase the use of clinker substitutes (Brazil is among the countries that use them the most). By reducing the clinker/cement ratio from 67% in 2014 to 52% in 2050, it would be possible to achieve a cumulative reduction of 290Mt in CO_2 emissions. This would represent 69% of the CO_2 emissions reduction in the sector by 2050. The expected scarcity of both blast furnace slag and fly ash in the long-term would increase pressure on the industry to identify other clinker substitutes, such as increasing the use of limestone filler and calcined clay.
- The use of alternative fuels, substituting fossil fuels, such as petroleum coke, represents the second largest carbon emissions mitigation strategy for the sector. The increase in thermal substitution rate from 15% in 2014 to 55% in 2050 would result in a cumulative reduction of 55Mt in CO_2 emissions. This would signify around 13% of the CO_2 emissions reduction. The use of Municipal Solid Waste (17% of thermal substitution) and Non-Hazardous Solid Waste (other 17%), both with a high content of biomass, represent the greatest potential.
- Brazil has a modern and efficient industrial complex, with an average thermal consumption of 3.5 GJ/t of clinker and electricity consumption of 113 kWh/t of cement. Therefore, major changes in energy intensity of cement production are not expected before 2030, when the gradual replacement of the more obsolete units and equipment with new lines using the best available technologies (BAT) will start taking place. It will then be possible to achieve values of 3.2 GJ/t of clinker and 91 kWh/t cement by 2050 and a cumulative reduction of 38Mt of CO_2 by 2050, representing around 9% of the sector's mitigation effort. Process control and optimization, recovery of heat in the coolers, vertical mills, and waste heat recovery (WHR) equipment for generating electricity will each have a pivotal role in this reduction.

- To achieve emissions reduction compatible with the global commitments of minimum climate impact, it is necessary to search for innovative and disruptive solutions, such as Carbon Capture and Utilization or Storage (CCUS). By doing so, it would be possible, from 2040, to achieve a cumulative reduction of 38 Mt CO_2, representing about 9% of the sector's mitigation by 2050.
- The different measures for carbon emissions reduction are not distributed evenly around the country. Considering Brazil's continental dimensions, and its many different regions, it is fundamental to understand that the various actions recommended in this Roadmap, as well as their potential for penetration and reduction of CO_2, cannot be replicated with the same intensity in all regions of the country.

Manufacturing process and formation of CO_2 emissions

Cement manufacturing can be considered as a two-step main process. It starts with clinker production in high temperature kilns, and it is at this stage that direct CO_2 emissions occur. Typically, 30% to 40% of the direct CO_2 emissions come from the burning of fuels and the remaining 60% to 70% are inherent to the process and come from the chemical reaction involved in the conversion of limestone to calcium oxide (calcination), in the formation of clinker. Another 5% of CO_2 emissions occur indirectly because of electrical consumption by the industrial plant. In Brazil, the burning of fuels represents 36% of total emissions, while the emissions from calcination contribute another 63%. Contribution from electrical energy is approximately 1%, due to 74% of the country's electric supply being renewable.

Figure 1: CO_2 emissions from cement production in Brazil



Key message: Almost 2/3 of the sector's emissions are inherent to the process and happen during the calcination of raw material.

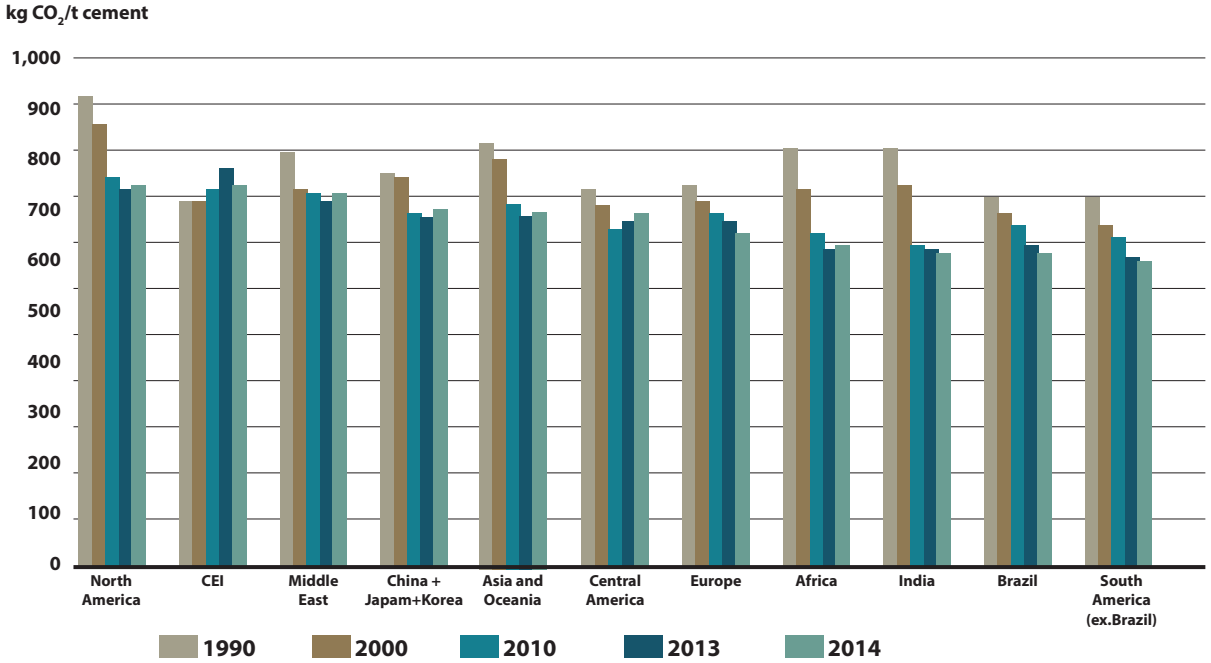
Source: CSI: SNIC, 2014

Actions taken to reduce emissions in Brazil

Globally, the cement industry's CO_2 emissions represent around 7% of total CO_2 emissions produced by man. In Brazil, due to actions being implemented for years, this participation is practically one third of the world average, or 2.6%, according to the National Inventory of Greenhouse Gases.

The efforts of the Brazilian cement industry to reduce its carbon footprint, by adopting better practices available today, are reflected in its carbon intensity indicators. Since the first records of CO_2 emissions in the sector, in 1990, until today, Brazil has taken a leading position among the countries/ regions with lower specific emission per ton of cement produced in the world.

Figure 2: Emission intensity in cement production



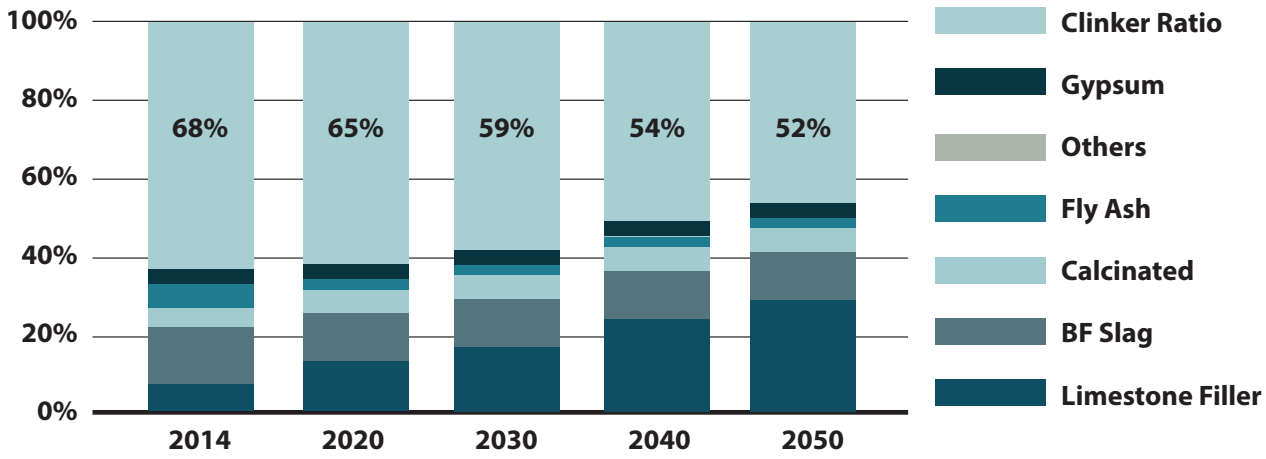
Key message: Due to actions implemented throughout the decades, Brazil has one of the lowest indices of specific emissions in the world, since the start of historical records.

Source: Cement Sustainability Initiative (CSI), 2014

Clinker Substitutes

An increase in the use of clinker substitutes would reduce around 290 Mt of CO_2 or 69% of the cumulative mitigation of CO_2 emissions by 2050 in the "2°C Scenario", when compared to the "6°C Scenario."

Figure 3: Evolution of the use of clinker substitutes in "2°C Scenario"



Key message: If the availability of slag and fly ash is reduced, the major potential for further reduction of the clinker proportion is in greater use of limestone filler.

Source: IEA modelling developed for this project. © OCECD/IEA, 2016

Figure 4: Characteristics of clinker substitutes in Brazil

Clinker Substitutes	Source	General characteristics of blended cements comapared to ordinary cements		Estimated level of production and comsumption
		Positive	Limiting	
Blast furnance granulated slag	Production of pig iron	HIgh mechanical strength at long ages and better durability	Higher power consumption of the grinding and lower mechanical strength, regionalization of supply	Production: 7.4Mt in 2014, 11.1 Mt in 2030 and 14.9 Mt in 2025 consumption: 7.1 Mt in 2014, 10.0 Mt in 2030 and 14.7 Mt in 2050
Fly ash	Coal fred thermo-electric plants	Low demoand for water, improvements in workability, greater mechanical strength at long ages, improved durability	Les relative mechanical resistances, principally at early ages, regionalization of supply	Production: 2.2 Mt in 2014, 3.0 Mt in 2030 and 3.3 Mt in 2050 Consumption: 1.4 Mt in 2014, 2.7 Mt in 2030 and 3.1 Mt in 2050
Calcinated clays	Specifically produced from clay mines	Improved durability and unrestricted distribution	Lower relative mechanical strength, especially at early ages and larger counterparts to ensure the rheology	Great availability of clay reserves. Consumption: 1.5 Mt in 2014, 3.4 Mt in 2030 and 5.4 Mt in 2050
Limestone filler	Limestone mines	Improved workability and synergetic effect when associated with calcined days	Cement content limitation, as it does not perform as traditional additions	Greate availability of limestone reserves. Comsumption: 4.0 Mt in 2014 16.Mt in 2030 and 33.5 Mt in 2050
Blast furnace acid slag	Production of pig iron using coal	Improved durability, greater response to thermal cure	Lower relative mechanical strength, especially in early ages	Production: 1.22 Mt in 2030 and 1.64 Mt in 2050 Consumption: 0.24 Mt in 2030 and 0.49 Mt in 2050
Steel slag	Steel production	Reduction in clinker-to cement ratio: synergetic effect with blast furance slag	Lower relative mechanical strength, especially in early ages	Production: 5.6 Mt in 2030 and 7.5 Mt in 2050 Consumption: 1.1 Mt in 2030 and 2.2 Mt in 2050

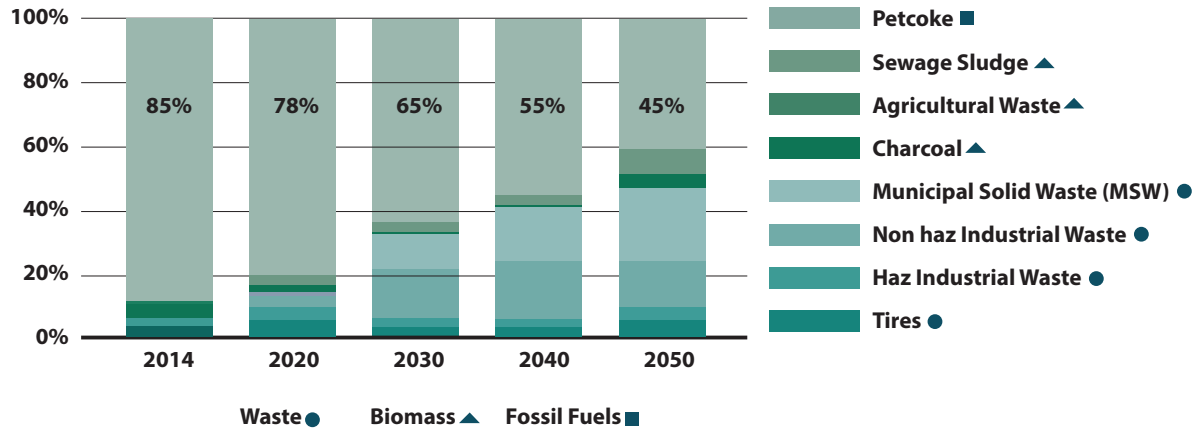
Alternative Fuels

The increase in the use of alternative fuels would reduce around 55 Mt of CO_2 or 13% of cumulative mitigation of CO_2 emissions by 2050 in the "2°C Scenario", when compared with the "6°C scenario".

Table 2: Principal types of waste used by the cement industry

Waste oil	Scrap tires
Solvents	Waste from rubber factories
Greases	Sludge from chemical processes
Textile waste	Distillation bottoms
Plastic waste	Sludge from municipal sewers
Sawdust	Animal bones and bone meal
Waste from paper factories	Expired grains

Figure 7: Evolution of the use of alternative fuels in the "2°C Scenario"



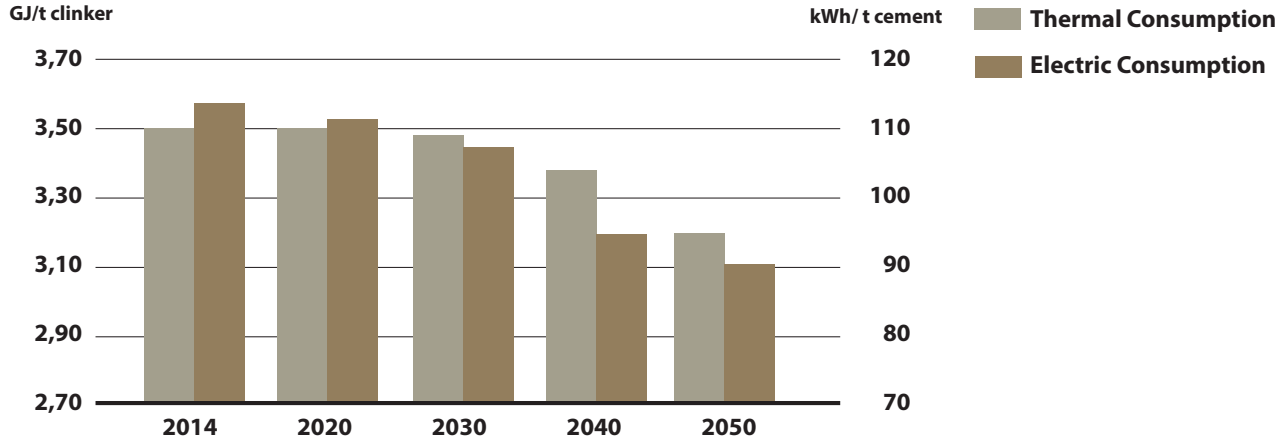
Key message: The contribution of non-renewable fossil fuels in cement production should diminish from 85% to 45% in the "2°C Scenario", due to the growing use of wate and biomass.

Source: IEA modelling developed for this project. © OCECD/IEA, 2016

Thermal and Electrical Efficiency

Improvements to the energy efficiency would reduce around 38 Mt of CO_2 or 9% of cumulative mitigation of CO_2 emissions by 2050 in the "2°C Scenario", in comparison to the "6°C Scenario".

Figure 8: Thermal and electrical intensity in cement production in the "2°C Scenario".



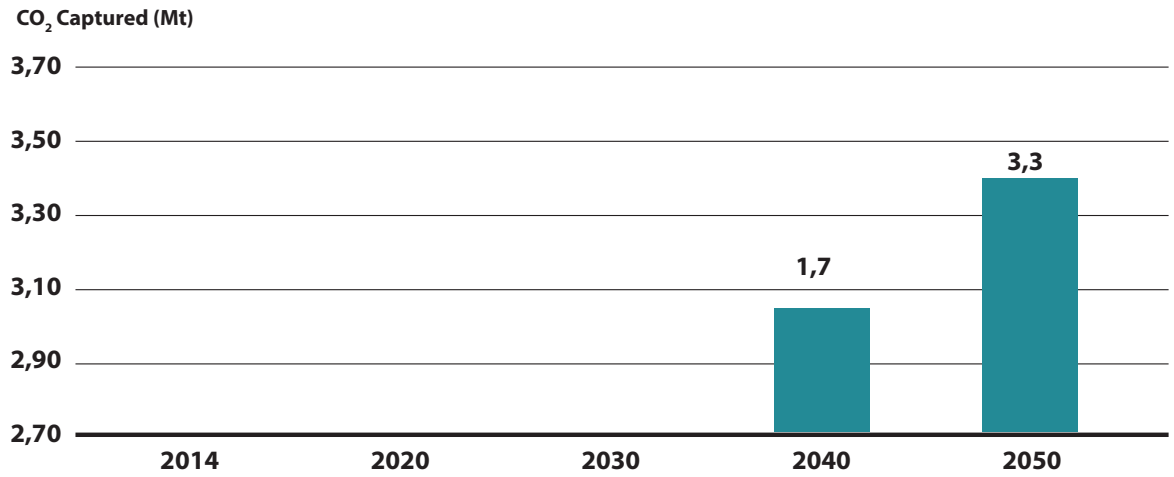
Key message: More significant advances in thermal and electrical efficiency will be observed after 2030, with the substitution of the more obsolete units and equipments by new plants operating with the best available technology (BAT)

Source: IEA modelling results for the evolution of the share of alternative fuels.

Innovative and emerging technology

The viability of innovative and emerging technology would reduce around 38 Mt of CO_2 or 9% of cumulative mitigation of CO_2 emissions by 2050 in the "2°C Scenario", in comparison with the "6°C Scenario".

Figure 9: Carbon captured by the cement industry in the "2°C Scenario".



Key message: Carbon capture, an alternative still emerging for the mitigation of CO_2, emissions, would become viable for the Brazilian cement industry only after 2040.

Source: IEA modelling developed for this project. © OCECD/IEA, 2016

Key Indicators for the Brazilian Cement Industry by 2050

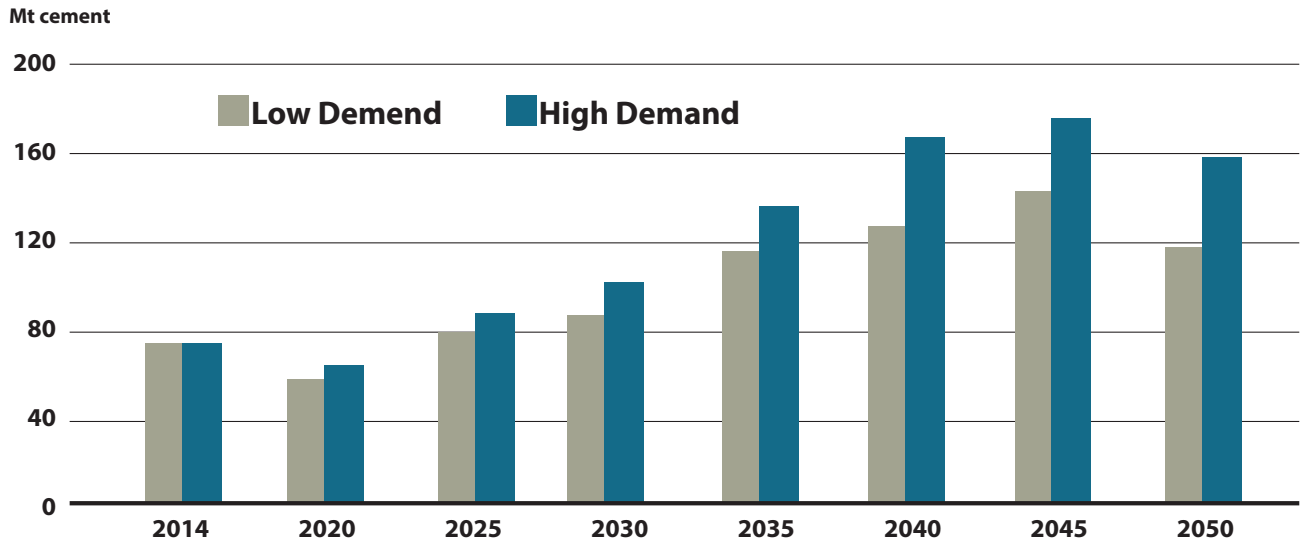
Table 3 : Key indicators for the Brazillian cement industry by 2050

		2°C				6°C			
	2014	2020	2030	2040	2050	2020	2030	2040	2050
Cement production [Mt]	71	62	87	126	117	62	87	126	117
Clinker factor [clinker to cement ratio]	0.67	0.66	0.59	0.54	0.52	0.67	0.67	0.67	0.67
Thermal intensity [GJ/t clinker]	3.50	3.49	3.47	3.38	3.22	3.50	3.49	3.46	3.44
Electrical intensity [kWh/t cement]	113	110	106	95	91	111	108	101	99
Alternative fuel use [% of thermal substitution rate]	15%	22%	35%	45%	55%	15%	15%	15%	15%
CCUS [Mt CO_2/year]	-	-	-	1.7	3.3	-	-	-	-
Gross emission [Mt CO_2/year]	40	34	42	52	44	35	49	71	66
Emission intensity [t CO_2/t cement]	0.56	0.53	0.48	0.41	0.38	0.56	0.56	0.56	0.56

Note: Values shown are for low-demand variants of the scenarios. Alternative fuel use includes biomass as well as renewable and non-renewable waste. Electricity intensity of cement production does not include reduction in the demand for purchased electricity from waste heat recovery equipment or electricity used in carbon capture equipment. Direct CO_2 intensity refers to net CO_2 emissions, after carbon capture.

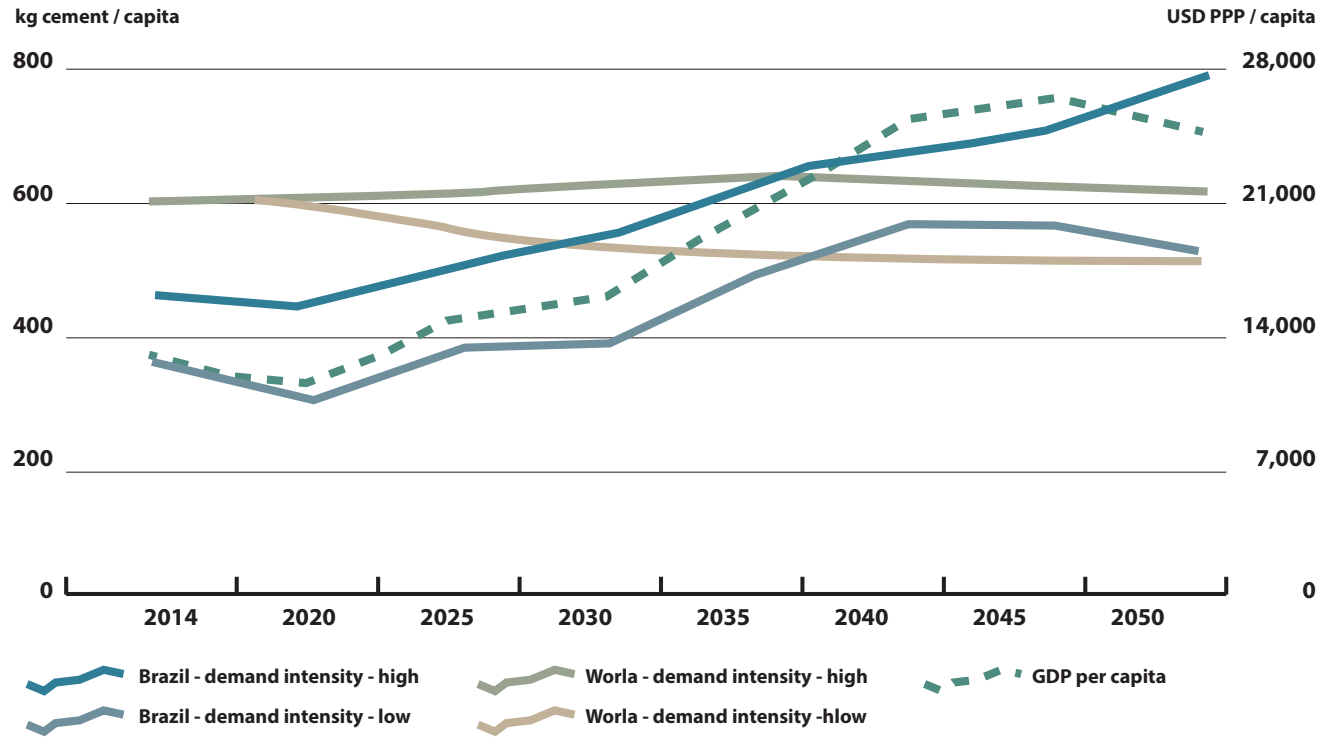
Source: IEA modelling developed for this project. © OCECD/IEA, 2016

Figure 11: Projection of cement production in Brazil



Key message: The projection for emission and potential reduction were evaluated with the low demand cariant as a parameter, considered more realistic. the eventuality of more optimistic production variants can have a significant impact on the efforts of the sector to reduce CO_2.

Figure 12: Economic indicators and cement production

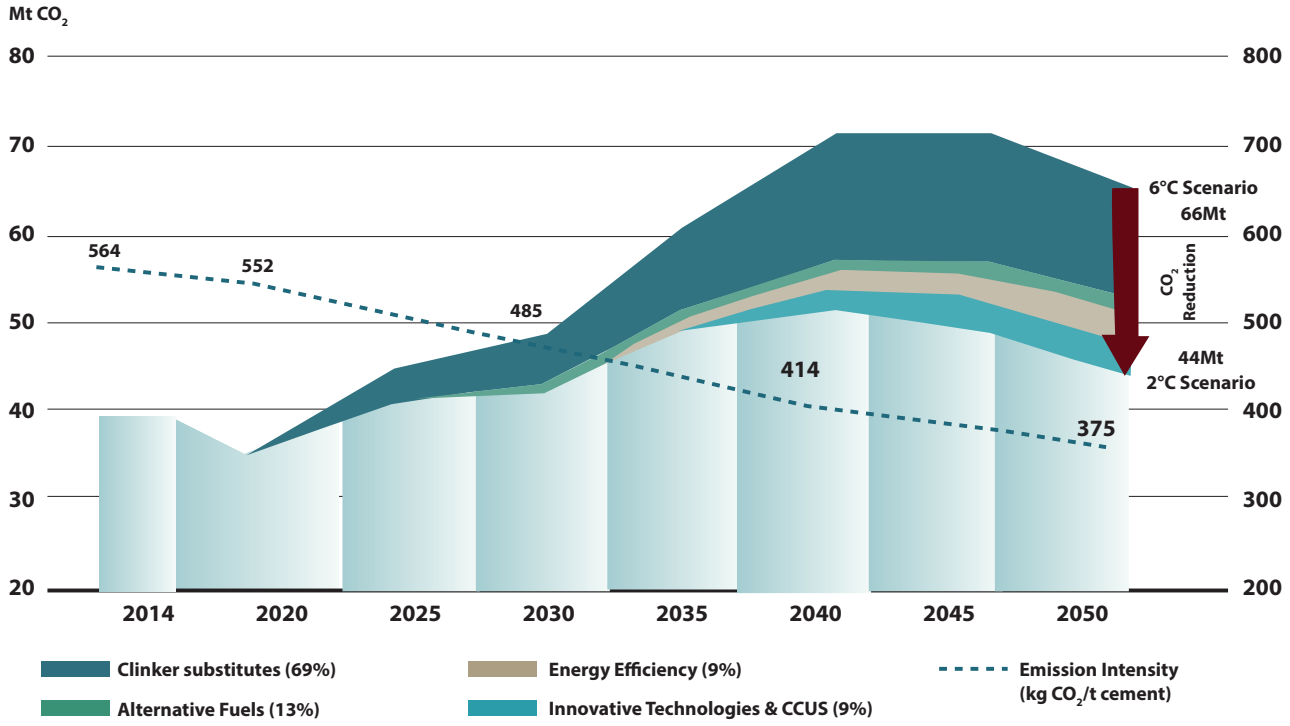


Key message: As incomes rise, increasing demand for cement drives up production levels, which then stabilize by 2050 as population growth levels off and high levels of demand intensity are reached.

CO_2 Emissions up to 2050

The potential for reduction of direct CO_2 emissions gives different results through time, reflecting both existing demand and the degree of maturity and penetration of solutions suggested for the sector. Using as a basis 40 Mt of CO_2 emitted by the Brazilian cement industry in 2014, emissions could reach around 66 Mt of CO_2 in 2050, if no mitigating action is adopted ("6°C scenario"). However, this value could fall to 44 Mt of CO_2 in the same year from a combination of measures suggested in this Roadmap ("2°C Scenario"). This represents a growth in emissions of only 10% on the current volume, against an increase in projected cement production of around 65% in the period. Under these conditions, the specific emissions would go from the current 564 kg CO_2 /t cement to 375 kg CO_2 /t cement in 2050, a reduction of 33%. In terms of emissions accumulated throughout the whole period, comparing the two scenarios, it would be possible to avoid the emission of 421 Mt of CO_2. The chief factor contributing to this reduction is clinker substitution, with 290 Mt of CO_2 mitigated between 2014 and 2050 (or 69%). The use of less carbon intensive fuels, as the sector migrates from petroleum coke towards biomass and waste, contributes 55 Mt of CO_2 of this total (13%). Energy efficiency measures and innovative technology such as CCUS each account for 38 Mt of CO2 (9%).

Figure 13: Reduction of direct CO_2 emissions per strategy, "2°C Scenario" comapred with "6°C Scenario".



Key message: By impacting as much on emissions of calcination as on the bluring of fuel, clinker substitutes will contribute a large part of the reduction on CO2 emissions compared to other options.

Source: IEA modelling results for the evolution of the share of alternative fuels.

Key recommendations for achieving these objectives

1. Increase the use of clinker substitutes

- Promote the development and acceptance of new cement standards.
- Promote and encourage the propagation of good practices and R&D, to create better understanding of opportunities in clinker substitutes.
- Develop campaigns and training events and awareness for the actors in the entire length of the cement supply chain.

2. Encourage and enable the use of alternative fuels

- Modify existing legislation
- Create specific legislation on co-processing of Solid Recovered Fuels (SRF) from Municipal Solid Waste (MSW)
- Encourage other ways of disposing of waste, promoting isonomic conditions of competitiveness between disposal methods.
- Promote the creation of an energy policy that accelerates the transition from an economy based on fossil fuels to a low carbon economy.
- Encourage the development and use of new alternative fuels, especially biomass.

3. Promote the adoption of best available technologies in energy efficiency for new plants and retrofits

- Share the best practices on a national and international level for the promotion of energy efficiency and reduction of CO_2 emissions in the cement industry.
- Create or identify the available mechanisms for financing both on a public and private, national, and international level.

Acknowledgements

A special thanks to Paulo Camillo Penna, President of ABCP and SNIC and his team for all support and contribution with information, material and studies.

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ADVANCED TOOL FOR GREEN AND ENERGY EFFICEINT BUILDING DESIGN

By Ankur Mittal, Ashutosh Saxena, B N Mohapatra
National Council for Cement & Building Materials (NCB), Ballabgarh (Haryana)

Abstract

Current projections indicate that 66 percent of the world's population will live in cities by 2050. Population equivalent to 7 (seven) "New Delhi" size cities is added per year to world's urban population. According to the data published by The Energy and Resources Institute (TERI), urban share of GDP in India will rise to 75% in 2030-31. Buildings represent around 40% of world's primary energy consumption. They are, therefore, directly responsible for increase in greenhouse gases and can play a key role in climate change adaptation. To achieve an energy efficient building regime, governments, businesses and individuals must transform the way buildings are designed, built and operated. Energy efficient buildings (new constructions or renovated existing buildings) can be defined as buildings that are designed to provide a significant reduction of the energy need for heating and cooling, independently of the energy and of the equipments that will be chosen to heat or cool the building.

The area of study is to develop understanding of high performing building envelope and drive adoption of energy efficient built to investigate and quantify the energy impact from the expected proliferation of important energy efficient solutions.

Introduction

Construction of building uses land, energy, water, and natural resources, and produces construction waste and releases greenhouse gases causing ecological imbalance. The buildings can develop the capacity to curtail GHG emissions and reduce the carbon footprint by incorporating building codes or rating systems in India. In a building. Energy audit reports and literature review indicates a typical break up of electrical energy consumption in Built Environment of commercial buildings is indicated in Table 1

Table 1: Energy consuming areas in Commercial Building

Area of Comsumption	Percentage Break-up
HVAC System	**55%**
Lighting	**25%**
Office equipments	**15%**
Other auxillaries	**5%**

Heating, Ventilation and Air Conditioning system (HVAC) are energy guzzlers in any air conditioned commercial building. The purpose of a HVAC system is to create a comfortable environment by adjusting the four parameters of indoor air - temperature, humidity, air flow, and cleanliness, for the person inside the room/facility or product/process to meet requirement. Another high energy consuming section in building is lighting systems. Lighting not only provide a basic visual environment for occupants, but also have a significant impact on human health, work efficiency, and building energy consumption. Today, many people spend most of their day indoors. Therefore, it is important to create a comfortable visual environment to improve the living environment of the occupants and improve the efficiency of work.

Indoor environmental quality (IEQ) is the quality of a building's environment directly linked to health and comfort of occupants using that space. IEQ is determined by many factors including lighting, air quality, and damp conditions. Indoor environmental quality (IEQ) is a general indicator of the quality of conditions inside a building. It can also include functional aspects of space, for example whether the layout provides access to equipment when needed and whether the building has sufficient space for its occupants. In this regard it is necessary to address for thermal comfort, visual comfort and air quality etc. and their role in IEQ improvement.

Thermal Comfort

Thermal comfort in environment is important because discomfort in thermal conditions are potentially life-threatening for humans if the core body temperature reaches conditions of hyperthermia (> 37.5–38.3 °C or 99.5–100.9 °F) or hypothermia (< 35.0 °C or 95.0 °F). Buildings modify the conditions of the external environment and reduce the effort that our body needs to do in order to stay stable at a normal human body temperature, important for the correct functioning of our physiological processes.

Six primary factors that directly affect thermal comfort are defined as

- Metabolic rate
- Clothing insulation
- Air temperature
- Mean radiant temperature
- Air speed
- Relative humidity

Visual Comfort

Visual comfort is usually defined through a set of criteria based on the level of light in a room, the balance of contrasts, the colour 'temperature' and the absence or presence of glare.

Visual comfortis a reaction to the quantity and quality of light within any given space at a given time. It depends on our ability to control the light levels around us. Inadequate as well excessive light can cause visual discomfort. Changes in light level or sharp contrast can cause stress and fatigue due to human eye permanent adaption to light levels. It can vary depending on the following factors:

- Time of exposition
- Type of light
- Color of the eyes/ age of the person

Working in a window-less office, even under adequate light conditions, and working in an office with a view, are totally different experiences. Abundant scientific studies show positive impacts of the latter on mood and job satisfaction. A well-designed lighting system must provide adequate illuminationto ensure safety and enable movement, contribute to visual comfort and facilitate visual performance and color perception. Monitored parameters include quantitative physical measures of the luminous environment (illuminance, luminance, daylight provision and glare) and qualitative aspects of vision(distribution, uniformity, color rendering, the spectral composition of radiation).

Air Quality

Indoor Air Quality (IAQ) directly affect over occupant health, comfort, and productivity significantly. Serious health impacts resulting from poor IAQ include Legionnaires' disease, lung cancer from radon exposure, and carbon monoxide poisoning. More widespread health impacts include increased allergy and asthma from exposure to indoor pollutants (particularly those as associated with building dampness and mold), colds and other infectious diseases that are transmitted through the air and "sick building syndrome" symptoms due to elevated indoor pollutant levels as well as other indoor environmental conditions. The two fundamental connections include the impact of ventilation on indoor pollutant levels and the impact on heating and cooling energy (sensible and latent). Given equation expresses the relationship between the outdoor air ventilation rate Q and the indoor pollutant concentration Cin for a single zone under steady-state conditions

$$C_{in} = C_{out} + \frac{S}{Q} - \frac{R_{fac}}{Q}$$

where Cout is the outdoor pollutant concentration, S is the indoor contaminant source strength, and Rfac is the rate at which the contaminant is removed by filtration or air cleaning.
This relationship shows that as the ventilation rate increases, the indoor concentration decreases (assuming S>Rfac).
The amount of energy E required to heat (or cool) and move the ventilation air is expressed as

$$E = \rho C_p Q \Delta T + \rho C_l Q W + E_{fan} - E_{hr}$$

where p is the air density, Cp is the specific heat of air, Cl is the air latent heat factor, ΔT is the temperature difference between indoor and outdoor air, W is humidity ratio difference. Efan accounts for the energy associated with equipment used to move the ventilation air (e.g., fans), and Ehr is the energy recovered by heat recovery equipment.

Equation shows that as the ventilation rate increases, the energy required to heat (cool) the outdoor air also increases, but it also implies flexibility in how the air is delivered and through the use of heat recovery.

Built environment and energy efficiency

Thermal comfort, indoor air quality and visual comfort have to be taken into consideration while designing an energy efficient and healthy building environment, as the overall goal is not just the deployment of such environments but also their overall acceptance by their occupants. The objective of developing low energy consuming or low carbon buildings is to increase the sustainability of the built environment while ensuring the long-term well-being of occupants.However, for an existing it is challenging to modify and redesign a building to meet thermal comfort, visual comfort and indoor air quality for low energy consumption. The field case studyfindings for energy use implications and adaptive models are discussed to develop clear depiction. There have been a number of studies investigating the energy use implications in the built environment. In this paper, we are briefly discussing measures focusing on performance assessment and approaches to improveenergy efficiency of HVAC system in facility.

a. Sustainability of the Built Environment

Sustainable planning for a commercial building derived from thermal modeling of a particular site and the built environment. Several factors taken into account; sunlight path analysis, orientation of building, climatic conditions. The building shape and orientation are optimised reduce the heat tominimise the delta temperature outside and inside of the building thereby minimizing overall HVAC requirement. In a new building, planned and designed external cladding, insulation and glazing minimizes heat gain/ loss, increase natural ventilation and day light saving in and around the building.

To stop solar heat gain from roof, reflective coating material or installing light-colored roofing materials capable of absorbing, and not transferring, solar radiation should be provide. No other data available. The energy performance of chiller systems depends on the heat rejection medium, ambient conditions, compressor efficiency and the load carried by each operating chiller. Instead of operating chillers at the same part load ratio, it is recommended to properly accounting for their part load performance characteristics, which maximize the entire system performance.

In an existing building, modifying and improving the chilled water lines, replacing the single glazed glasses with double glazed glass, improving the thermal insulation, is complicated and challenging. It is always advised to consider building envelope design, materials, thermalconfort with overall energy consumption during the construction phase of the building.

The behavioural change for setting higher indoor temperatures in summer-time lead to less prevalence of cooling systems. In situations/locations where air conditioning is unavoidable, a wider range of indoor thermal environment would mean less cooling requirements and hence less electricity consumption for the air conditioning systems.

b. Energy Efficiency of Built Environment

Maximum energy is consumed by HVAC systems and other chillering units. Some of the reasons for high power consumption and low efficiency are: Operating at low set temperature, Wrong selection of system (oversize or undersize equipment), manual control of system, aged system and poor maintenance, choked filters. The poor insulation of the chilled water tank leads to heat gain in summer and more loads on chiller. With proper insulation, the heat gain from the storage tank can be reduced up to 2- 5% based upon the ambient conditons.

Energy Conservation Act 2001 support the uptake of energy conservation practices for equipments and appliances announced under energy conservation building code, the adoption of energy efficient appliances and technologies and several rating system in India. The changeover to energy efficient appliances leads to lower energy consumption (reduction of up to 23% in households) and lower instantaneous electric demand.

c. Energy Efficiency and Recent Developments

Advanced IEQ control systems use learning-based methods, Rule-Based Control (RBC),Model based Predictive Control (MPC) and agent-based control systems. The application of Artificial Intelligence (AI) techniques and smart metering systems create intelligent buildings to improve energy efficiency, comfort, health and productivity of occupant in facility units. Recent domains of AI that are widely used in buildings are Computational Intelligence (CI) or soft computing and Distributed Artificial Intelligence (DAI). Selection of building climate control strategy is highly dependent on the available computational capacity. Appliances equipped with motion sensors or connected to an automatic centralized control system based on occupancy or utilization, bring higher reduction than conventional appliances and can result in a 10% reduction in energy consumption compared to appliances without any power control systemor equipped with a standby mode.

Buildings equipped with recent lighting system like LEDsthrough out in their campus can lead to optimized use of lighting however, in the less occupied spaces there is a need of motion sensors. Buildings with centralized chiller plants may be provided with thermal storage facility for chilled water in the basements or in underground holes. Most of the commercial complexes require the HVAC system during day time so the buildings with thermal storage can operate their chiller plants during nonpeak hours and store the chilled water and same could be utilized during day time.

Sensors are used to collect data on environmental conditions to manage and operate a facility. These are distributed through the monitored spaces to collect relevant data. Wireless Sensor Networks (WSNs) are a promising technology that will upgrade the data collection and convenient to monitor. The sensors are coupled with actuators which are responsible for the system operation (blinds, lightings and heaters). Indoor environmental climate controls can be linked to immediate occupancy information.

Discussion and conclusions

We have defined the factors that limit the interactions between occupants, IEQ and building design. It is crucial to respect the interdependencies in a human-built environment system for a successful design of healthy, energy efficient and comfortable indoor environment.

Energy consumption, conservation, and the impact of climate change are the upcoming challenges for the future IEQ research. The flexibility and adaptability on smart energy saving measures can be achieved through better built design during construction stage, automated building parameter control, behavioural change and tangible energy conservation measures.

However, substantial uncertainties still exist in operation and maintenance, usage and monitoring. There is a need to create a structure enabling continuous training and awareness in the field of building technology and operation for users. The future building environment will be highly automated, based on artificial intelligence and prediction methods. It is believed that highlighted points in this paper will be relevant, especially concerning the emergingmarketswhen it comes to building automatization and that they will contribute to more human-centric and environmentally-conscious building initiatives.

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BEST PRACTICES TOWARDS ENERGY EFFICIENCY

By N Srinivasa Rao, Joint President (works), R V Krishna Kumar, General Manager (process) & M Veera Babu, Assistant Manager (process)
My Home Industries Private limited, Mellacheruvu Cement Works

Introduction

The cement industry and its clinker production is under continuous pressure of fuel cost reduction and reduction of CO2 emission. India, being the second largest cement producer in the world uses coal as primary fuel for production of clinker. Cement plant having captive power plant for operational electricity requirement also use coal as primary fuel for power generation. Cost of energy in cement production shares above 50% of the cost of production. The finite nature of global fossil fuel resources, high prices and most importantly, their damaging effect on the environment underscore the need to develop alternative sources for many industrial systems that rely on fossil fuels.

My Home Group - Significant Player in Cement Production

My Home Industries Private Limited (MHIPL- MCW) is operating Cement manufacturing unit from 1998 located at Mellacheruvu Village & Mandal in Suryapeta district of Telangana State. Under the leadership of Dr. J Rameshwar Rao - Chairman, MHIPL reputation grown as organization that stands for the best Quality, Energy efficiency, Environment, Health & Safety Systems with reliability.

MHIPL currently has two integrated cement plants located at Mellacheruvu in Suryapeta district, Telangana and at Yanakandla Village in Kurnool District, Andhra Pradesh and one grinding unit at Mulakalapalli village in Visakhapatnam District, Andhra Pradesh and one grinding unit at Tuticorin, Tamilnadu. The combined capacity of the three plants is 10 million tons per annum.

MCW - Mellacheruvu Cement Works operations are Environment / Eco friendly, Energy Efficient Unit & Best in Safe Practices and meet the most efficient production parameters in the world.

MCW manufacture the cement product range - OPC 43 & 53 grade, PPC, PPC HD+ and marketing in India and abroad under the brand name of "MAHA CEMENT" through a wide network of over 2000 dealers spread across South India, Eastern India and Maharashtra. Since last couple of years MCW is exporting its clinker and cement to Bangladesh.

MCW is having three cement lines, two captive power plants, an alternative fuel plant and railway siding for wagon handling &Waste Heat Recovery (WHR) Power Plant.

The Three kilns are set-up with state of the art technology from M/s Walchand Industries - India, M/s KHD - Germany and M/s FLSmidth - Denmark, the world's leading suppliers of cement manufacturing equipment.

The Organization has Established, Implemented the Quality , Environment, Occupational Health & Safety Management and Energy management Systems and certified in accordance to the requirements of ISO 9001:2015 , ISO 14001:2015 ,ISO 45001:2018 & ISO 50001:2018, Greenco Gold rating and continuing to comply with the requirements. My Home is also an active member of Cement Sustainability Initiatives (CSI) making its humble contribution towards sustainable business model including Energy Conservation.

The Significant Energy Efficient Projects completed at MCW are

- Cooler optimization by modification of MFR hole size in line-1 FLS Cross bar Cooler to improve the cooler efficiency
- Enlargement of all major process fans inlet box to reduce the power consumption
- Replaced existing kiln burners with Low Nox KHD Pyro jet burners in all three kilns for thermal efficiency improvement

Cooler optimization by modification of MFR hole size in line-1 FLS Cross bar Cooler to improve the cooler efficiency

As indicated Kiln is one of the major sources of thermal energy utilization in cement industry and the energy saving measures in kiln will result in significant thermal energy savings.

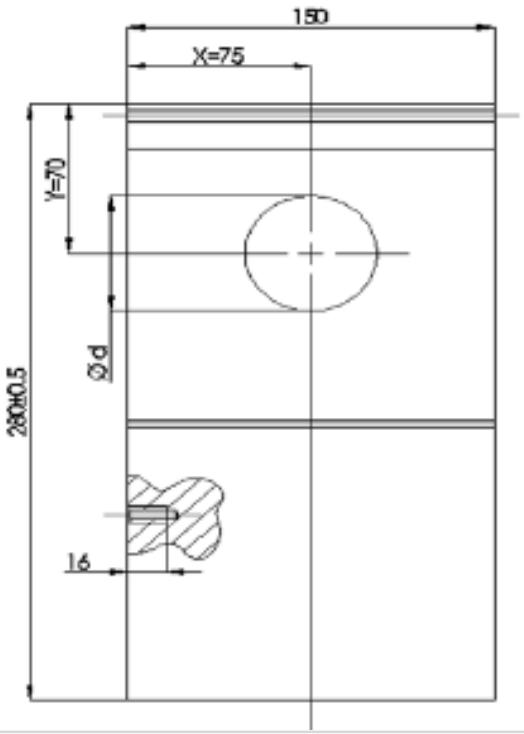
Clinker generated in the kiln has very high temperature of about 1400®C. Effective and appropriate cooling of clinker can be done with the latest generation cooler and the heat released thereof can be used for fuel burning in the kiln and calciner and preheating of raw materials.

Cooler efficiency places major role in cement plant to reduce thermal and power consumption. At MCW, the Cooler efficiency of unit-1 is about 66 %. During the measurements carried out at the Cooler , it was observed that the cooler discharge temperature is high at 180 Deg C. The high temperature was attributed to the low cooler efficiency.

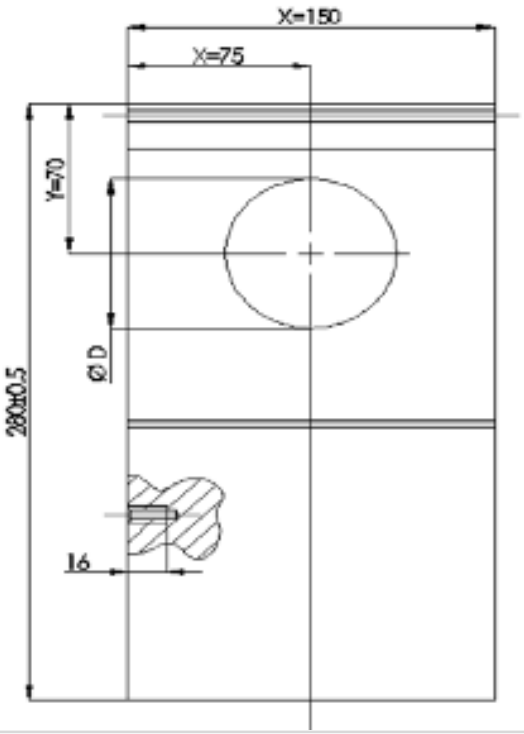
An energy saving proposal was made by in-house energy team to increase the Cooler MFR hole size and to increase the cooler efficiency .Based on the suggestion and the proposal the cooler MFR hole size were modified.

MFR Modification Schematic

MFR Before modification



MFR After modification



MFR size	DWG no	Dim X (mm)	Dim Y (mm)	Actual hole size d (mm)	New hole size D (mm)
40404	13016443	75	70	NO HOLE	Ø34
50504	13016444	75	70	Ø15	Ø42
60604	13016445	75	70	Ø22	Ø51
70704	13016446	75	70	Ø25	Ø46
80804	13016447	75	70	Ø33	Ø56
90904	13016448	75	70	Ø39	Ø60
1001004	13016439	75	70	Ø54	Ø70

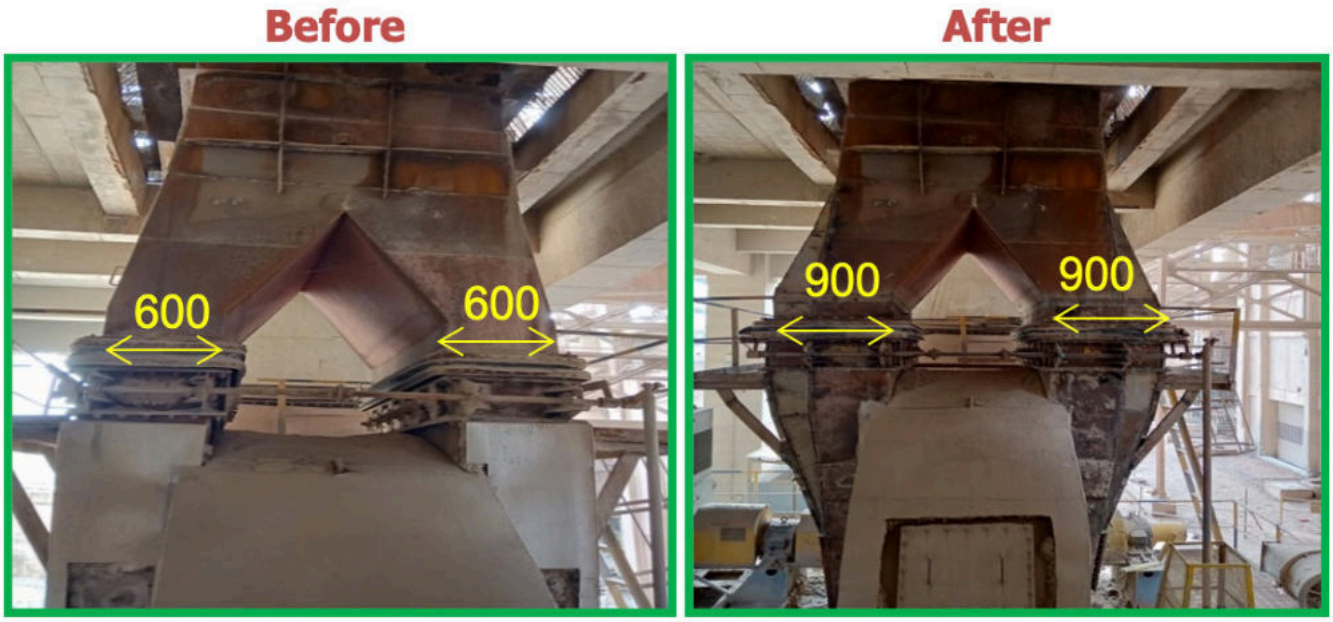
Benefits achieved

As a result of the interventions, annual cost saving of INR 70 Lakhs including 54 Lakhs from thermal energy savings (8 kcal / kg clinker reduction) and 16 Lakhs from electrical energy savings (0.52 Kwh / MT Clinker) was achieved in this cooler MFR hole size modification.

Description	Before	After
Recuperation Efficiency %	66.0	68.3
Cooler losses kcal/kg clinker	135	127
Clinker temperature °C	180	145
Cooling air, Nm3/ kg Clinker	1.70	1.87
Specific Energy consumption SEC, kcal / kg clinker	744	736

Enlargement of all major process fans inlet box to reduce the power consumption

Process fans are one of the major energy consumers in cement plant. At MCW, the power consumption of unit-1 preheater fan is about 9.8 kWh/ton. During the measurements carried out at the preheater fan, it was observed that the preheater fan inlet box velocity was about 30.38 m/s. The high velocity was attributed to the high pressure drop across the inlet box and the damper. An energy saving proposal was made by in-house energy team to increase the inlet box area and to reduce the pressure drop to the extent of about 25 to 30 mmwc. Based on the suggestion and the proposal the preheater fan inlet box and the damper were modified and achieved 21 kW/hr power reductions. After achieving the power reduction, we have implemented the similar modification in four other major fans.



As a result of the interventions, annual saving of INR 42 Lakhs from electrical energy savings (0.30 kWh / MT Clinker) and (0.1 kWh/MT Cement) was achieved in this fan inlet box modification.

Description	Units	PH fan-1	VRM-1	PH fan-2	PH fan-3	CM-2CA fan
Fan inlet pressure drop reduction	mmwg	25	15	40	30	14
Fan power reduction	kW/hr	21	8	45	40	10
Annual savings	Rs Lakhs/Annum	7.48	2.37	16.03	14.25	2.25
Investment	Rs Lakhs	1.0	0.9	1.0	1.1	0.8

Replaced existing kiln burners with Low NOx KHD Pyro jet burners in all three kilns for thermal efficiency improvement

Earlier kiln-2 coal firing burner was M/S FLS Duoflex burner where the % of primary air consumption was 12% .

Compared with Duoflex burners, the main changes with the Low NOx Pyro jet burners is the jet air nozzles design.

As per jet air nozzle design, no chance of flame divergence is there and maintaining high tip velocity with low primary air helps in increase of secondary air flow to the kiln. This ensures that the thermal efficiency of the kiln is improved.

After achieving the thermal reduction, we have implemented the similar modification in all three kilns.

Low NOx KHD Pyro jet burner

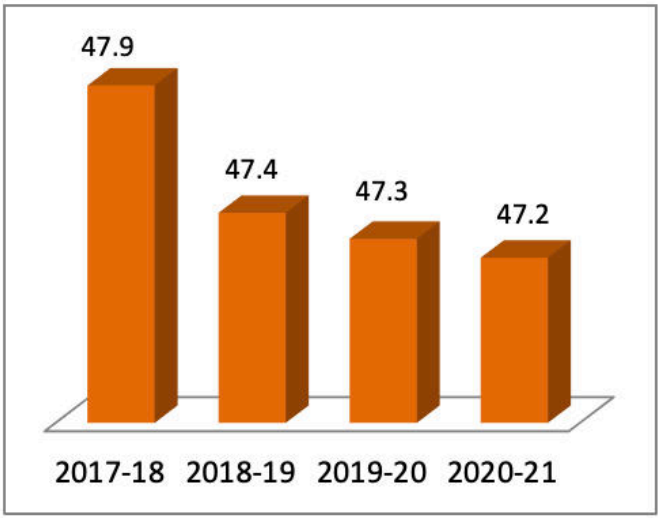
Benefits achieved

As a result of the interventions, total annual cost saving of INR 135 Lakhs including 120 Lakhs from thermal energy savings (5 kcal / kg clinker reduction) and 15 Lakhs from electrical energy savings (0.11 Kwh / MT Clinker) was achieved in this kiln burner replacement.

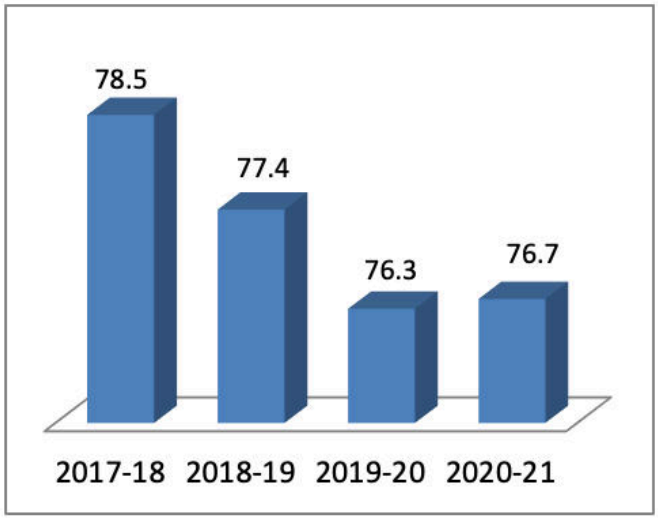
Description	UOM	Kin-1	Kiln-2	Kiln-3
% of Primary air Reduction	%	6	6	4
Power Reduced	%	20	10	10
Kiln Sp. heat Reduction	Kcal/kg clinker	5	5	3
Annual savings	Lakh/Annum	40.9	55.9	38.6
Investment	Lakh	1.2	1.2	1.4

Energy performance

Specific Power comsumption
(KWh/Ton of Clinker)



Specific Power comsumption
(KWh/Ton of Cement)



Conclusion

Cement Industry being a power intensive industry, one has to think in terms of energy optimization and implement the latest technologies, those contribute significantly, to the electrical/thermal energy saving.

The reduction in power consumption reflects the CO_2 reduction which makes it environmental & eco friendly.

CASE STUDY: ENERGY MANAGEMENT SYSTEM (EMS)

By Sachin Gupta (Head E&I)
JK White Cement Works, Gotan

About Plant

JK White Cement Works, Gotan is the first White Cement manufacturing factory in India which manufactured White Cement through dry process technology. The Gotan plant was commissioned in 1984 with an initial production capacity of 50,000 TPA. It uses technical expertise from FLSmidth & Co. of Denmark with their State-of-the-art technology of continuous on-line quality monitoring and control by X-Ray Analyser and PLC Systems, ensuring manufacturing of purest white cement. Over the years, continuous process improvements and modifications have increased the plant's production capacity to 6,10,000 tons per annum.

Presently, the plant is operating at lowest energy levels since its inception.

Introduction

Energy is an essential component in supporting of people's daily lives and a significant economical element in development of country. For a nation to progress economically, the industrial sector has to be constantly encouraged and developed, but as the number of industrial units and industrial sectors increase, energy demand and consumption also increases.
The industrial sector is the largest consumer of all the electrical energy that is commercially generated for utilization, and process industries like fertilizer, cement, sugar, textile, aluminium, paper, etc. are extremely energy intensive in nature. To reduce the increasing demand-supply gap, either more industrial energy has to be generated or the existing consumption of energy has to be brought down without any compromise on either product quality or quantity. Along with population upsurge, economic growth and living standards improvement, the demand and consumption of various energy resources is increasing worldwide. Therefore, many companies, especially energy intensive, are trying to identify the most effective measures to improve energy management in manufacturing processes and to integrate new energy management systems in production management and as a result to improve overall economic efficiency.
Energy management system has become an important issue when many utilities around the world find it very difficult to meet energy demands which have led to load shedding and power quality problems. An efficient energy management in residential, commercial and industrial sector can reduce the energy requirements and thus lead to savings in the cost of energy consumed which also has positive impact on environment.

Team of Innovators

We are thankful to our management for investing and showing faith in our E&I team for the project and also thankful to our team for their commitment and continuous efforts.

1. Shri S K Jain (Unit Head)
2. Shri Anil Gupta (Technical Head)
3. Shri Sachin Gupta (Head- E&I)
4. Shri Virendra Singh Rathore (Head-Planning)
5. Mr Rahul Dwivedi
6. Mr Ramraj Beda
7. Mr SL Suthar
8. Mr Anshu Sharma
9. Mr Deepak Khabya
10. Mr Sahdev Singh Rathore
11. Mr Rahul Gupta
12. Mr Keshav Sharma

Energy Management System- need of the hour

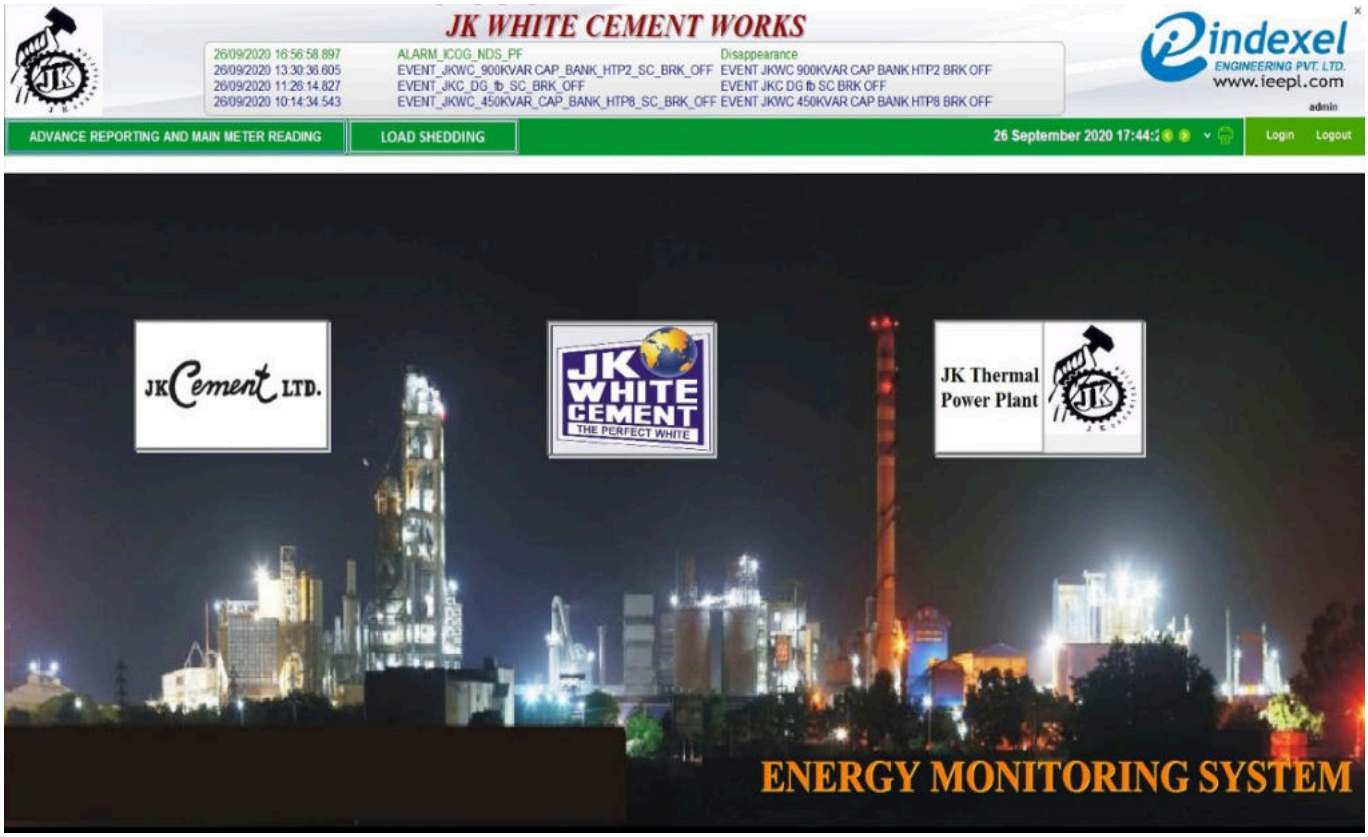


Figure 1: EMS System main screen

5W & 1H analysis

What - Energy Management System

Why - When we plan to implement or install a new system, the very first question asked by the management is why it is needed and for our plant it was the need of the hour. We didn't have any system to monitor the data of our all three locations of Gotan -JK White, JK Cement (Grey) and Thermal Power Plant. Even the daily power consumption reports were prepared manually by taking readings of meters. This results in engagement of manpower, inaccurate and not very précised data and there was no means of analysing critical equipment's power on daily, hourly or monthly basis.

Where- All our 3 plants in Gotan i.e. JK White, JK cement(Grey), Thermal power plant

When - 2018-19

Who - E & I Team

How - Implementation plan

Implementation plan

SR. NO.	ACTION PLAN	JAN-18	FEB-18	APRIL-18	MAY-18	JUNE-18	JULY-18
1	Identification of requirement						
2	Approval from management & third party qoutation finalisation						
3	Procurement, inspection & testing of system						
4	Rs-485 communication of meters & di-do wiring						
5	Meter configuration in scada & load shedding programming						
6	Testing of load shedding system, reports						
7	Checking all meters parameters such as trends, values, alarms						

Technical Details

Software - SCADA- PSE 8.2
Mode of Communication- RS485 & Ethernet
Devices used for communication- Ethernet Switch- EGX 100, Media Convertor
Types of Meters configured- PM500, PM820, PM5330, EM6400NG, EM6436, ION 7650

Project Details

Meter Communication

All the meters whose consumption was to be monitored and captured were Connected through Modbus communication. Energy meters away from server More than 100meters, were connected through 6 Nos. of I/O panels(JKWC,TPP, JKC) which were connected to server through Optical Fibre cable. Total No. of meters communicated – 267Nos

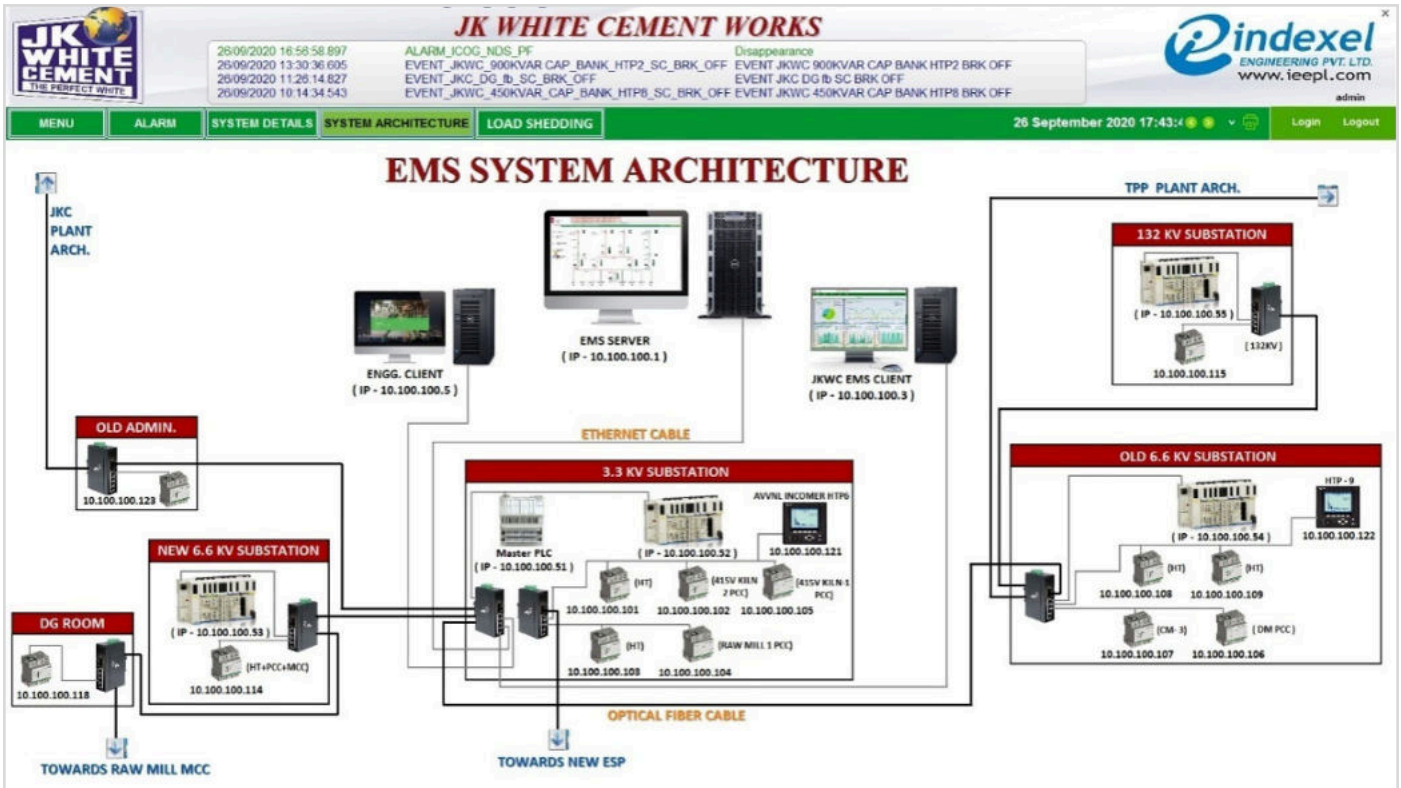
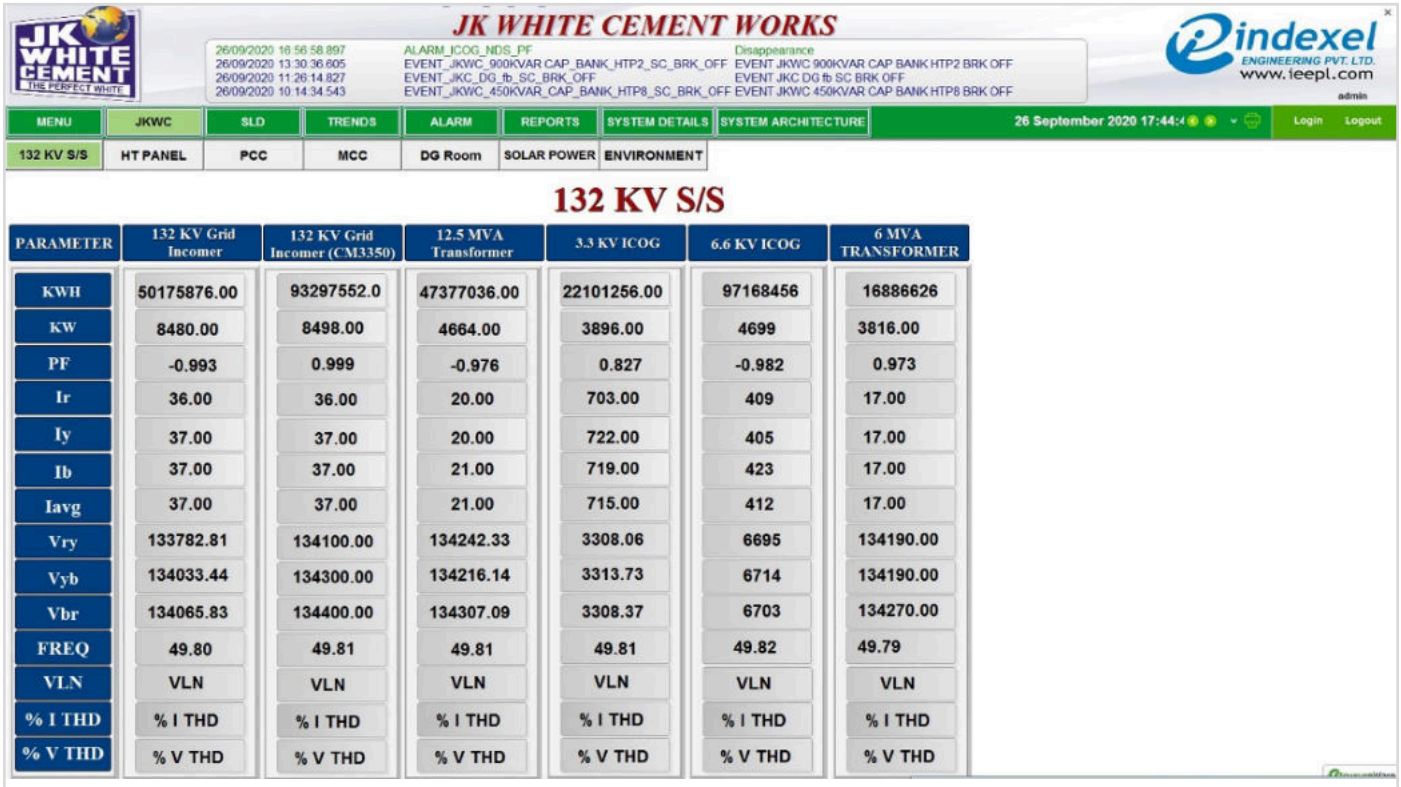


Figure 2: EMS Architecture

Tags/ Parameters

For each of the meters there were 24 parameters configured which are displayed in graphics of EMS such as Frequency, Voltage, KW, KVA, Current, Ith, Vth, PF etc. as shown in fig.



PARAMETER	132 KV Grid Incomer	132 KV Grid Incomer (CM3350)	12.5 MVA Transformer	3.3 KV ICOG	6.6 KV ICOG	6 MVA TRANSFORMER
KWH	50175876.00	93297552.0	47377036.00	22101256.00	97168456	16886626
KW	8480.00	8498.00	4664.00	3896.00	4699	3816.00
PF	-0.993	0.999	-0.976	0.827	-0.982	0.973
Ir	36.00	36.00	20.00	703.00	409	17.00
Iy	37.00	37.00	20.00	722.00	405	17.00
Ib	37.00	37.00	21.00	719.00	423	17.00
Iavg	37.00	37.00	21.00	715.00	412	17.00
Vry	133782.81	134100.00	134242.33	3308.06	6695	134190.00
Vyb	134033.44	134300.00	134216.14	3313.73	6714	134190.00
Vbr	134065.83	134400.00	134307.09	3308.37	6703	134270.00
FREQ	49.80	49.81	49.81	49.81	49.82	49.79
VLN	VLN	VLN	VLN	VLN	VLN	VLN
% I THD	% I THD	% I THD	% I THD	% I THD	% I THD	% I THD
% V THD	% V THD	% V THD	% V THD	% V THD	% V THD	% V THD

Figure 3: EMS graphics

Configuration of Advance Reporting System

For analysis of various parameters, Sag/Swell, transients in case of any Fluctuation of grid voltage because of any reason Advance reporting system Was configured which enables us to analyse the data and fetch trends accurately and precisely.

Auto generation of reports

EMS apart from monitoring data also provides us auto generated reports. Through EMS we configured various reports such as Daily power consumption report, Environment report, solar generation report, Hourly kW data, detailed report through which consumption of any meter can be generated for a given time interval.

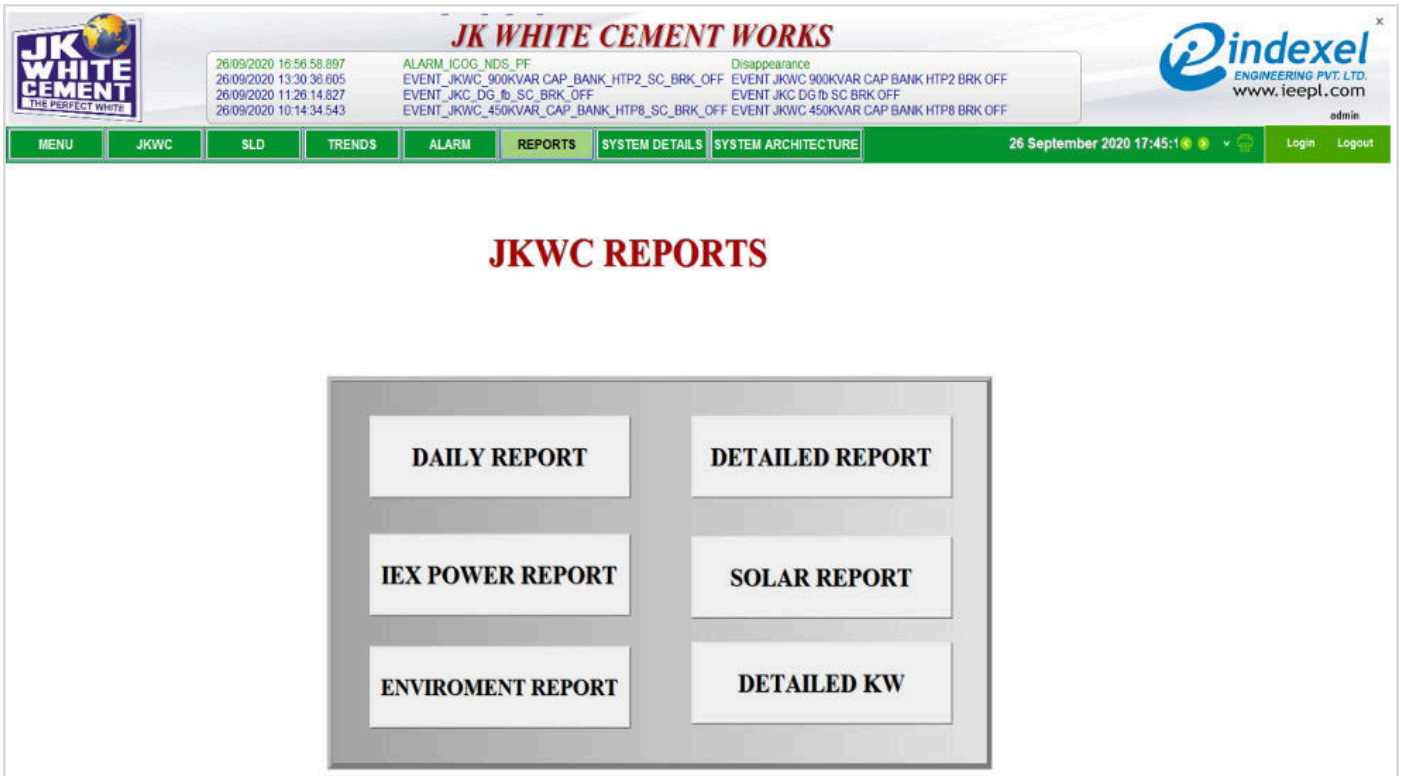


Figure 4: EMS system – Reports page

Alarms, Events and Trends configuration

For each parameter trends were configured for real time analysis of any Parameter. Trends of all the parameters are available by clicking on the value Displayed.
Also, various alarms were configured.

- For Power Factor less than 0.95 of 132KV I/C CM3350 with a time delay of 5minutes.
- For NDS ICOG & DS ICOG MDI cross i.e. 675KVA
- For Power Factor of DS & NDS less than 0.95 with time delay of 5 minutes
- In case of underdrawal i.e. Load (KW) on 132KV I/C is less than Bidding Approved X 0.06(losses).
- In case of any breaker gets switched off because of load shedding then a Pop Up will generate.
- In Case MDI crosses as per bidding sheet.
- In case of DS & NDS voltage less than 3135V & greater than 3465V.

Figure 5: EMS System- Real time trend of energy parameters

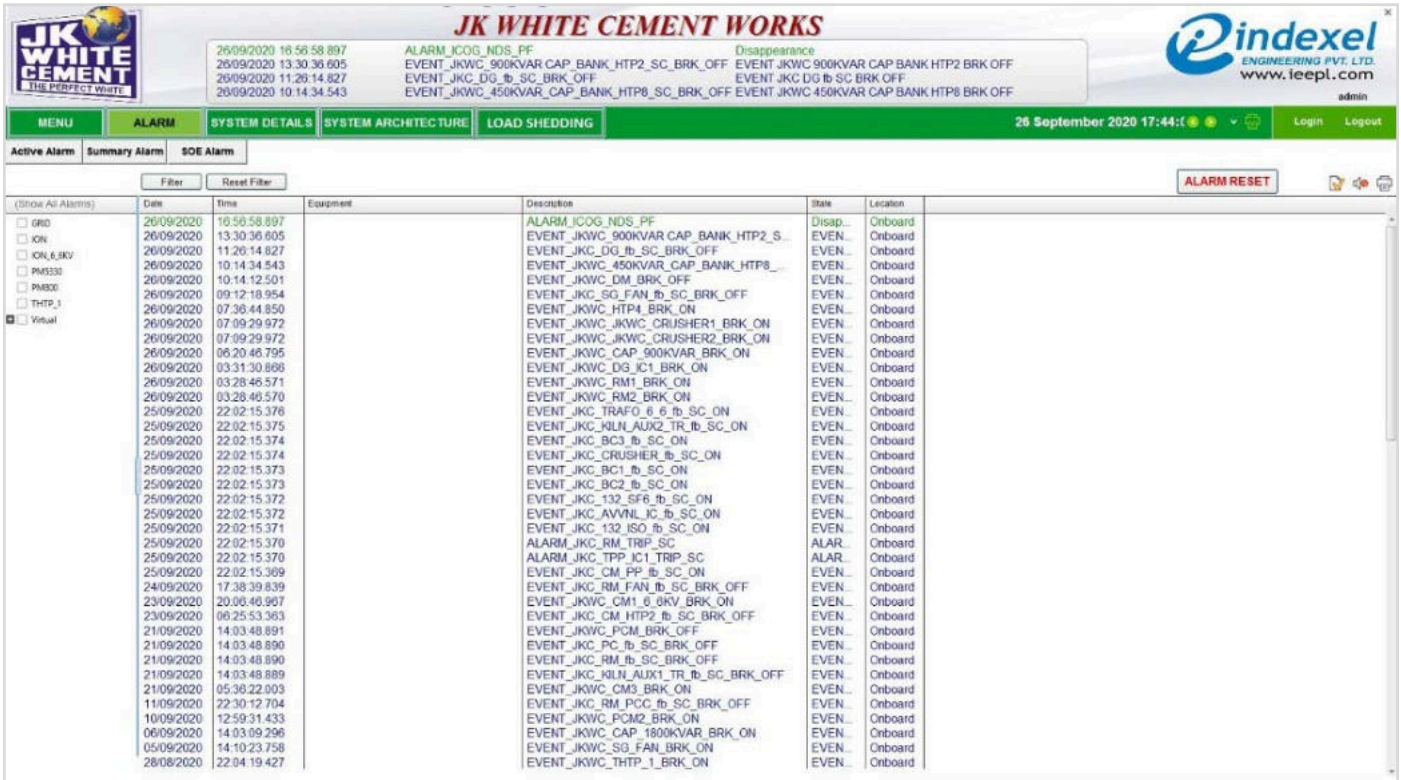


Figure 6: Events & Alarms

Load Shedding: An Innovative Approach

Load shedding was an important aspect of the project and this led to innovative idea through which we enabled the system to shed load automatically and give pop up and alarms. There are total 3 no. of power sources through which our plant takes the load.

- TPP
- AVVNL
- IEX Open Access power

We made logics through programming in PLC considering different conditions.
Also, we made a separate SLD named as load shedding SLD to monitor the critical loads and power sources.

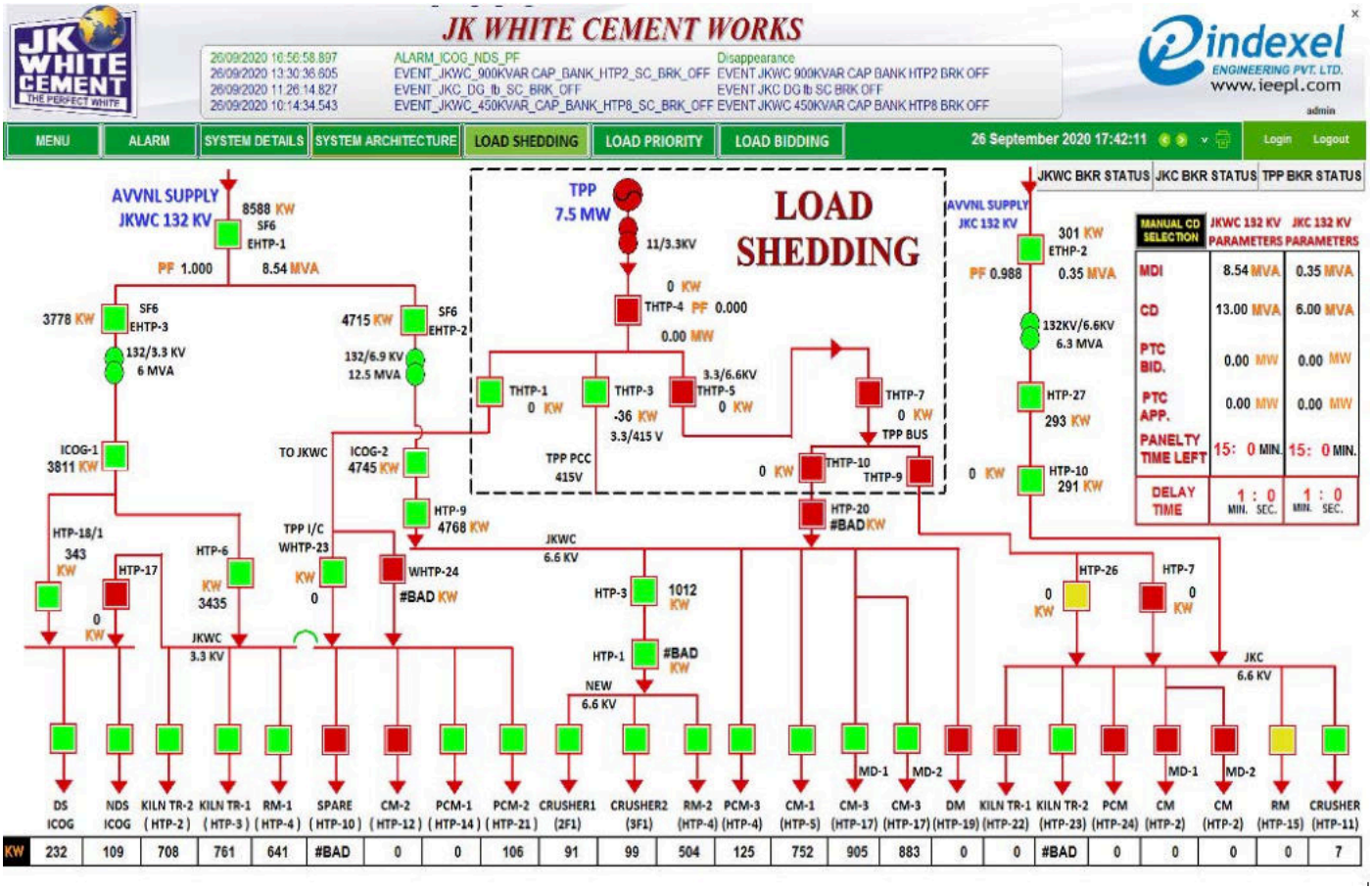


Figure 7: Load Shedding SLD

Power trading is done for 96 nos. of 15min blocks for the whole day and is done one day advance. As per regulations by IEX and Electricity Board when we trade for an amount of power then our MDI reduces in case we don't get power in a particular block. In case MDI is crossed at any instance then the user is penalised heavily. Till now this was taken care manually by an engineer.
Now for us the challenge was to develop a system which would automatically monitor the load and also shed the load accordingly.

For this we developed a program in PLC which works as given below

- A day before bidding schedule and approved power is uploaded by the engineer in system through excel sheet by a single click.

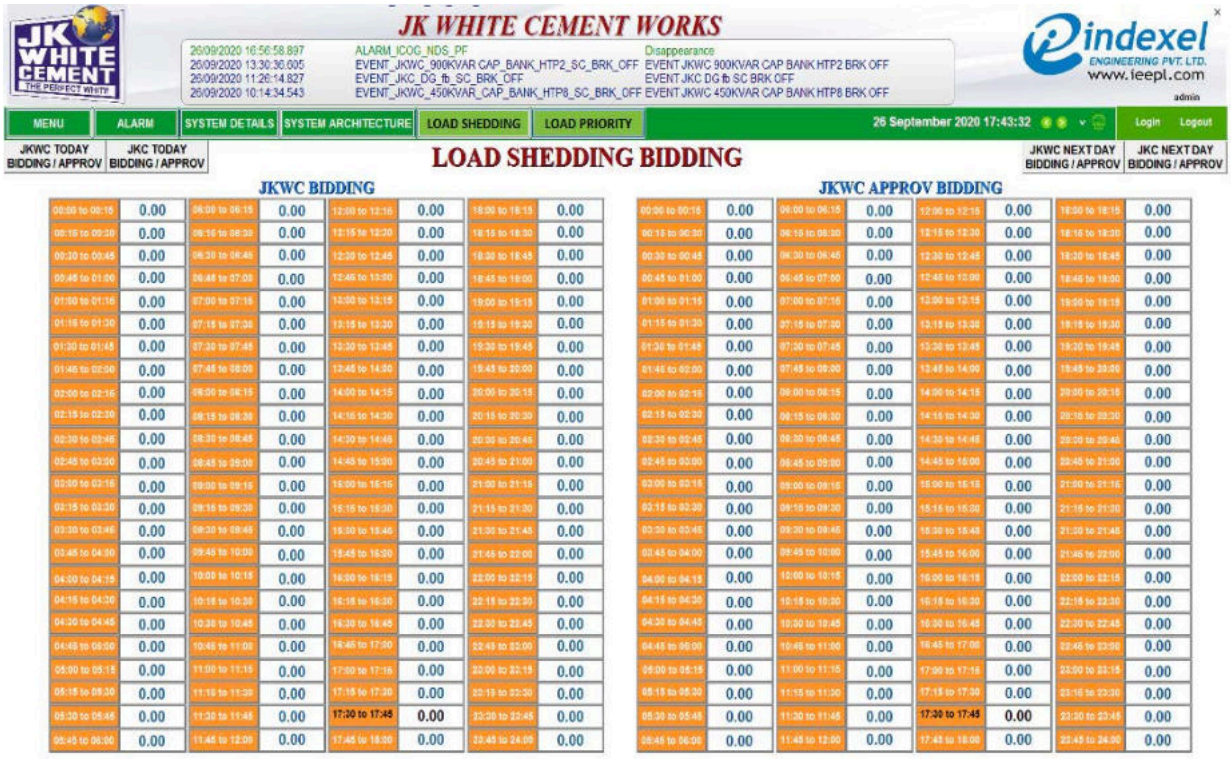


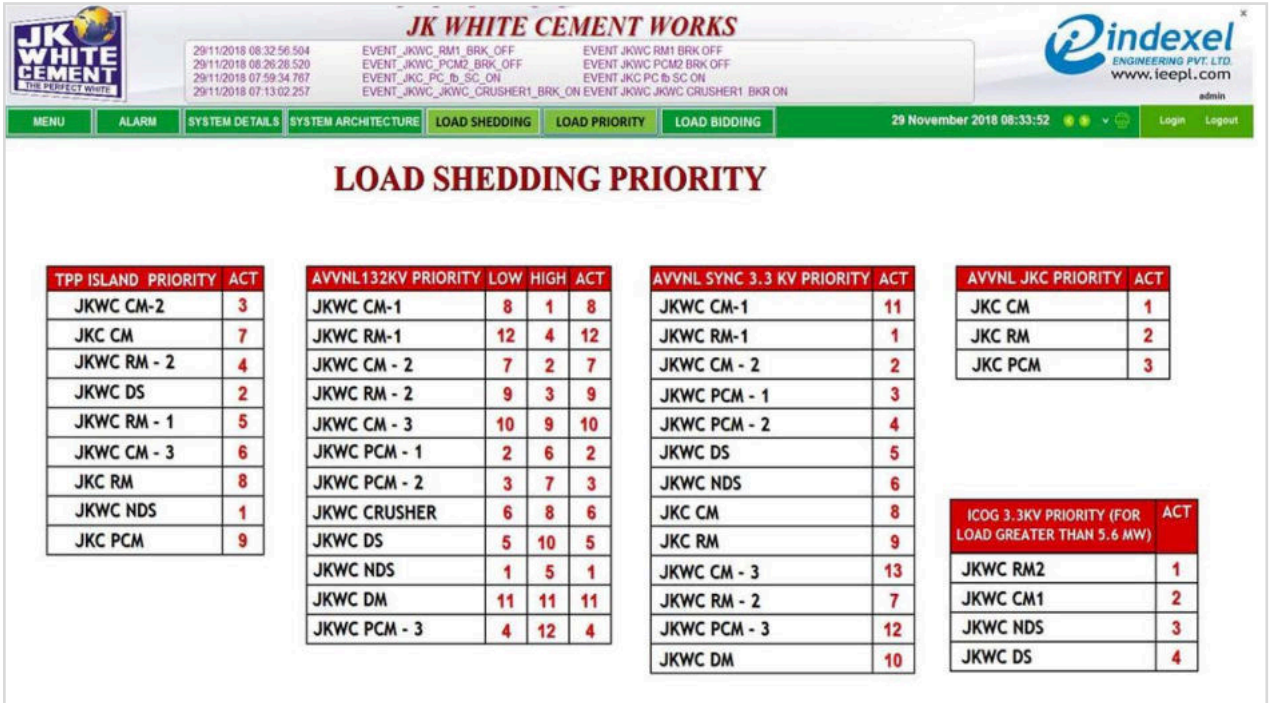
Figure 8: Bidding Schedule Uploading sheet

- System automatically fetches that schedule at 12 midnight and load shedding is done accordingly.
- In which case load shedding will take place

A. For AVVNL & TPP Sync and only AVVNL:If the MDI exceeds the permissible limit it will first generate an alarm and pop up and then if load is not managed manually within 10min then it will start to trip the load as per the priority decided by the user. Priority can be changed according to production requirement

B. For TPP Islanding Mode: In case the system is running on thermal power plant load only then it will cut the load if load on thermal power plant exceeds the capacity of the plant. Priorities have been given for subsequent tripping or shedding of Load.

C. For 6MVA Power Transformer: At the time of shutdown to save our power transformer getting overloaded logic was made, in case load exceeds its rated capacity it will automatically shed the load.



TPP ISLAND PRIORITY	ACT
JKWC CM-2	3
JKC CM	7
JKWC RM - 2	4
JKWC DS	2
JKWC RM - 1	5
JKWC CM - 3	6
JKC RM	8
JKWC NDS	1
JKC PCM	9

AVVNL132KV PRIORITY	LOW	HIGH	ACT
JKWC CM-1	8	1	8
JKWC RM-1	12	4	12
JKWC CM - 2	7	2	7
JKWC RM - 2	9	3	9
JKWC CM - 3	10	9	10
JKWC PCM - 1	2	6	2
JKWC PCM - 2	3	7	3
JKWC CRUSHER	6	8	6
JKWC DS	5	10	5
JKWC NDS	1	5	1
JKWC DM	11	11	11
JKWC PCM - 3	4	12	4

AVVNL SYNC 3.3 KV PRIORITY	ACT
JKWC CM-1	11
JKWC RM-1	1
JKWC CM - 2	2
JKWC PCM - 1	3
JKWC PCM - 2	4
JKWC DS	5
JKWC NDS	6
JKC CM	8
JKC RM	9
JKWC CM - 3	13
JKWC RM - 2	7
JKWC PCM - 3	12
JKWC DM	10

AVVNL JKC PRIORITY	ACT
JKC CM	1
JKC RM	2
JKC PCM	3

ICOG 3.3KV PRIORITY (FOR LOAD GREATER THAN 5.6 MW)	ACT
JKWC RM2	1
JKWC CM1	2
JKWC NDS	3
JKWC DS	4

Figure 9: Load Shedding Priority Screen

Benefits

Energy management is the process of monitoring, controlling, and conserving energy in a building or organization. Typically, this involves the following benefits

- Metering our energy consumption and collecting the data.
- Finding opportunities to save energy, and estimating how much energy each opportunity could save. Generally, we would typically analyse our meter data to find and quantify routine energy loss, and also investigate the energy savings that could be made by replacing equipment (e.g. lighting).
- Taking action to target the opportunities to save energy (i.e. tackling the routine waste and replacing or upgrading the inefficient equipment).
- Tracking our progress by analysing our meter data to see how well our energy-saving efforts have worked.
- Energy management is the means to control and reduce organization's energy consumption and this is important because it enables to reduce costs – this is becoming increasingly important as energy costs rise.
- Reduce carbon emissions and the environmental damage that they cause as well as the cost-related implications of carbon taxes and the like, organization may be keen to reduce its carbon footprint to promote a green, sustainable image.
- Reduce our dependence on the fossil fuels that are becoming increasingly limited in supply.
- Reduce risk – the more energy you consume, the greater the risk that energy price increases or supply shortages could seriously affect your profitability.

Achievements, Continuous Updating and Innovations

Monitoring of Power factor

Power Factor monitoring through our EMS system is giving us benefits such as maintaining power factor of our system near to unity and rebate in electricity bill every month. Below are the recent month wise achievements for JK White Cement Works, Gotan.

Month	Feb-21	Jan-21	Dec-20	Nov-20	Oct-20	Sep-20
P.F	0.998	0.998	0.999	0.999	0.998	0.999
cost saving (Lac)	10.4	12.06	16.03	16.08	15.04	14.77

Maintaining our Contract Demand and load on grid in case of Open Access Power Supply

Better monitoring of grid load helps us in maintaining our contract demand and protects our system from exceeding contract demand and from huge penalty by electricity board.

Minimising transmission and Distribution Losses

EMS is a platform which enables us to analyse our T & D losses and provides us all the parameters on our system to rectify issues and monitor our system.

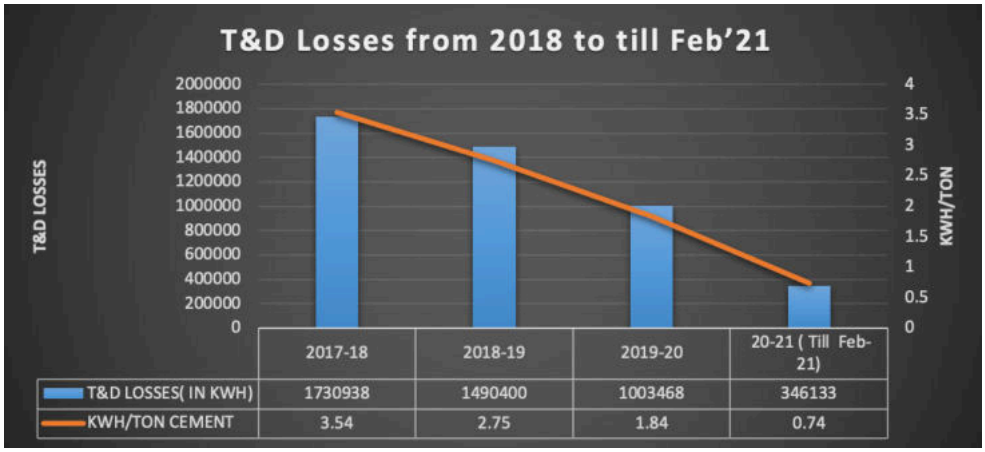


Figure 10: Reduction in T&D losses

Capacitor Bank On/Off from remote through EMS

For better safety and to reduce manual engagements we configured the DI/DO of HT breakers of Capacitor banks of our all three substations and now we enabled our system to switch on and off capacitor banks from remote through EMS.

Alarm for Optimisation of Compressor Power

For optimising the requirement of compressed air in our plant we first analysed the minimum requirement and then configured an alarm and pop up i.e. whenever 5 or more than 5 compressors run it will generate the alarm and popup so that the requirement can be reviewed and power can be optimised.

Conclusion

With increasing energy prices directly impacting the product prices in addition to widening energy demand-supply gap, industries are encouraged to go in for energy saving in addition to use of multiple energy sources. This can be accurately gauged by having an appropriate energy audit. A good and comprehensive energy audit will lead to a list of energy saving options that can be adopted. A detailed discussion on the audit findings leads to an energy management program. Some of the energy saving options requires additional investment. It is also important to remember that introducing renewable energy sources into the process needs additional systems that concerns power quality issues. Energy management system (EMS) enables regular energy data gathering and analysis used as a tool for continuous energy management. An EMS provides sensitive information to manage energy use in all aspects and is therefore an important element of an energy management programme.

All organization should show its commitment to energy management by having a well-defined energy policy. The energy policy should be definitive, straight forward and motivating enough for all employees to contribute towards achieving the organizational goals.. Thus energy management in industrial utilities is the identification and implementation of energy conservation opportunities, making it a technical and management function, thus requiring the involvement of all employees so that energy is utilized with maximum efficiency.

ROLE OF MANUFACTURED SAND IN SUSTAINABILITY ISSUES - I

By Professor Mainak Ghosal, Joint Secretary, Coal Ash Institute of India & Governing Council Member
Indian Association for Structural Engineers

Abstract

The usage of river sand is now being confronted by the artificial end products of stone quarries or construction & demolition wastes. This unique industrial product is named as Artificial sand or Manufactured sand and is superior to our natural river sand as this paper suggests. Not only in physical characterizations they can substitute river sand in cementitious systems like mortar and concrete. Also, common river sand is expensive due their ban by the government but manufactured sand can alleviate the costing issues and can be an economical alternative to natural sand. The problems of waste management can be solved through the use of tail end manufactured sand products in concrete. Durability parameters of manufactured sand are more favorable than natural sand and the former can be used to make durable and sustainable concrete in the long run. Indian standards like IS:383 encourage the use of manufactured sand through latest revisions.

Keywords: Concrete, Manufactured, Products, Sand

Introduction

Sand is an integral part of concrete systems. It constitutes about 30% of the concrete matrix and acts mainly as an inert filler for concrete. Though it has minimum or no role to play in cement hydration process, it mainly transfers the dead/live load of the whole structure to the aggregate part of the cementitious mix. From engineering point of view, sand is also termed or known as Fine Aggregates and can be classified based on the following types

1. Types of Sand Based on Source
2. Classification based on Sieve analysis.
3. Classification based on purpose of use
4. Classification based on grain size.

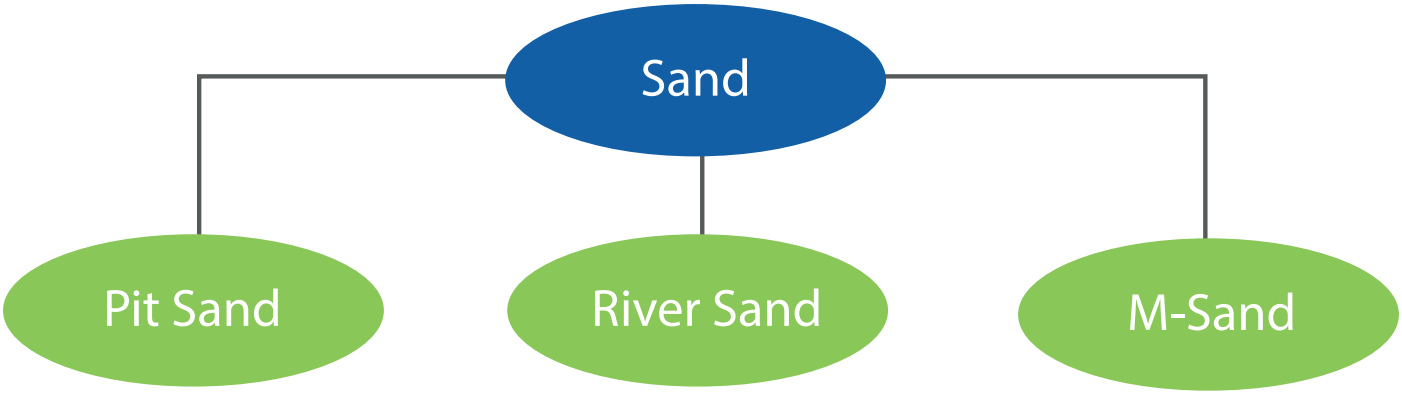


Figure 1: Classification on Types of Sand Based on Source

In classification of sands from source types there are three sub-heads namely - Pit sand, River sand and manufactured sand(M-Sand) respectively as discussed below.

Pit Sand

Pit sand is a natural and coarse type of sand which is extracted by digging 2-3m underneath the ground. It's in red-orange color due to a presence of iron oxide around the grains. These sand grains are free from salts. Hence it doesn't react with the moisture content present in the atmosphere. Due to its superior binding properties pit sand is used in construction. As mentioned above, pit sand is a coarse type of sand and this is not recommended if the sand is coarser than the acceptable limits of 4.75mm IS particle sizes.

Figure 2: Pit-Sand being quarried from a source.

River Sand

River sand is obtained from the bank of rivers and river beds. It is usually found in white – grey color and has a very fine quality. River sand is well graded, and it is good for all types of concrete and masonry works. Natural river sand was the cheapest resources of sand. However, excessive mining of river bed to meet the increasing demand for sand in the construction industry has led to the ecological imbalance thereby adversely affecting the environment. River sand has a huge silica content in it. Excessive presence of silica content makes the sand useless for concrete work and responsible for efflorescence on the surface in future. To overcome this, the sand should be tested for silica content before using it. A good sand should have less than 5% of silica in it.

Figure 3: Sand lying on the River bed source.

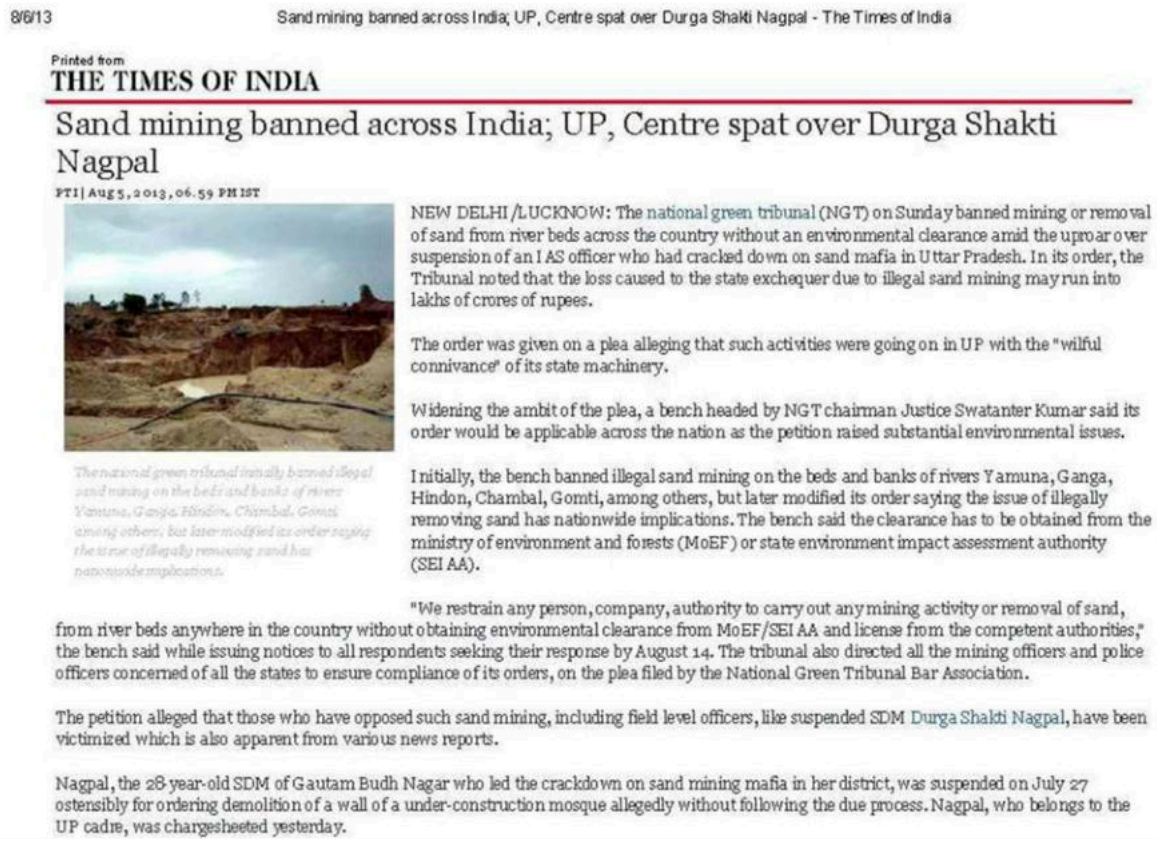
M-Sand (Manufactured Sand)

M Sand is an alternative to River sand. M-Sand (manufactured sand) is produced by crushing of hard granite stone. M-Sand is manufactured through the process of shaping cubically, grading and cleaning by using VSI machine. The size of Manufactured sand is less than 4.75mm and the color of M sand is greyish-blue to red colour based on type of rock used in crushing. To meet the huge demand of construction sector and to maintain the ecological balance without affecting the environment, M-sand is manufactured. As the name suggests, M-Sand is manufactured artificially and is also called Artificial Sand. The sizes of M-sand can be easily controlled during crushing. Since, quality control is maintained in the process of preparing manufactured sand. The best part of it is that M-Sand don't have any silt materials or organic impurities, so it is best suited for concrete construction.

Figure 4: Sand being manufactured from a stone quarry source

Brief Description

India today is divided into two parts-North vs South when sand availability is concerned after the National Green Tribunal (NGT) of Supreme Court banned sand mining in August,2013(see Figure.5). Misconceptions regarding M-sand are abounding and some even compared them with crushers' dust. The following Table 1 gives the comparison between manufactured sand(M-sand) with crushers' dust.



8/6/13 Sand mining banned across India; UP, Centre spat over Durga Shakti Nagpal - The Times of India

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THE TIMES OF INDIA

Sand mining banned across India; UP, Centre spat over Durga Shakti Nagpal

PTI | Aug 5, 2013, 06.59 PM IST

NEW DELHI/LUCKNOW: The national green tribunal (NGT) on Sunday banned mining or removal of sand from river beds across the country without an environmental clearance amid the uproar over suspension of an IAS officer who had cracked down on sand mafia in Uttar Pradesh. In its order, the Tribunal noted that the loss caused to the state exchequer due to illegal sand mining may run into lakhs of crores of rupees.

The order was given on a plea alleging that such activities were going on in UP with the "wilful connivance" of its state machinery.

Widening the ambit of the plea, a bench headed by NGT chairman Justice Swatanter Kumar said its order would be applicable across the nation as the petition raised substantial environmental issues.

Initially, the bench banned illegal sand mining on the beds and banks of rivers Yamuna, Ganga, Hindon, Chambal, Gomti, among others, but later modified its order saying the issue of illegally removing sand has nationwide implications. The bench said the clearance has to be obtained from the ministry of environment and forests (MoEF) or state environment impact assessment authority (SEIAA).

"We restrain any person, company, authority to carry out any mining activity or removal of sand, from river beds anywhere in the country without obtaining environmental clearance from MoEF/SEIAA and license from the competent authorities," the bench said while issuing notices to all respondents seeking their response by August 14. The tribunal also directed all the mining officers and police officers concerned of all the states to ensure compliance of its orders, on the plea filed by the National Green Tribunal Bar Association.

The petition alleged that those who have opposed such sand mining, including field level officers, like suspended SDM Durga Shakti Nagpal, have been victimized which is also apparent from various news reports.

Nagpal, the 28-year-old SDM of Gautam Budh Nagar who led the crackdown on sand mining mafia in her district, was suspended on July 27 ostensibly for ordering demolition of a wall of a under-construction mosque allegedly without following the due process. Nagpal, who belongs to the UP cadre, was chargesheeted yesterday.

Figure 5: Online edition (5th August',2013) of Times of India (TOI) highlighting NGT's ban on Sand mining

Table 1: Comparison between M-Sand v/s Crusher Dust

Sl No.	Parameters	M-Sand	Crusher Dust
1	Colour	Grey	Grey
2	Particle Shape	Cubically shaped	Elongated(shapeless) & Flaky
3	Product Spec.	Manufactured as per IS, BS, ASTM standards	Waste of stone crusher obtained as fractured dust
4	Manufacturing process	International technology-controlled manufacturing process through imported machines	No controlled manufacturing process as it is a by-product
5	Gradation	As per IS:383(1970), Zone II	Doesn't adhere to any standards
6	Suitability for concreting	Recommended for usage in concrete & mortar by concrete technologists worldwide & conforms with international standards.	Not recommended for use in concrete or masonry, neither it has any quality.

Conclusion

Acute shortage of sand and a steep rise in price has forced builders and engineers to depend substantially on manufactured sand (M-sand) especially in Southern parts and some Western pockets of India. Some builders, who began to use M-sand as a temporary measure, now prefer it. Since the rate of river sand was more than or double to that of M-sand, buyers invariably preferred M-sand and as a result, many builders and engineers had now switched over to M-sand. But M-sand has one disadvantage – that is due to their coarseness they are not preferred for plastering of walls when compared with natural river sand or pit sand. Vaastu Shastra – the traditional Indian system of architecture originating in India, says Building material must be free from traces of human body or animal. M-Sand is free of such material and is produced by crushing hard granite stone when compared to river sand that is produced naturally from weathered rock.

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COMPRESSED AIR SAVING DEVICE

"A PORTABLE, ECONOMIC HOT SPOT COOLING SOLUTION TO PLUG AND ELIMINATE ROUTINE ENERGY WASTE IN CEMENT PLANTS"

By K K Sharma, U K Sharma & Ketan Goel
Invotech Industrial Solutions Private Limited

Abstract

Compressed air is a very useful tool in cement manufacturing process. It is used to provide the energy to move materials and items of equipment. However, it is a very expensive form of energy. The air is almost always compressed by electrically-driven screw compressors. Unfortunately, only 10 per cent of the electrical energy input goes for producing useful mechanical work. The remaining some 90 per cent is lost as heat with compression and idling losses being the greatest. Owing to this, Compressed air is such an expensive form of energy.

Introduction

India is reckoned as the second largest cement producer in the world, which accounted for over 12% of the global installed capacity as of 2020. India's overall cement production capacity was nearly 545 MT in FY20. Of the total capacity, 98% lies with the private sector and the rest with public sector. The top 20 companies account for around 70% of the total cement production in India. Further, as India has high quality and quantity of limestone deposits, the cement industry promises huge potential for growth. The demand of cement industry is expected to reach 550-600 MT per annum (MTPA) by 2025 because of the expanding demand of different sectors, i.e. housing, commercial construction, and industrial construction.

The above data may be enough to assume at what level cement manufacturing units must be using Compressed air in their production facilities. It is too easy for Companies to take compressed air for granted for their use and abuse to grow. Such abuses become ingrained in the way the cement factory is operated. However, in order to survive in a tough competitive environment, many companies are searching for ways to make savings in their production. Such savings can often be found in their existing compressed air systems, which have generally been in place for years. Up to 60% of energy costs can be saved through optimization at both the production facility and system level. Even small gains in efficiency and reduction in consumption

can translate into significant cost savings. However, companies can only achieve this target by considering the compressed air system as a whole. Similarly, use of Compressed air must be carefully controlled and not abused. Further, cement companies also have to pay heed towards the aspect of energy management.

Energy management

Energy management is the means to control and reduce any organization's energy consumption. It is reckoned that Industry uses more energy than any other end-use sector, consuming about one-half of the world's energy requirement. Controlling and reducing any organization's energy consumption is important because it enables to reduce costs which increase as energy costs rise. Similarly, it has other aspects also, as under

- **Reduce** carbon emissions, environmental damage, cost-related implications of carbon taxes and carbon footprint to promote a green, sustainable image
- **Recognition** of any company as a "green company"
- **Reduce risk** of energy price increase or supply shortages which seriously affect profitability or even sometimes make it impossible for any business/organization to continue
- **Improves/increases productivity** and can provide the products to customers at minimal cost
- **Gives** competitive advantage to organization/company
- Improve operational reliability and control

What are the costs of compressed air generation?

Compressed air costs are normally expressed in Nm^3 (at 1.0 bar and 20°C to ISO 6358 or, for many compressor manufacturers, in m^3 to ISO 1217:2009, Annex C). These can be determined using the sum of fixed and variable costs and using the annual delivery output of the compressor station

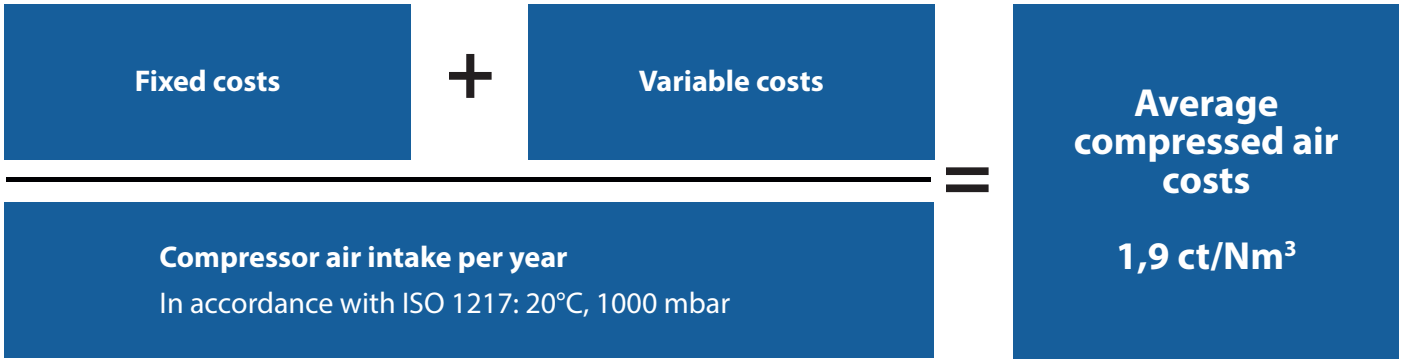


Figure showing calculation of average compressed air costs

Annual (p.a.) fixed costs include

- Depreciation of the investment made
- Interest rate
- Space utilization costs

Variable costs are made up of

- Energy costs over the full-load periods and no-load times of the compressors
- Costs of consumables such as oil, coolant etc. p.a.
- Maintenance and costs

The largest part of the costs, at approx. 75%, is taken up by the energy costs. In order to generate 1 Nm^3 of compressed air, modern compressor stations require between 100 and 120 Wh/Nm^3 (compressed air index [kWh/Nm^3])

How much do leakages cost?

Even small leakage offers the potential for significant savings. The table below shows how much air is lost as a result of leakages with a specific hole diameter and what additional costs are incurred:

p1 (rel.)	Leakage rate in Nl/min					
	0.5 mm	1.0 mm	1.5mm	2.0 mm	2.5mm	3.0mm
3 bar	9	36	81	145	226	325
4 bar	11	45	102	181	282	407
5 bar	14	54	122	217	339	488
6 bar	16	63	142	253	395	569
7 bar	18	72	163	289	452	651
8 bar	20	81	183	325	508	732

p1 (rel.)	Costs/year					
	0.5 mm	1.0 mm	1.5mm	2.0 mm	2.5mm	3.0mm
3 bar	€ 90	€ 361	€ 812	€ 1,444	€ 2,256	€ 3,248
4 bar	€ 113	€ 451	€ 1,015	€ 1,805	€ 2,820	€ 4,061
5 bar	€ 135	€ 541	€ 1,218	€ 2,166	€ 3,384	€ 4,873
6 bar	€ 158	€ 632	€ 1,421	€ 2,527	€ 3,948	€ 5,685
7 bar	€ 180	€ 722	€ 1,624	€ 2,888	€ 4,512	€ 6,497
8 bar	€ 203	€ 812	€ 1,827	€ 3,248	€ 5,076	€ 7,309

Note: 1 Euro equals 88.65 Indian Rupee as on 25-02-2021

Table 1/2: Leakage costs within one year for operation 24 h/365 days, calculated using compressed air costs of 1.9 ct/Nm³.

The point at which a leakage is identified as a loss depends on the ratio of leakage to overall consumption. Major leakages – where the air leak is clearly audible – are costly and supposed to be rectified immediately. Similarly, medium and small leakages (leakages with a hole diameter of less than 0.5 mm) which can be detected simply by using professional leakage detection equipment are also supposed to be rectified promptly. It is a thumb rule that 20% of the detectable leakages in existing systems account for up to 80% of the avoidable costs. Therefore, it is felt prudent that leakages be fixed immediately which will ultimately save energy as well as cost of production.

Energy efficient solution

We at IISPL, took this issue as a challenge and started identifying the ways for eliminating routine wastes, which cause higher energy consumption in cement process industry. We also studied on means to provide best and economic solution to cement industries so as to save production cost as well as conserve natural resources. Having done in depth study, Invotech Industrial Solutions Private Limited has recently developed a product called Arrest Master ABS for enhancing energy efficiency. It can be used to cool down the area rapidly with less air consumption but gives output 7 to 8 times as compared to normal air consumption. It is a special design Nozzle, works on COANDA EFFECT.

Arrest Master ABS uses little amount of compressed air to deliver high volume output. Arrest Master ABS, is a compressed air boosting device, which has been designed in a way so as to give trouble free & maintenance free service as there is no moving part in it. It can also be used to cool down bearing housing, cutting hot material, cooling of lathe machine jobs etc.

Arrest Master ABS: Compressor air saving Nozzle System- For Kiln Shell, Bearing housing cooling

Bearing housing cooling by Energy efficient device (Arrest Master ABS)
Input @ 6 Bar = 11 CFM, Output= 77 CFM, Atmospheric contribution= 66 CFM

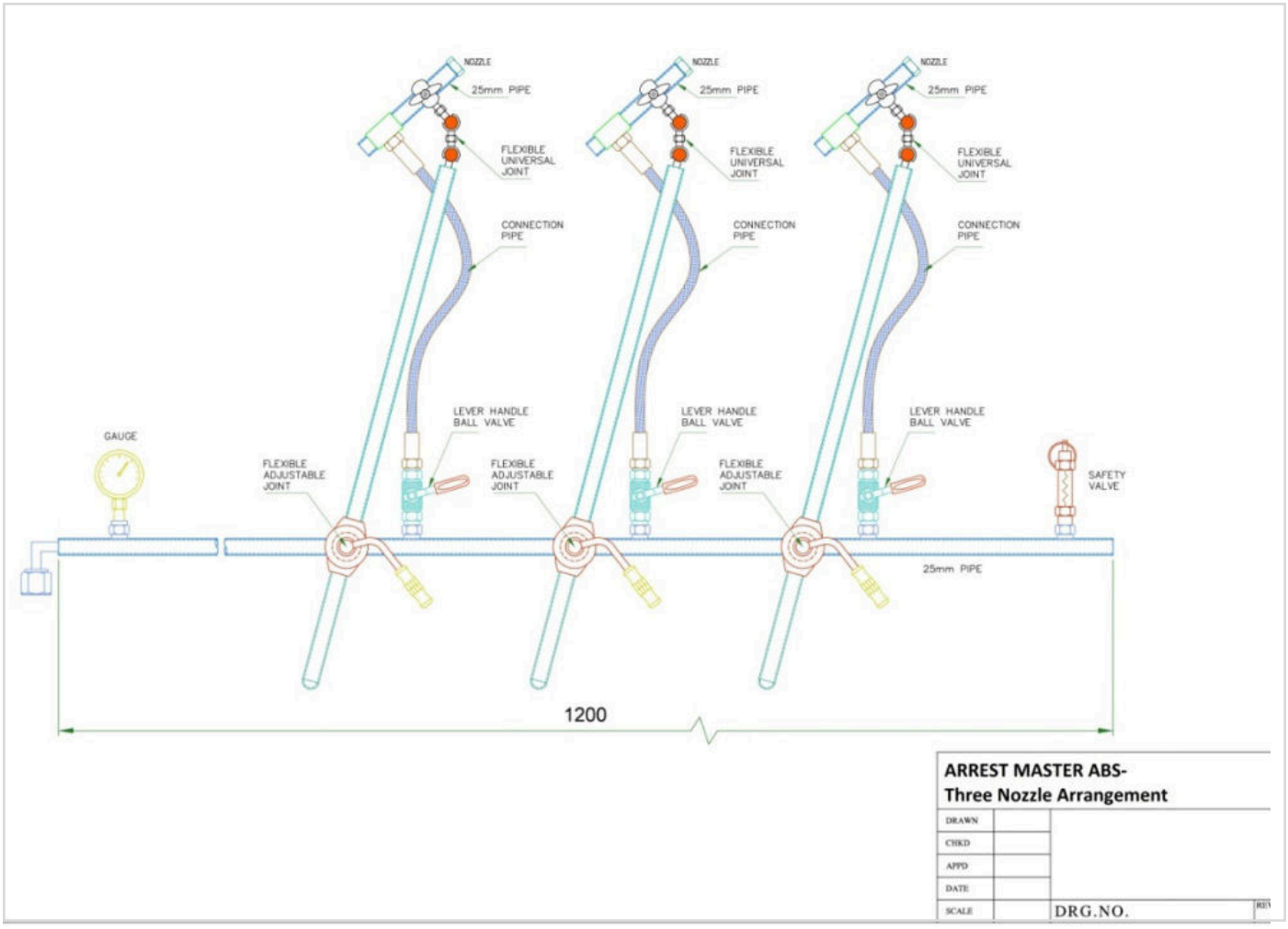
Product highlights of arrest master abs

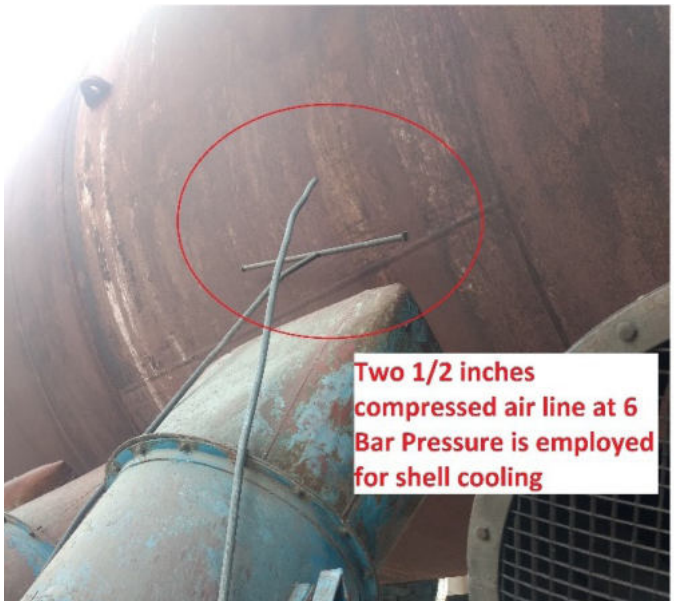
- Energy efficient device
- Provides efficient cooling
- User friendly & ready-to-use modules
- Easy installation and Relocation

Power consumption comparison of abs v/s fad & axial fan

	Cooling By	Consumption	Power cons.	Per day Cons.	Power Rate	Power Cost	Yearly cost
A	½ inch pipe (With compressed air)	100 CFM	20 KW	480	6	2880	950400
B	By Axial fan (5.5 KW motor)		5 KW	120	6	720	237600
C	ABS	11 CFM	0.2 KW/CFM	52.8	6	317	104544
	ABS savings V/S FAD ½ inch pipe	9 times less power cons with compare ½ inch pipe line air					
	ABS saving V/S Axial fan	2.25 times less power consumption with compare with Axial fan					
	Payback period	22 Days (Compare ABS V/S Axial fan)					
	Pay back Pd.	3 Days (Compare ABS V/S FAD ½ inch)					

Arrest master abs- three nozzle arrangement





Conventional practice

Air output = 200 cfm by two ½ inch lines

Total consumption= 200 cfm

Arrest master abs- three nozzle arrangement at kiln shell

Air inpu t= 11 cfm/nozzle

Air output = 77cfm/ nozzle

Total output = 231 cfm

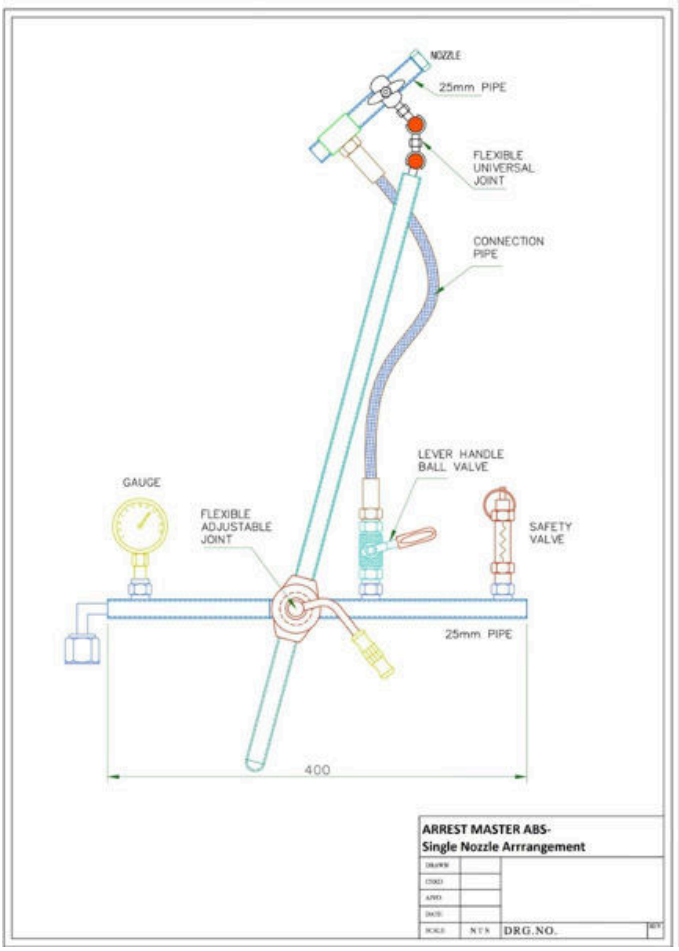
Total air consumption = 33 cfm

Arrest master abs- three nozzle arrangement for kiln shell

Launched Arrest Master ABS System at

16th NCB International Seminar on Cement, Concrete & Building Materials held from and 03rd to 06th December, 2019 at Manekshaw Center, New Delhi.

Arrest master abs- single nozzle arrangement



Conventional practice

Air output = 100 cfm by ½ inch line

Total air consumption = 100 cfm

Arrest master abs- single nozzle arrangement at bearing housing

Air input = 11 cfm/nozzle

Air output = 77 cfm/nozzle

Total air consumption = 11 cfm

Invotech Industrial Solutions Private Limited keeps itself abreast of latest development in Cement/Power Industry so as to cater the need of the Industry using latest technology and quality systems. Also, with a view to retain the requisite competitive edge in the market, participated in various Seminars, details as under

- 15th & 16th NCB International Seminar on cement, concrete & building materials held from 5th to 8th Dec, 2017 and 3rd to 6th Dec, 2019 at Manekshaw Center, New Delhi.
- "National workshop cum technology exhibition to promote energy efficient & cleaner production for sustainable industrial growth" held from 8th to 9th March, 2018, at India Habitat center, New Delhi, where presented a Technical Paper on "SIGNIFICANT SAVINGS IN ENERGY THROUGH FALSE AIR REDUCTION" & received an award for "UPCOMING ENTREPRENEUR IN THE FIELD OF ENERGY EFFICIENCY".
- 14th & 15th Green Cementech 2018 & 2019 at Hyderabad International Convention Center, Hyderabad where presented Technical Paper on "Enhancing Energy efficiency in Captive Power Plants by reduction of False Air".
- Some of our articles also published in prestigious CMA's Technical Journal "Cement Energy & Environment", Vol. 17 No. 1 (Jan – Jun 2018) & Vol. 18 No. 1 (Jan – Jun 2019).

Summary

An integral approach to optimize energy usage in a compressed air system has a range of benefits for the operator of compressed air systems, such as:

- Reduction in energy costs and, as a result, in operating costs
- Reduction in costs for maintenance and servicing
- Increase in process security
- Reduction in unplanned production downtime and associated costs

Conclusion

Substantial potential for energy efficiency improvement/cost cutting by adopting innovative ways exist in the Cement industry. Persistent efforts are also being made by Cement industry to continue to improve energy efficiency and reduce the energy cost for survival and growth. Our baby step towards saving "Compressed Air" can contribute immensely towards cost cutting of Cement Industry. It is needless to mention that our efforts to improve energy efficiency will also minimize greenhouse gas and mitigate the environmental problems associated with cement production.

CASE STUDY ON ACHIEVEMENT OF BEE 5 STAR LABEL CERTIFICATION

By S K Jain (Unit Head), C P Jhagdawat (Head C&A), Anil Gupta (Head Technical) and Sachin Gupta (Head E&I)
J.K White Cement Works, Gotan

About Plant

JK White Cement Works, Gotan is the first White Cement manufacturing factory in India which manufactured White Cement through dry process technology. The Gotan plant was commissioned in 1984 with an initial production capacity of 50,000 TPA. It uses technical expertise from FLSmidth & Co. of Denmark with their State-of-the-art technology of continuous on-line quality monitoring and control by X-Ray Analyser and PLC Systems, ensuring manufacturing of purest white cement. Over the years, continuous process improvements and modifications have increased the plant's production capacity to 6,10,000 tons per annum .Presently, the plant is operating at ever since lowest energy levels.

Bureau of Energy Efficiency – Star Labelling Program for office buildings

Bureau of Energy Efficiency(BEE)is an agency of Govt. of India,engaged in developing programs which will increase the conservation and efficient use of energy in India.

Commercial buildings in India account for nearly 8% of the total electricity supplied by the utilities. Electricity usage in the sectors has been grown at about 11-12% annually. Building energy consumption has seen an increase from14% in the 1970s to nearly 33% in 2004-05. Electricity use is primarily from lighting, space conditioning (Heating, ventilation and air-conditioning) appliances and equipment (including IT equipment) and water heating.

A Star Rating Program for BPO buildings has been developed by BEE which would create a demand in the market for energy efficient buildings based on actual performance in terms of Average Annual hourly Energy Performance Index (AAhEPI). This program would rate BPO buildings on a 1-5 Star scale with 5 Star labeled buildings being the most energy efficient.

This programme targets BPO building located within the following 4 climatic zones:
i. Warm and Humid
ii. Composite
iii. Hot and Dry
iv. Temperate
assuming an air-conditioned floor area of more than 50% of its built up area.

Participation inStar Labelling Program for office buildings

In a developing economy like India improved energy efficiency is a primary goal which could be achieved through promotion of higher performance standards in buildings and J.K. White Cement – Gotan preaches the same in order to maintain a control on overuse of natural resources. The nurturing of a performance and result-oriented culture, based on quality, is crucial in bringing about an in-depth transformation under Energy Saving Practices to continually improve. Applying for the BEE Star Labelling Certification for our New ADM building is driven by this philosophy.

Figure 1: Administration Building, JKWhite Cement Works

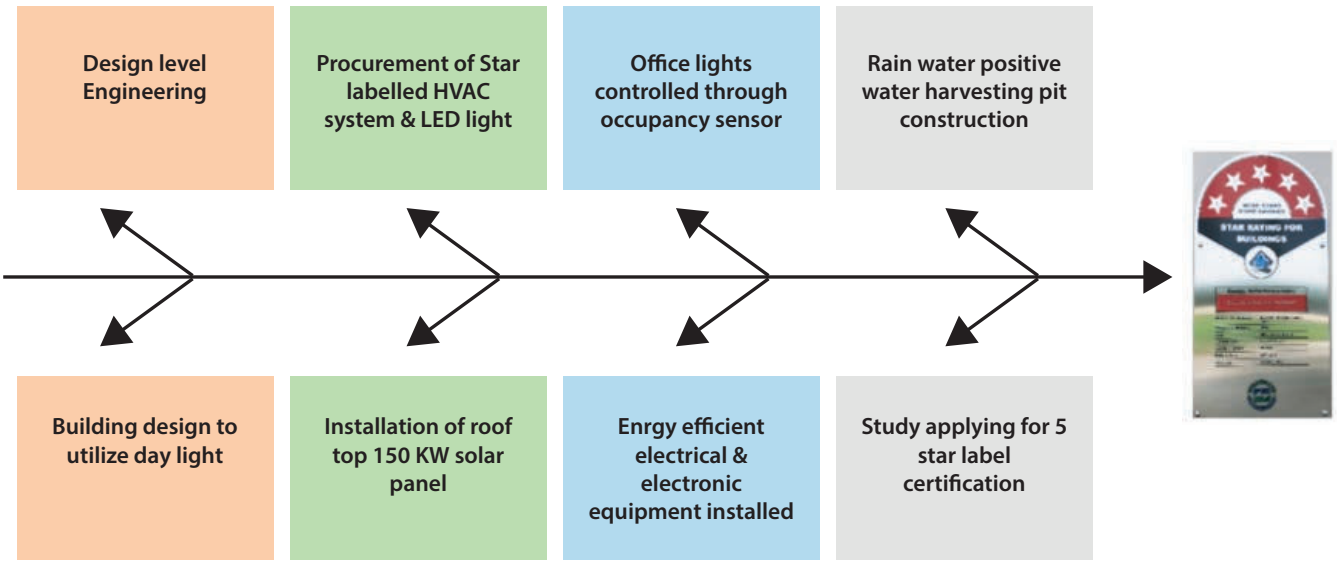
J.K. White Cement gained a label of recognition, that of operating according to BEE Star Labelling energy savings standards. The New ADMIN building is located in the plant premises with desired energy saving measures.The building connected load is about 190 kW with a built-up area of about 3011 sq. m. having 55% of it as air-conditioned area and EPI for the duration between May 2018 to April 2019 is 39.24. Main Energy saving measures installed in the building are: **star labelled air conditioners HVAC System with VFD operation, LED lights, Lights controlled through Occupancy Sensor, Energy efficient electrical & electronics equipment installed, Building design to utilize Day lights with Sun film glazing & proper ventilation, and Rain Water Harvesting Pits installed in becoming water positive.**

Table 1 – Connected Load of New Administrative Building

New Administrative Building Connected Load Detail in Watt	
Lighting Load	11620
Electrical Load	4695
HVAC	165000
Electronics & Misc.	9030
TOTAL	190345

Figure 2: Work done to achieve 5 star Label Certification

Fishbone diagram represent progressive journey of JKWCW ADM building to 5 star label certification



Energy efficient technologies installed in New Admin Building

HVAC System, LED Lights and Occupancy Sensor

The Variable Refrigerant Volume HVAC System is a relatively new technology developed by Daikin, the world's leading HVAC manufacturer.

New VRV systems offer high levels of energy efficiency, as well as flexibility. They operate quietly and provide the user full control of the environmental temperatures.

a. Energy Saving Operation

Precise individual control and inverter technology minimize energy consumption to deliver optimum energy savings.

b. Adaptable Design

Modular design of outdoor units and wide selection of indoor units ensure system designs that are ideally suited to the environment where they are installed.

c. Flexible Layout

In addition to a maximum connection of 64 indoor units to 1 outdoor unit, large allowances for piping length and level difference provide a flexible layout.

d. Ceiling Mounted Cassette (Round Flow) Type

360° airflow improves temperature distribution and offers a comfortable interior environment

e. Individual Control

VRV systems enable individual climate control settings for each zone to provide the utmost in comfort to commercial building settings.

Figure 3: Variable Refrigerant Volume HVAC System

Installation of LED lights

As per analysis, luminous efficacy of LED lights are at pardue to low power consumption in driver circuit& negligible loss of power in terms of heat generation.

Lights controlled by occupancy sensor

An occupancy sensor is an indoor motion detecting device used to detect the presence of a person to automatically control lights or temperature or ventilation systems.

The sensors use infrared, ultrasonic, microwave or other technology. The term encompasses devices as different as PIR sensors, hotel room keycard locks and smart meters. Occupancy sensors are typically used to save energy, provide automatic control, and comply with building codes.

Motion sensors are often used in indoor spaces to control electric lighting. If no motion is detected, it is assumed that the space is empty, and thus does not need to be lit. Turning off the lights in such circumstances can save substantial amounts of energy. In lighting practice occupancy sensors are sometime also called “presence sensors” or “vacancy sensors”.

Figure 4: Occupancy sensor controlled Lights

System design

Occupancy sensors for lighting control typically use infrared (IR), ultrasonic, tomographic motion detection, microwave sensors, or camera-based sensors (image processing). The field of view of the sensor must be carefully selected/adjusted so that it responds only to motion in the space served by the controlled lighting. For example, an occupancy sensor controlling lights in an office should not detect motion in the corridor outside the office.

Sensors and their placement are never perfect, therefore we incorporate a delay time before switching. This delay time is often user-selectable, but a typical default value is 15 minutes. This means that the sensor must detect no motion for the entire delay time before the lights are switched. If lights are off and an occupant re-enters a space, sensor systems switch lights back on when motion is detected. However, systems designed to switch lights off automatically with no occupancy, and to switch lights on when person re-enter.

Rooftop photovoltaic power station

A rooftop PV system, is a photovoltaic system that has its electricity-generating solar panels mounted on the rooftop of a commercial building. The various components of such a system include photovoltaic modules, mounting systems, cables, solar inverters and other electrical accessories.

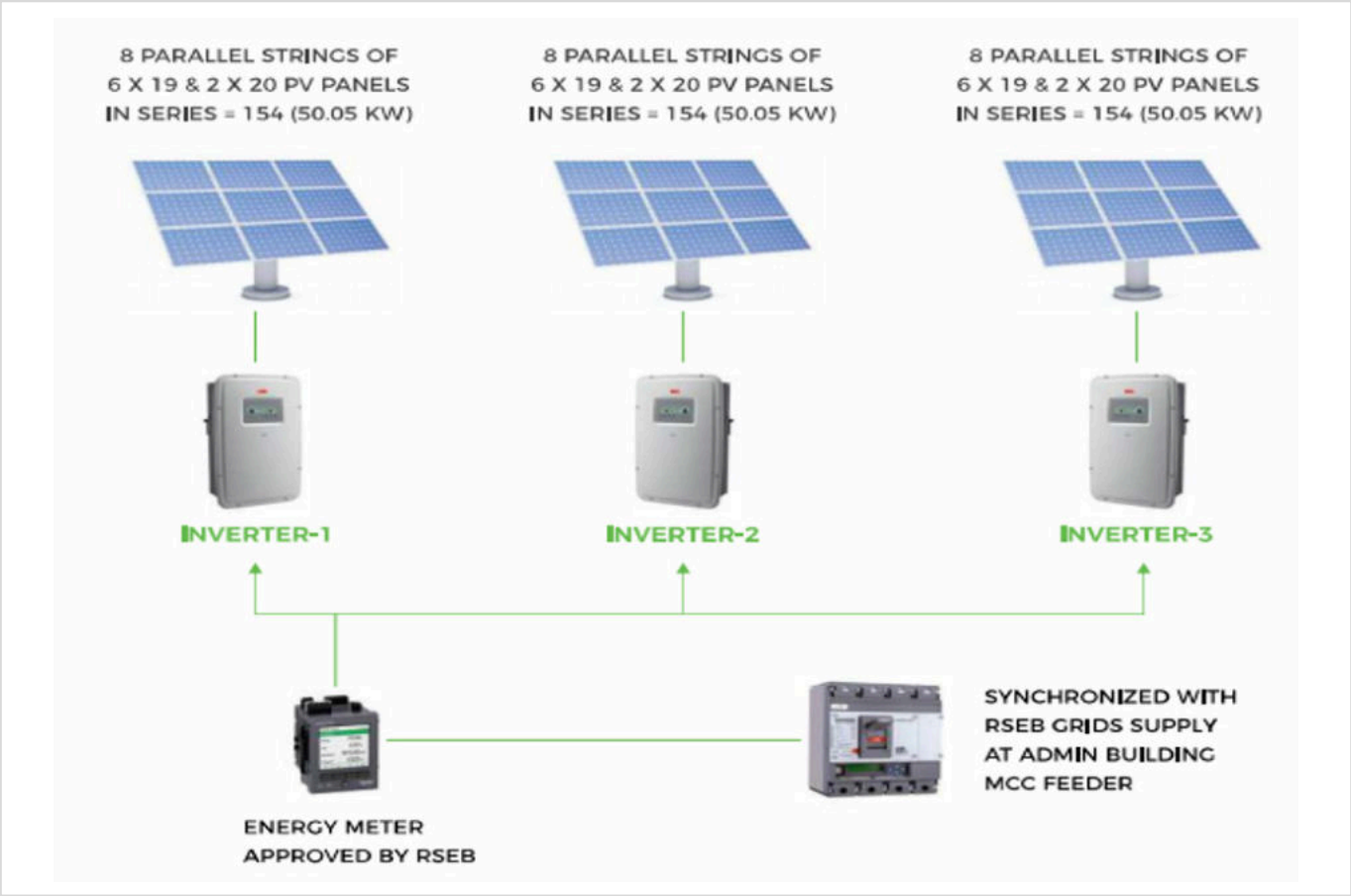


Figure 5: Solar PV System arrangement

The urban environment provides a large amount of empty rooftop spaces and can inherently avoid the potential land use and environmental concerns. Estimating rooftop solar insolation is a multi-faceted process, as insolation values in rooftops are impacted by the following:

- Time of the year
- Latitude
- Weather conditions
- Roof slope
- Roof aspect
- Shading from adjacent buildings and vegetation.

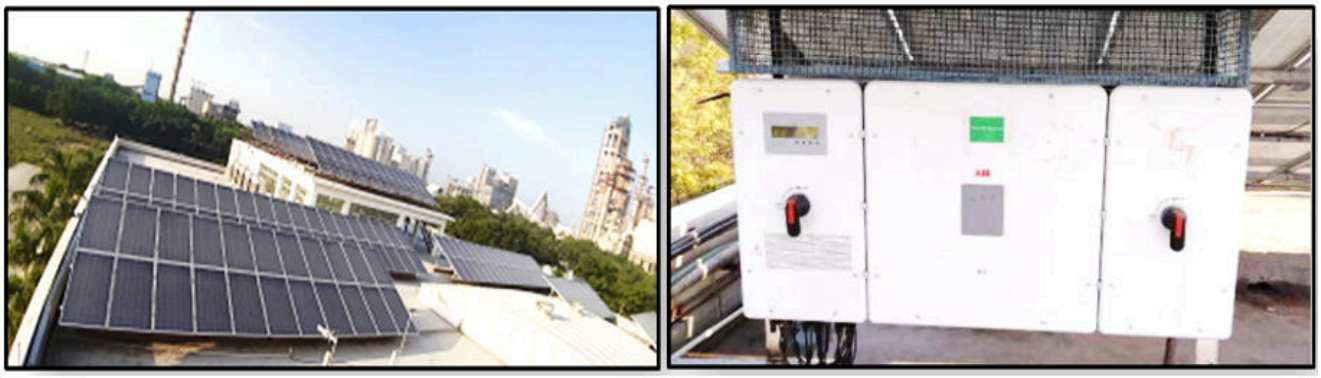


Figure 6: Rooftop Solar PV Panel

This 150 KW solar power system consist of 3 inverters & 462 solar PV panels. The peak power of solar PV panel is 325 W. Each inverter is connected with solar PV panel of approx. 50 KW peak power capacities. These solar PV panels convert solar energy to electrical energy in the form of direct current. Inverters then convert direct current to alternating current. The inverters have local display& facility of communication with laptop/computer via Ethernet or Wi-Fi. These inverters also have feature of communication with mobile application. The output supply of all three inverters are connected in parallel& synchronized with Rajasthan SEB grid supply with MCC feeder of Administration Building. An energy meter is installed at MCC feeder measurement of generated power &hooked up with plants Energy Mgmt. System through which daily generation is monitored.

Benefits:

- Total solar power harnessed in FY 19-20 is 210990 KWH.
- Around 1.73 Lakh Kg of CO2 reduction done per annum by solar PV installation.
- Reduces carbon footprint of organization & has low maintenance.

Utilisation of Day Lighting

Daylighting is the practice of placing windows, skylights, other openings, and reflective surfaces so that sunlight (direct or indirect) can provide effective internal lighting. Particular attention is given to daylighting while designing a building when the aim is to maximize visual comfort or to reduce energy use.

Energy savings can be achieved from the reduced use of artificial (electric) lighting or from passive solar heating. Artificial lighting energy use can be reduced by simply installing fewer electric lights where daylight is present or by automatically dimming/switching off electric lights in response to the presence of daylight – a process known as daylight harvesting.

The amount of daylight received in an internal space can be analyzed by measuring illuminance on a grid or undertaking a daylight factor calculation. Computer programs such as Radiance allow an architect or engineer to quickly calculate benefits of a particular design. The human eye's response to light is non-linear, so a more even distribution of the same amount of light makes a room appear brighter.

Windows are the most common way to admit daylight into a space. Their vertical orientation means that they selectively admit sunlight and diffuse daylight at different times of the day and year. Therefore, windows on multiple orientations must usually be combined to produce the right mix of light for the building, depending on the climate and latitude. There are three ways to improve the amount of light available from a window:

- Placing the window close to a light coloured wall,
- Slanting the sides of window openings so the inner opening is larger than the outer opening, or
- Using a large light coloured window-sill to project light into the room.

Different types and grades of glass and different window treatments can also affect the amount of light transmission through the windows. The type of glazing is an important issue, expressed by its VT coefficient (Visual Transmittance), also known as visual light transmittance (VLT). As the name suggests, this coefficient measures how much visible light is admitted by the window. A low VT (below 0.4) can reduce by half or more the light coming into a room. But be also aware of high VT glass: high VT numbers (say, above 0.60) can be a cause of glare. On the other hand, you should also take into account the undesirable effects of large windows.

Figure 7: Day lighting utilization with sun filmglazing

Skylights

Skylights are light transmitting fenestration (products filling openings in a building envelope which also includes windows, doors, etc.) forming all, or a portion of, the roof of a building space. Skylights are widely used in daylighting design in residential and commercial buildings, mainly because they are the most effective source of daylight on a unit area basis.

Figure 8: Day light utilization using skylight

Turbo Ventilators

Wind operated Turbo ventilator is installed on the roof and is rotated by the Wind. The stale air inside is exhausted through the vanes and a natural inward flow of fresh air is boosted. Turbo Air ventilators work without electricity, it runs on wind velocity and it works 24 x 365 days a year. Turbo ventilator system functions and performs with the unlimited energy source like wind energy thus saving running cost of exhaust fans, wiring, maintenance etc.

Wind Turbo ventilator does not require operating time, it continuously rotates with the wind , removes moisture laden air in the winter and extremely hot air in the summer. Turbo Ventilators provide energy free cooling and fresh air throughout the year.

Figure 9: Turbo ventilators

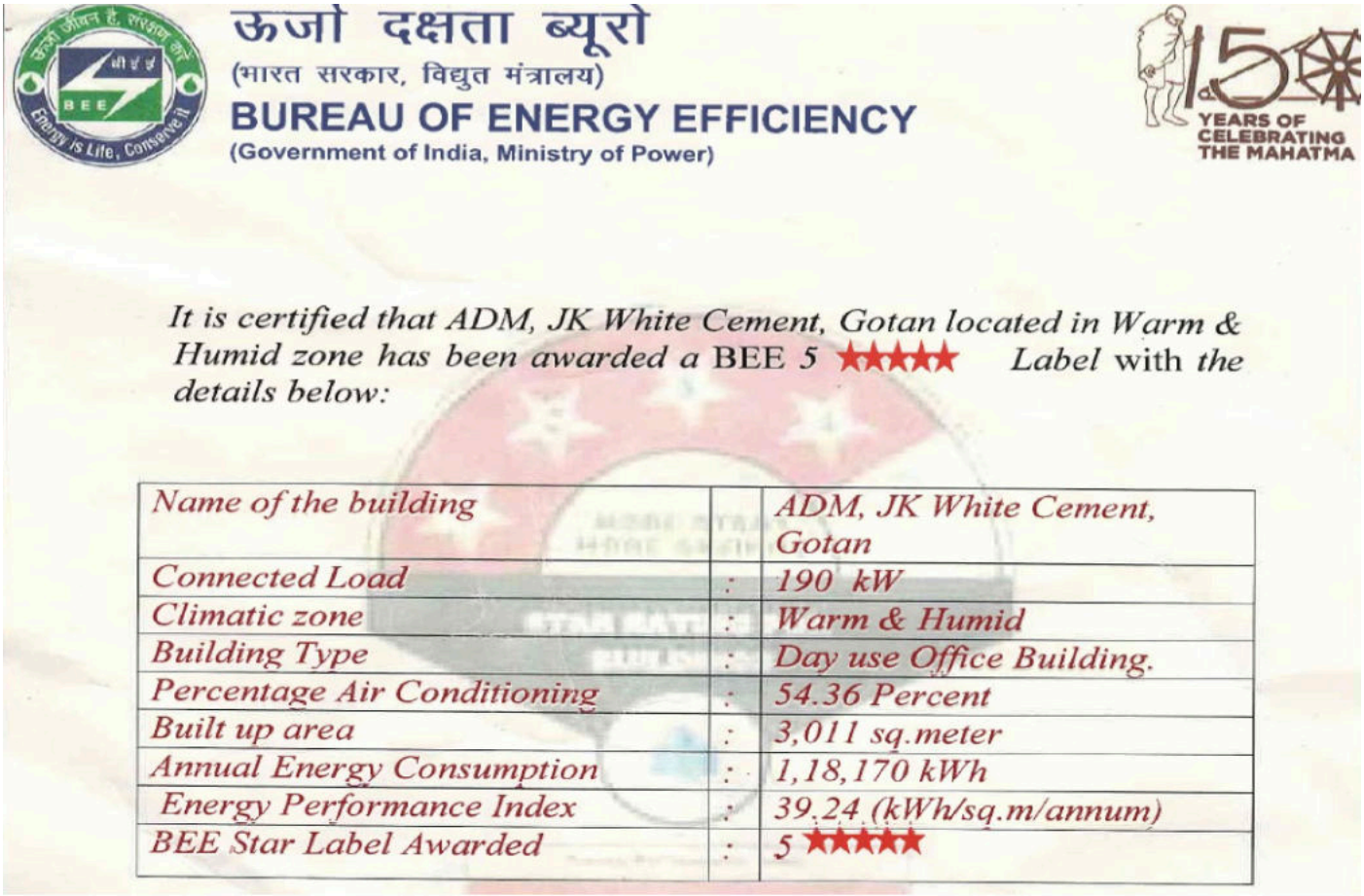
Rain Water Harvesting Pit

- Of the total water on earth, only 3% constitutes freshwater. Rest is saline water in the oceans.
- 11% of the total freshwater on earth is groundwater available upto a depth of 800m which can be extracted for use.
- Mindless extraction and over exploitation of very small quantity of this precious nature resource has caused a rapid depletion and deterioration in its quantity and quality both.
- In alluvial areas where permeable rocks are exposed on the land surface or are located at very shallow depth, rain water harvesting can be done through recharge pits.
- The technique is suitable for buildings having a roof area of 100 sq. m. These are constructed for recharging the shallow aquifers.
- Recharge Pits may be of any shape and size. They are generally constructed 1 to 2m. wide and 2 to 3m deep. The pits are filled with boulders (5-20 cm), gravels (5-10mm) and coarse sand (1.5- 2mm) in graded form. Boulders at the bottom, gravels in between and coarse sand at the top so that the silt content that will come with runoff water will be deposited on the top of the coarse sand layer and can easily be removed. For smaller roof area, pit may be filled with broken bricks/ cobbles.
- A mesh should be provided at the roof so that leaves or any other solid waste / debris is prevented from entering the pit. A desilting / collection chamber may also be provided at the ground to arrest the flow of finer particles to the recharge pit.
- This technique is ideally suited for area where permeable horizon is within 3m below ground level.
- Recharge well of 100-300 diameter is constructed to a depth of at least 3 to 5m below the water level. Based on the lithology of the area, well assembly is designed with slotted pipe against the shallow and deeper aquifer.
- A lateral trench of 1.5 to 3m width and 10 to 30m length, depending upon the availability of water is constructed with the recharge well in the centre.
- The number of recharge wells in the trench can be decided on the basis of water availability and local vertical permeability of the rocks.
- The trench is backfilled with boulders, gravels and coarse sand to act as a filter media for the recharge wells.
- If the aquifer is available at greater depth say more than 20m, a shallow shaft of 2 to 5m diameter and 3-5metres deep may be constructed depending upon availability of runoff. Inside the shaft a recharge well of 100-300mm dia is constructed for recharging the available water to the deeper aquifers. At the bottom of the shaft a filter media is provided to avoid choking of recharge well.

Figure 10: Rain water positive water harvesting pit

Achieving of BEE Star Labelling Audit & Certification

J.K. White cement works, Gotan invited National Productivity Council (NPC) to this landmark for an audit under Bureau of Energy Efficiency – Star Labeling Program that resulted in the following Certification.



ऊर्जा दक्षता ब्यूरो
(भारत सरकार, विद्युत मंत्रालय)
BUREAU OF ENERGY EFFICIENCY
(Government of India, Ministry of Power)

150 YEARS OF CELEBRATING THE MAHATMA

It is certified that ADM, JK White Cement, Gotan located in Warm & Humid zone has been awarded a BEE 5 ★★★★★ *Label* with *the details below:*

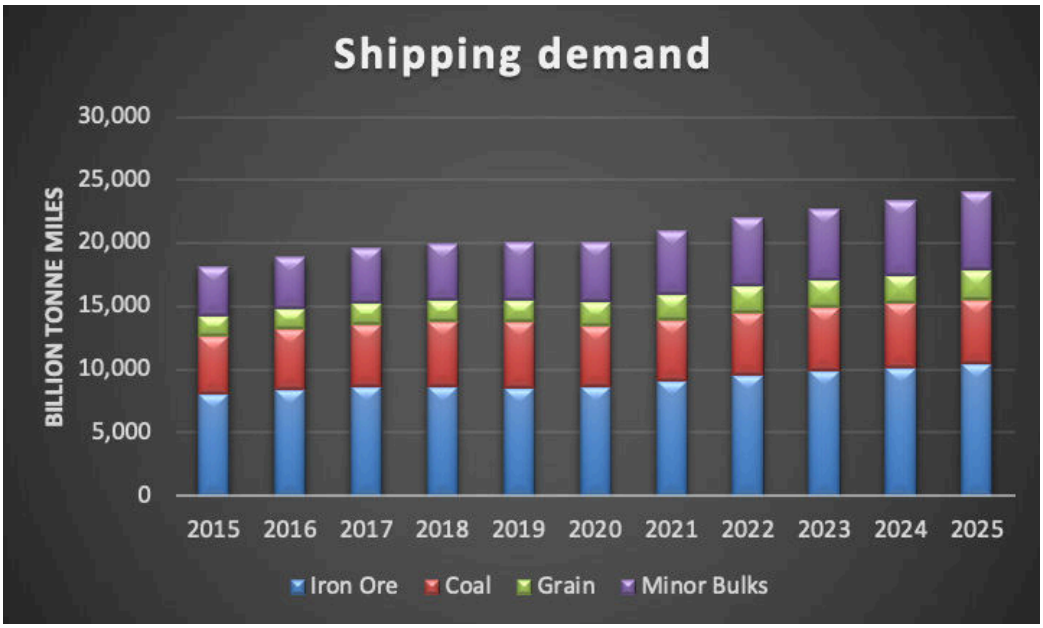
Name of the building		*ADM, JK White Cement, Gotan*
Connected Load	:	*190 kW*
Climatic zone	:	*Warm & Humid*
Building Type	:	*Day use Office Building.*
Percentage Air Conditioning	:	*54.36 Percent*
Built up area	:	*3,011 sq.meter*
Annual Energy Consumption	:	*1,18,170 kWh*
Energy Performance Index	:	*39.24 (kWh/sq.m/annum)*
BEE Star Label Awarded	:	*5* ★★★★★

The BEE Star Labelling Certification for our New ADM building gain a label of recognition for us, that of operating according to BEE Star Labelling energy savings standards. BEE Star Labelled certificate for our New ADM building is a start. The certificate will be maintained over time and this will be carried out with the collaboration of one and all at J. K. White Cement.

DRY BULK MARKET OUTLOOK & MOVEMENTS OF CEMENT, CLINKER AND COAL

By Rahul Sharan, Lead Research Analyst
DREWRY

Although many countries in the world including India have been battling with the new strains of the virus and mass vaccination will also take time, the impact of the pandemic has been fading gradually especially when people are learning to live with the virus. With better management of handling the pandemic, supply disruptions will further diminish even in the countries that are currently struggling to contain the infection. The global economic activity has already begun rebounding, which is helping the trade of dry bulk commodities as well as the recovery in charter rates of dry bulk vessels.



Source: Drewry Maritime Research

Dry bulk vessels are such vessels which carry iron ore, coal, grain, cement, clinkers and many other similar commodities. An increase in charter rates or hire rates will eventually mean an increasing cost of shipping dry bulk commodities including cement and clinkers. However, cement and clinkers form a small fraction of total dry bulk commodities. Iron ore and coal are the largest traded commodities followed by grain, soybean, bauxite, steel products and forest products. The global dry bulk trade was more than four billion tonnes while that of cement and clinkers put together was less than 200 million tonnes forming less than 5% of total dry bulk trade.

Hence, it is important to watch the development of all key factors which could influence the overall charter rates. The total landed cost of all dry bulk commodities, including cement and clinkers, significantly gets impacted by any change in charter rates. The major reasons behind our forecast of increasing charter rates are rebound in global construction and manufacturing activities and a robust grain production in many key grain exporting regions.

The manufacturing and construction activity has begun expanding as fiscal stimulus and recovery packages such as Euro 750 billion Next Generation EU (NGEU) has been helping rebuild the recession-hit economies. In China, the activity is already rising as reflected in the country's Purchasing Manager's Index which stayed above 50 points for past one year. Improving activity will support crude steel production and drive up the imports of iron ore to Europe and Asia.

China has the largest influence on the dry bulk market as it is the largest importer of many dry bulk commodities including iron ore. Amid its rising domestic steel consumption and low iron ore inventories at ports, Chinese annual iron ore imports are expected to rise by 4% in 2021 following a rise of 6.9% in 2020. The aftermath of a Brazilian dam disaster in early-2019 and subsequent iron ore supply crunch in the global market, the iron ore inventories at Chinese ports declined steeply. Strong iron ore imports in 2020 assisted in the partial recovery of port inventories which reached 124.5 million tonnes by the end of the year. Nonetheless, its inventory is still lower than a couple of years ago, implying that the traders will require to raise imports of the commodity in 2021 for inventory rebuilding besides importing the commodity for crude steel production.

More importantly, the iron ore trade will rise steeply on Brazil-China route over the next couple of years. Worsening relations between China and Australia has not impacted iron ore shipments on Australia-China route yet but it will eventually prompt Chinese traders to look for alternatives. Average haulage distance between Brazil-China is more than twice of that between Australia-China, therefore, any shift in China's import away from Australia to Brazil will add to tonne-mile demand and lift demand for dry bulk vessels increasing charter rates.

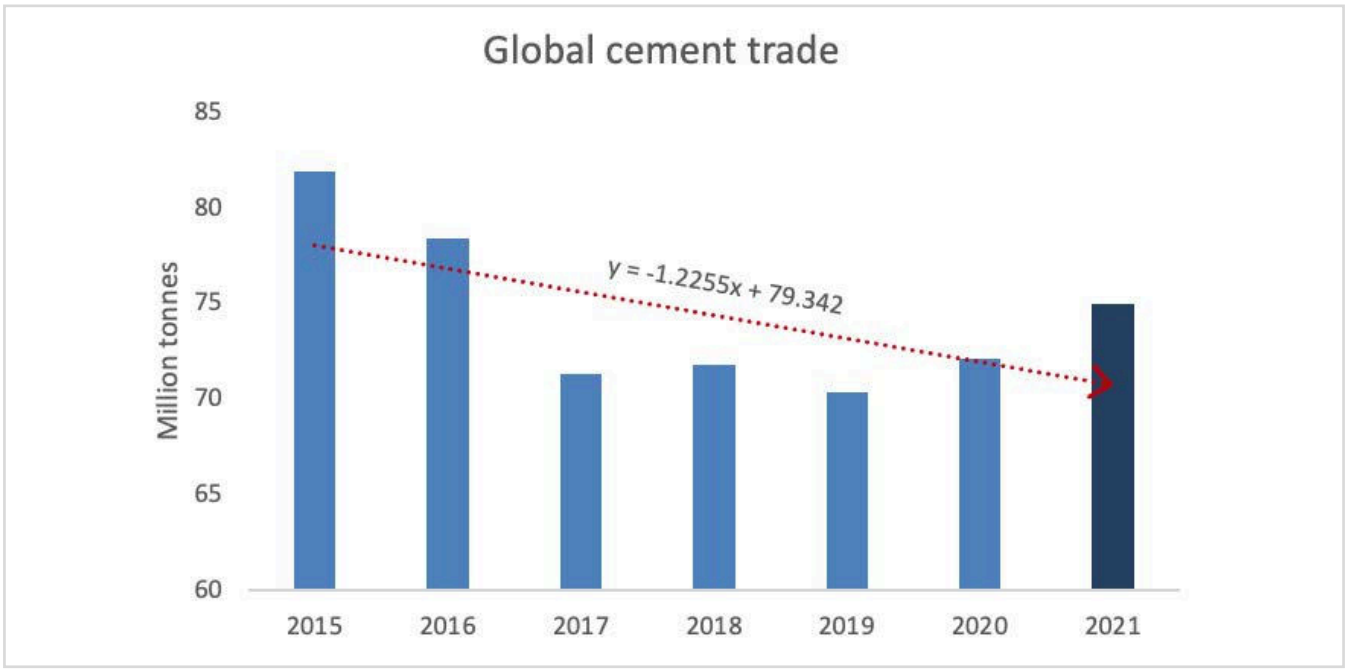
Similarly, the non-coking coal trade will also expand significantly this year, by close to 4% in 2021 due to the recovery in non-coking coal imports to Europe and Asia. Non coking coal is used, primarily, in thermal electricity generation and cement production. The imports of non-coking coal plummeted in 2020 because the slowdown in industrial operations and closure of offices on account of lockdowns and travel restrictions squeezed the demand for power. As economic activity is slated to bounce back in 2021, the increase in energy demand will drive up the trade of non-coking coal. Some of the major importers such as the EU, Japan and South Korea where non-coking imports had been receding owing to their planned and faster switch towards non-fossil fuel-based power generation over past few years, would also increase their imports of coal in 2021 as the increase in demand for power is expected to outgrow their growth of power generation using renewable sources.

Meanwhile, thanks to an expansion in cultivation area and ample rainfall, Australia is set to have its strong wheat harvest, which will likely to be double than last season. Over the last couple of years, Australia's wheat harvest was struggling due to the adverse weather conditions in some of the major wheat-growing regions like New South Wales. An increase in Australia's grain exports, particularly to farther destinations such as Saudi Arabia will provide additional employment opportunities to smaller dry bulk vessels.

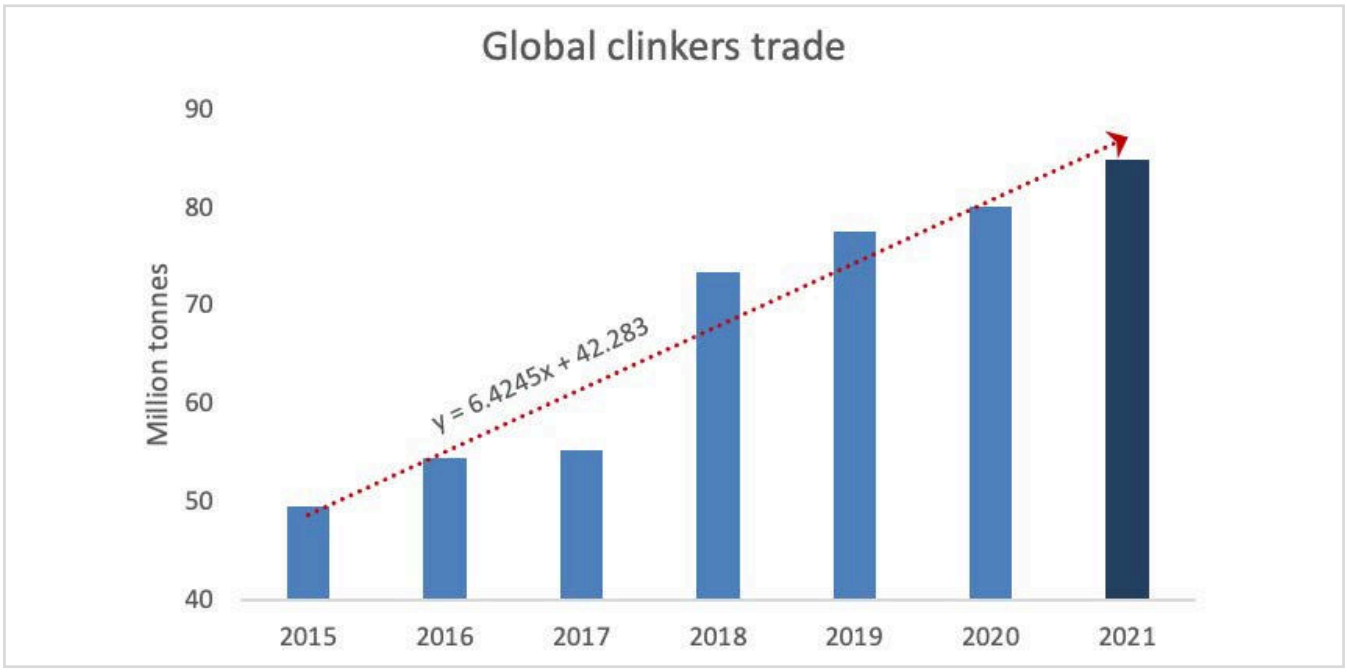
Brazil is expected to harvest record high soybean production this season, which will lead to increased exports. Improved yields on account of favourable weather conditions during growing period in tandem with expanding area under cultivation supported its soybean production. Strengthening Brazilian soybean exports will lift mid-sized dry bulk vessels' employment.

Cement trade

The global cement and clinkers trade is expected to rebound sharply in 2021 mostly on account of increasing investment and vibrant construction activities across globe. The current uptick in demand for the construction raw materials, the domestic production might not be sufficient in many of the traditional importers and they could increase their imports in 2021.



Source: Drewry Maritime Research

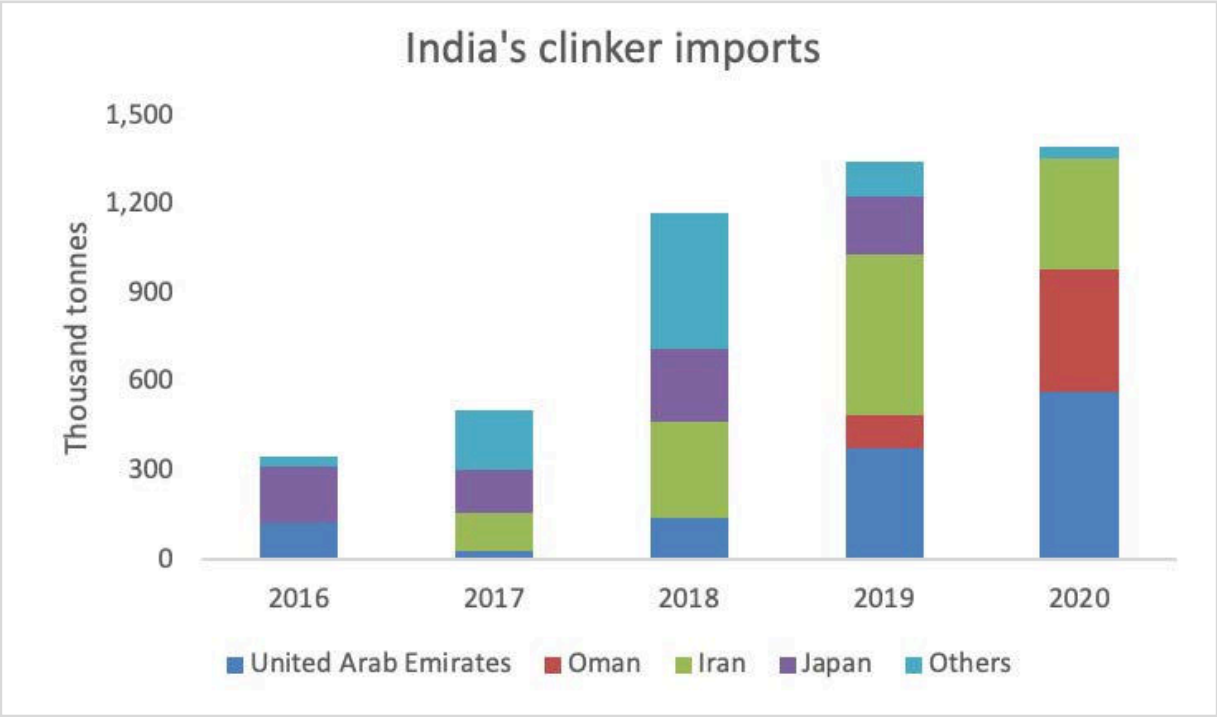


Source: Drewry Maritime Research

Meanwhile, Vietnam has been a major cement exporter, but its destination has mostly been other Asian countries. However, over past two years its share in the US and Central American countries has increased sharply. Vietnam was a non-existent trade partner with the Central American countries five years ago. It accounted for 30% of total cement imports to Central America in 2020 and we expect the share of Vietnam would continue to expand. Elsewhere, China's economic activity is already strengthening, which is driving the country's industrial sector. Strong fiscal support and favourable monetary policies such as liquidity injection into the banking system and firm infrastructure investment will keep the country's demand for cement upbeat in 2021.

India's cement and clinker trade

On a global scale India has not been a major clinker or cement trader. However, over past few years, India's clinker imports have increased substantially, mostly from the middle eastern countries.

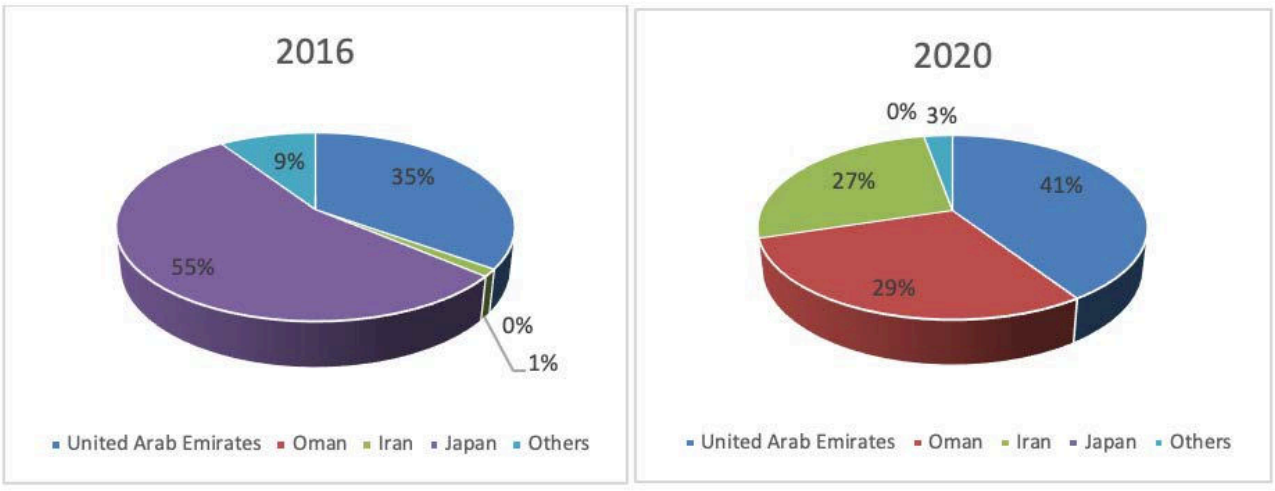


Source: Drewry Maritime Research

Five years ago, the small quantity of clinker that India used to import, it was mostly from Japan. However, Japan's share has become non-existent and has gone altogether to the Middle East.

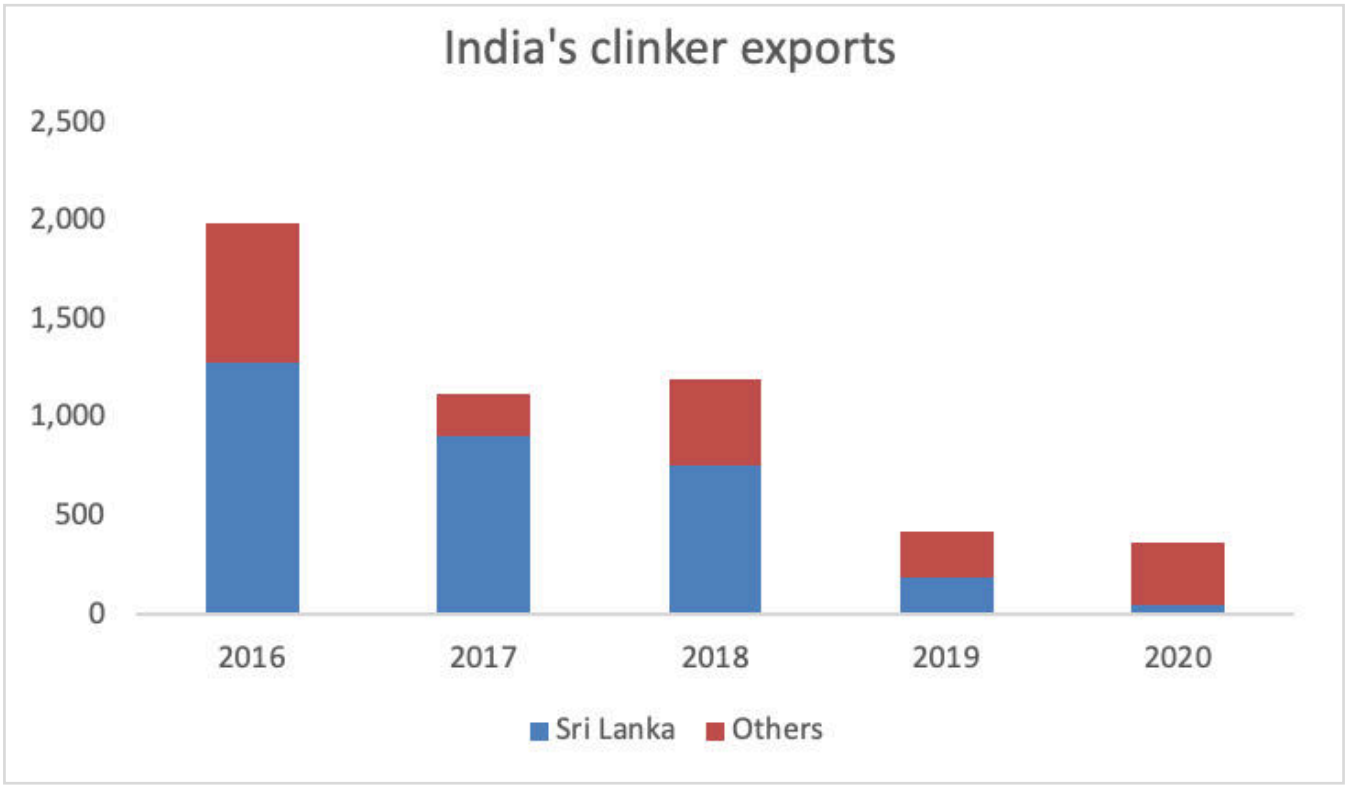
India's clinker import partners

On a global scale India has not been a major clinker or cement trader. However, over past few years, India's clinker imports have increased substantially, mostly from the middle eastern countries.

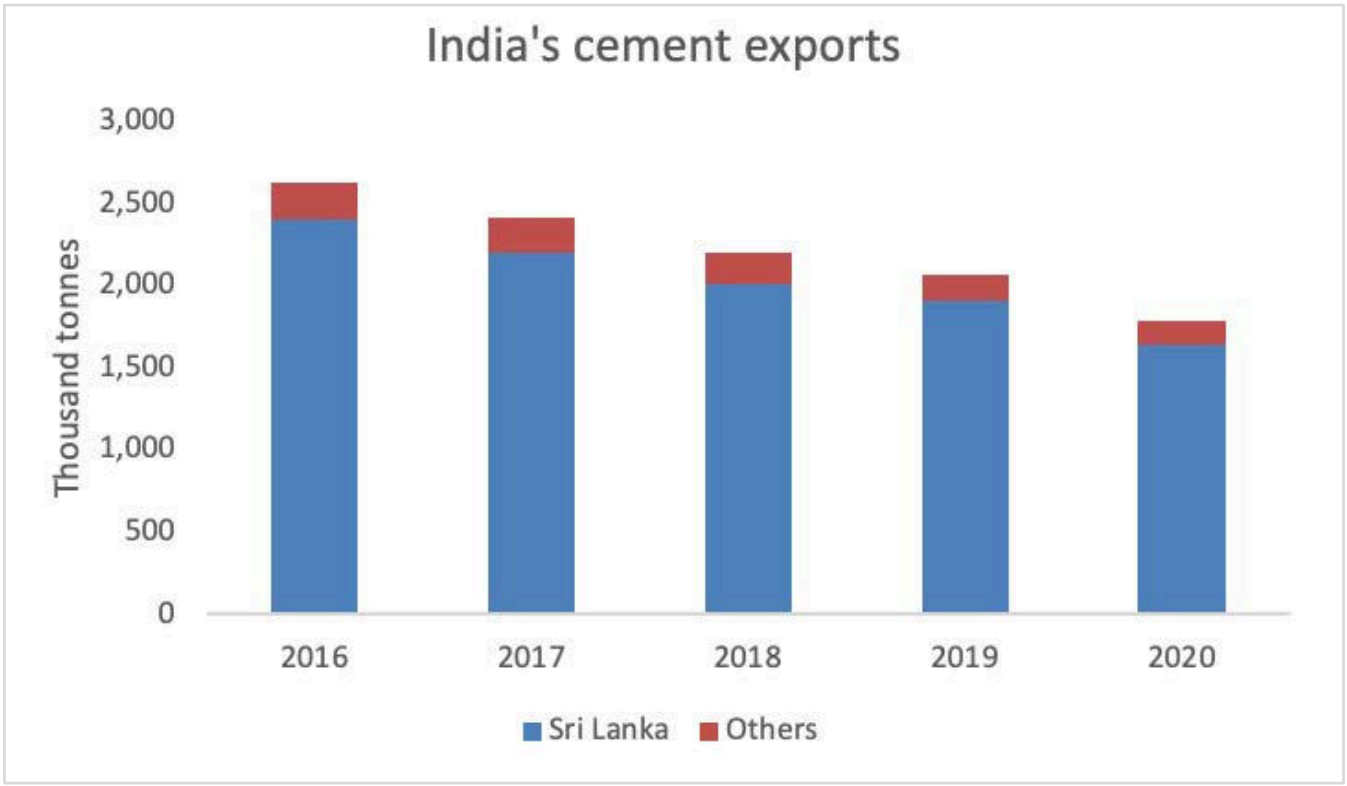


Source: Drewry Maritime Research

On the other hand, India's only significant export destinations for clinker as well as for cement has been Sri Lanka. Meanwhile, India's exports of both the commodities have declined considerably over the years as its domestic demand has kept on growing.

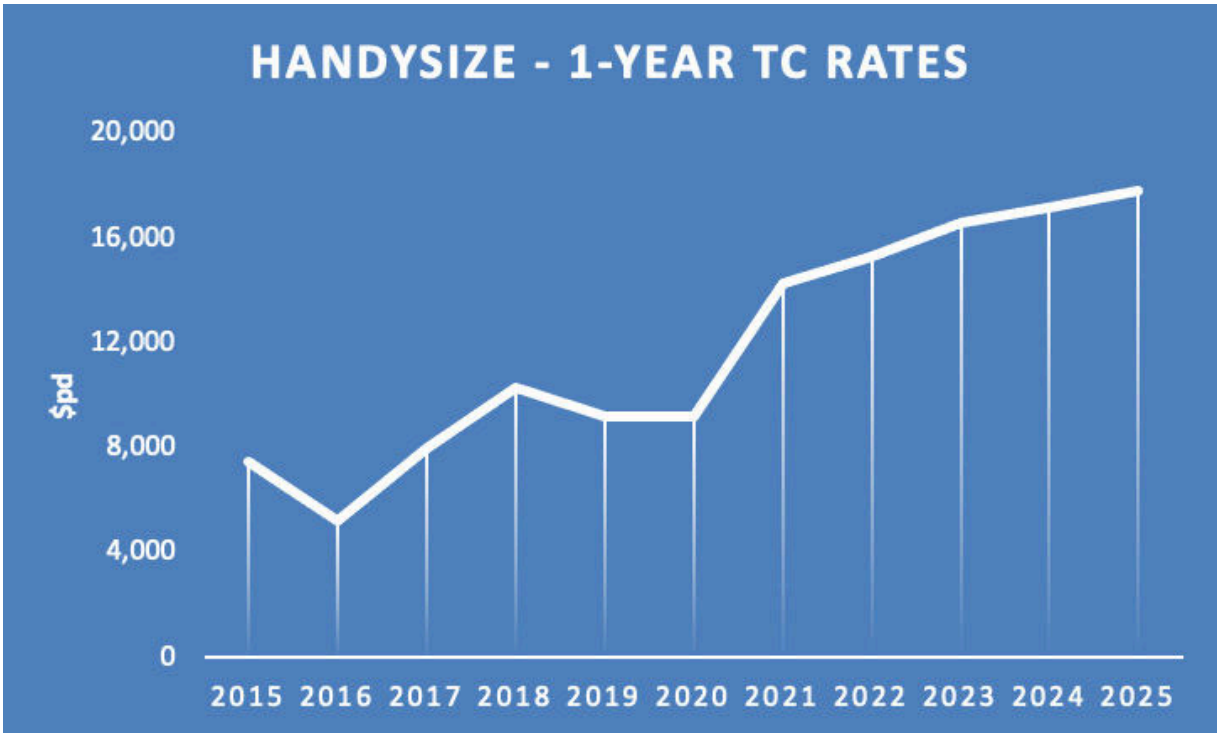


Source: Drewry Maritime Research



Source: Drewry Maritime Research

On the supply side, the dry bulk fleet will expand by 2.1% in 2021 which is half of the growth rate of 4.2% registered in 2020. The fleet growth will further taper down to 1.5% and 1.4% in 2022 and 2023 due to softening new deliveries. A low growth in fleet expansion will mean that the supply of dry bulk vessels will expand slowly compared to demand for these vessels, eventually increasing the utilisation which would support the charter rates.



The annual average of 1-year TC rates of a five-year-old 35,000 dwt Handysize vessel is expected to reach to $14,300 pd in 2021, compared with $9,200 pd in 2020. On the continent transatlantic route, the rates could surge even higher to $15,900 pd in 2021 from the average of $8,200 pd in 2020.

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